United States Patent Office 3,597,258
Patented Aug. 3, 1971

3,597,258

METHOD OF SCREENING A CATHODE-RAY TUBE

Howard G. Lange, Arlington Heights, and Song Whan So, Chicago, Ill., assignors to Zenith Radio Corporation

No Drawing. Filed Aug. 21, 1968, Ser. No. 754,458
Int. Cl. H01j 31/20
U.S. Cl. 117—33.5 4 Claims

ABSTRACT OF THE DISCLOSURE

The image area or screen of a color cathode-ray tube receives by electrophotographic deposition deposits of various phosphor materials arranged thereover in a regular interlaced pattern. Thereafter, the screen area is recharged to develop an electric field for holding the phosphor deposits in place. Next, a fixer, comprising a carrier liquid and a resinous binder partially in solution and partially in suspension, is applied to the screen. The fixer has a high electrical volume resistivity to the end that the charge on the coated area is retained, causing the electric field to resist the tendency of mechanical forces incident to the application of the fixer to displace the individual phosphor deposits from their assigned positions.

BACKGROUND OF THE INVENTION

The invention is addressed to electrophotographic screening of cathode-ray tubes and concerns most particularly an improved method of screening which is especially beneficial where it is contemplated that the screen be backed by a conductive layer having the property of specular reflection. In this sense, the invention is directed to filming, that is, preparing the screen to receive such a conductive backing layer.

Electrophotographic screening of a color cathode-ray tube is, at this juncture, known to the art and is highly attractive. Included in its benefits are a most conservative utilization of phosphor material, a shortened processing time, and adaptability to such improved screen characteristics as black surround. One disclosure of an eminently satisfactory electrophotographic screening process, including recitals of the materials involved, is the subject of an application Ser. No. 481,316, filed Aug. 20, 1965 in the name of Howard Lange, now U.S. Letters Pat. 3,475,169, issued Oct. 28, 1969, and assigned to the same assignee as the present invention. Since that application has a full disclosure of the processing steps and formulations of the various materials required, this application will refer to them only generally, incorporating the details of the early application by reference.

It is common practice in the fabrication of color television tubes to back the formed screen with a metallic layer that is specularly reflective to achieve a consequent increase in light output. Such a layer must obviously be permeable by the electrons of a scanning beam and is usually maintained at a potential corresponding to that of the final anode of the tube. This has come to be known in the art as aluminizing the screen since the backing layer is generally formed of aluminum. A number of processes are known for aluminizing although applying the backing layer to an electrophotographically deposited screen presents certain problems that are not encountered, for example, in slurry screening. The subject invention is particularly concerned with minimizing certain of those problems to facilitate screening of an aluminized color cathode-ray tube.

Accordingly, it is an object of the invention to provide a novel method of screening the image area of a cathode-ray tube.

It is a very particular object of the invention to provide an improved method of screening an aluminized color cathode-ray tube.

SUMMARY OF THE INVENTION

In accordance with the invention, the method of screening the image area of a cathode-ray tube comprises initially coating that area with a conductive layer and a superposed photoconductive layer and then uniformly charging the coated area. Thereafter, phosphor material is electrostatically deposited on the coated area following which that area is recharged. The recharging develops an electric field for holding the phosphor deposits in place. Finally, a fixer is applied to the coated area after the recharging. The fixer comprises a binder and a carrier liquid that has a high electrical volume resistivity so that the charge on the coated area is not dissipated too quickly. Retaining the charge, sustains the electric field and resists any tendency that mechanical forces incident to the application of the fixer may exert to displace the phosphor deposits on the coated area.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The organization and sequence of performance of the steps of the inventive method, together with further objects and advantages thereof, may best be understood by reference to the following detailed description.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Of course, the screening method of the inevntion is useful whether the image area of the picture tube is uniformly coated with phosphor material as in a monochrome tube or receives deposits of various phosphor materials in selected elemental positions of the area that are interlaced or interleaved in a regularly repeating pattern, such as is characteristic of a color tube. For convenience, the description will proceed on the basis of screening a shadow mask color tube with a multiplicity of dot triads each of which includes a dot of green phosphor, a dot of red and a dot of blue phosphor.

Electrophotographic screening lends itself most readily to the processing of color tubes simply because the envelopes of such tubes are sectionalized and the various components are initially separate from one another although they are designed to be mated into a single envelope structure by frit sealing or the like. One principal component of the envelope is the faceplate section which is rather like a flanged disc. The first process step in screening that section is to have the faceplate made chemically clean after which the image or screen area thereof is covered with a conductive layer of an organic material which is not adversely attacked by other materials employed in the screening process and which is readily removable through heat treatment when the screen shall have been formed. A water solution of polyvinyl alcohol and a humectant such as choline chloride is suitable. The polyvinyl alcohol is available under the trade name 52–22 Elvanol marketed by Du Pont.

A photoconductive layer is then deposited over the conductive layer. It must also be readily removable through heat treatment and must be resistant to the other materials, such as developers and fixers, that are used in the remainder of the screening process. A suitable material for the photoconductive layer is polyvinyl carbazole sensitized with anthraquinone and benzoic acid.

Having prepared the screen area with these layers and having dried them, the next step is to raise the entire area to a uniform charge level. This is accomplished by any well known form of corona discharge device. The polarity of the charge is of no particular consequence. It is usually dictated by the developer that is to be employed and by the preference as between direct and indirect imaging. For direct imaging purposes the polarity of the surface charge

of the screen area is opposite that of the developer, whereas for indirect imaging they are the same polarity.

The charged area now receives phosphor material through electrostatic deposition. To deposit the green phosphor electrostatically, for example, in assigned elemental areas of the screen, the shadow mask is installed within the faceplate under process and the screen is exposed to actinic radiation from a source positioned to simulate the beam of the electron gun that is to excite the green phosphor dots. This exposure creates a latent charge image of the screen areas assigned to green and, after the exposure step and after removal of the shadow mask, a developer or toner is flowed over the screen area to develop the latent image. The developer is a carrier liquid in which green phosphor in particulate form and of a mean particle size of 5 microns is suspended. The developer may also have a binder ingredient and a resin is suitable for that purpose. However, this binder may not hold the phosphor sufficiently fast to withstand subsequent process steps, such as filming, and is to be augmented by the teaching of the present invention in a manner presently to be described. The toner may further include a surfactant to facilitate establishing the polarity desired for the developer. The application of the developer causes the green phosphor to be deposited in the elemental screen areas assigned to that color. The charge effects of the screen and the developer are responsible for the selective depositing of the phosphor over the screen and permit the phosphor to remain in place as the excess developer is poured off. This screening process is repeated twice more; once for the application of red and once for the application of blue phosphor. The process steps are generally the same, it being only necessary to adjust the position of the source of energy for exposure to correspond with the assignment of elemental image areas to the various color phosphors.

Up to this point the screening process is that which is disclosed and claimed in the aforementioned Lange application. It has been found that some difficulty may be experienced in filming such a screen, where filming is the known technique of establishing a suitable organic layer over the coated screen preparatory to receiving the aluminum layer. In particular, the phosphor deposits may tend to be displaced or shifted on the screen in the following processing steps because their adherence to the screen is insufficient to resist mechanical forces exerted on the phosphor dots as other materials, such as the fixing and filming solutions, are introduced into the faceplate section under process. Of course, displacement of the dots even if it be a slight amount is most undesirable and this processing difficulty is obviated or substantially minimized in accordance with the present invention which introduces the step of recharging the coated area after the phosphors have been deposited in place and before the application of a fixing solution. The screen area bearing the phosphor deposits may easily be recharged through the use of a corona discharge device in essentially the same way that the photoconductive layer was initially brought to a condition of uniform charge. The recharging step may establish a charge of the same or opposite polarity to that originally given to the photoconductive layer but it simplifies matters if the screen is recharged to the same polarity as occurred in the first charging step. The phenomenon of recharging causes an electric field to be established across the phosphor deposits and the photoconductive layer and the effect of that field is to hold the deposits in position on the photoconductor.

The screen is now conditioned for the application of a fixer the purpose of which is to strengthen the mechanical adherence of the phosphor deposits to the photoconductive layer. The fixer comprises a carrier liquid and a binder which may be soluble in the carrier liquid or may be suspended therein in fine particulate form. Preferably, the binder is partially in solution and partially in suspension in the carrier liquid. The fixer is chosen to exhibit high electrical volume resistivity. If the liquid has low resistivity, the charge on the screen resulting from the recharging step will dissipate and a condition then may ensue which may lead to displacement of the phosphor deposits through mechanical forces incident to the application of the fixer solution. On the other hand, where the liquid has a high resistivity the charge is retained at least long enough to hold the phosphors securely in position as the fixer solution is introduced and the phosphor deposits receive an application of the binder ingredient.

As stated above, it is preferable that the binder be partially in solution and partially in suspension in the carrier liquid and have a particule size that is small compared with the average particle size of the phosphor material. Where this specification is satisfied, particles of resin may deposit in the interstices or voids which typify the surface condition of an electrostatically deposited phosphor area and otherwise cause it to exhibit a roughness which makes it difficult to prepare the screen for aluminizing. If the fixer does convey resin particles in suspension, these particles tend to smooth the phosphor coated surface and improve matters with respect to filming. After the fixer has been applied, it is permitted to dry. Evaporation of the carrier liquid leaves a residue of binder material which serves mechanically to fasten or attach the phosphor dots to the underlying photoconductive layer. In the case of insoluble resin particles in suspension, a suitable solvent vapor or heat could be used to soften the particles and bind the phosphor to the photoconductive layer. The carrier liquid of the fixer must not significantly dissolve the photoconductive layer and should have a resistivity in the range of 10^{12} ohm centimeter or greater. Suitable materials for the carrier include Shell Sol 71 marketed by the Shell Oil Company; as well as Isopar C, Isopar G, and Isopar H marketed by the Humble Oil and Refining Company. Other petroleum products of an aliphatic hydrocarbon nature are also acceptable. Indeed, many of the liquids used in toner or developer compositions in electrophotographic screening have the desired characteristics and may be utilized.

The resin binder materials include straight chain hydrocarbon resins in which considerable cyclic, but no aromatic structures, are present such as Piccopale 85SF; and styrene homolog copolymers, completely saturated, aromatic resins such as Piccotex 100; and terpene polymers such as Piccolyte S–135, all of which materials are distributed by Pennsylvania Industrial Chemical Corporation. By way of a specific example, a 5% partial solution of Piccotex 100 in Shell Sol 71 is a very acceptable fixing agent because of its resistivity value of 10^{16} ohm-cm. and its attractive wettability by emulsion films.

Having thus fixed the phosphor deposits in position and bound them mechanically by the binder ingredient of the fixer, the screen is now ready for the additional step of filming. This is simply the forming of a film of volatilizable material over the coated area preparatory to the formation of the aluminized backing layer. This may be accomplished by the application of a resin filming solution or an emulsion film to form an overcoat on the phosphor deposits. A particularly attractive filming process is described and claimed in a copending application Ser. No. 697,609, filed Jan. 15, 1968 in the name of Lester E. Schniepp and assigned to the assignee of the present invention. The disclosure of that application is addressed particularly to solving the problem of filming an electrostatically deposited screen and the process thereof is suitable for the film forming step of the process under consideration. After the film has been applied, the screen may be aluminized and heat treated in the usual way.

While a particular embodiment of the invention has been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

We claim:

1. The method of screening the image area of a cathode-ray tube which comprises the following steps:

coating said image area with a conductive layer and with a superposed photoconductive layer;

uniformly charging said coated area;

electrostatically depositing phosphor material on said coated area;

thereafter recharging said coated area to develop an electric field for holding said phosphor deposit in place on said coated area; and

applying to said coated area, after the recharging thereof, a fixer which comprises a binder of the class which includes straight chain nonaromatic hydrocarbon resins having cyclic structures and a carrier liquid which has a high electrical volume resistivity of at least 10^{12} ohm centimeter so that the charge on said coated area is retained and said electric field resists any tendency of mechanical forces incident to the application of said fixer to displace said phosphor deposit from position in said coated area.

2. The method in accordance with claim 1 for screening a color cathode-ray tube;

which includes the step of electrostatically depositing a plurality of different phosphor materials in a series of assigned interlaced portions of said coated area; and

the step of recharging said coated area after said plurality of phosphor materials has been deposited.

3. The method in accordance with claim 2 for screening a color cathode-ray tube;

which includes the additional step of forming a film of volatilizable material over said coated area after the application of said fixer and preparatory to the formation of an electron permeable, specularly reflective, and conductive backing layer over said coated material.

4. The method of screening the image area of a cathode-ray tube in accordance with claim 1 which includes:

the step of uniformly charging said coated area to a given polarity preparatory to electrostatically depositing said phosphor material, and

the step of uniformly recharging said coated area to the same polarity after said phosphor material has been deposited on said coated area.

References Cited

UNITED STATES PATENTS

3,475,169	10/1969	Lange	96—1.5X
3,489,556	1/1970	Drozd	96—1.5X
3,489,557	1/1970	Lange et al.	96—1.5X

ALFRED L. LEAVITT, Primary Examiner

W. F. CYRON, Assistant Examiner

U.S. Cl. X.R.

96—1.5; 117—93.4