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3,489,556

PROCESS OF ELECTROSTATICALLY SCREENING COLOR CATHODE-RAY TUBES

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No Drawing. Filed Mar. 16, 1966, Ser. No. 534,633

Int. Cl. G03g 7/00, 13/00, 5/00

U.S. Cl. 96—1

6 Claims

ABSTRACT OF THE DISCLOSURE

A method of electrostatically screening the cap section of a color cathode-ray tube is disclosed. The cap is coated with a conductive material and is then coated with a photoconductive material. Phosphor particles are then deposited by a charge, expose, develop process. The photoconductive layer is pretreated by either rinsing with a polymeric, non-ionic surfactant solution or by uniform exposure to actinic radiation.

The present invention is directed to the processing of color cathode-ray tubes by means of electrophotography, more particularly, by a technique that has come to be known as electrostatic screening.

A process of electrostatically screening color tubes is described and claimed in a copending application, Ser. No. 481,316, filed Aug. 20, 1965 in the name of Howard G. Lange, and assigned to the assignee of the present invention. It directs that the panel or faceplate of the tube be coated on its inner surface with a conductive layer and a superposed photoconductive layer. Thereafter, the photoconductive layer is subjected to a corona discharge and brought to a highly charged condition after which the photoconductive layer is exposed to actinic light through the color selection mask of the tube. As a consequence, the photoconductive layer exhibits areas that are fully charged and interspersed areas that have lost their charge per force of the exposure. This may be said to create a charge image on the photoconductive layer which may be developed by the application of a toner. If the toner is a vehicle carrying phosphor of one of the primary colors, the image or pattern of that particular color phosphor is developed and, of course, this will be a pattern of dots if the exposure has been through the aperture mask characteristic of currently available color tubes. This same general process, if performed three times with suitable allowance being made for the position of the exposing light source, establishes dot patterns of the several phosphors interspersed on the faceplate of the tube and defining the now familiar dot triads.

The present invention is an improvement over the development described in the Lange application and concerns itself most particularly with improving the quality of the dots i.e. shape, size and density.

Accordingly, it is an object of the invention to provide an improved process for electrostatically screening the image area of a color cathode-ray tube.

It is another object of the invention to provide an improved process of electrostatically screening such a tube to achieve a desired regularity in dot configuration and/or more uniformity in dot size and density.

In accordance with the invention, a process of electrostatically screening the image area of a color cathode-ray tube comprises applying over the image area a layer of conductive material, then a layer of a photoconductive material, and pretreating the photoconductor to establish a substantially uniform reference charge condition therein. Thereafter a charge image is developed in the photoconductive layer. To that end, the photoconductor is sub-

jected to a corona device which creates a uniformly high charge over the photoconductor and then selective portions thereof are discharged to establish a latent charge image which, upon development, constitutes the pattern of dots of a particular color phosphor.

In accordance with one aspect of the invention, the photoconductive layer is pretreated by a rinse with a surfactant. In accordance with another aspect of the invention, pretreatment of the photoconductive layer is accomplished by pre-exposure with actinic energy. Preferably, the photoconductive layer receives both of these pretreating steps. Where a prerinse is employed, it may be applied after the photoconductor has been selectively exposed but prior to the development of the charge image.

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.

A color cathode-ray tube lends itself to electrostatic or electrophotographic screening since the envelope is a two piece structure having a screen or cap section and a companion funnel or cone section. The cap may be likened to a flanged dish and it may have any desirable cross section but is usually round or rectangular. The cone has the same cross section as the cap and is dimensioned so that its large end may fit precisely with the free end of the flange of the cap section to facilitate their integration by frit sealing. The opposite or small end of the cone accommodates the neck of the tube which houses the electron gun or guns for generating scanning electron beams. Since this application is addressed to screening, the remaining description will be confined to processing the cap section in order to establish a tri-color screen of the dot triad type.

The cap section and in particular the inner surface thereof which constitutes the image area of the tube is first made chemically clean in any well known manner and is then provided with a conductive layer which has a resistivity less than 10^{10} ohms per square unit and preferably less than 10^8 ohms per square unit; the lower the resistivity the better. A suitable material for the conductive layer comprises a polymer of a predominant amount of a vinylbenzyl quaternary ammonium compound as described in U.S. Patent 3,011,918, issued Dec. 5, 1961 to Lloyd H. Silvernail et al. Such a material is available commercially from the Dow Chemical Company under the trade designation QX-2611.7. A quantity of this material diluted with water is spin coated over the panel of the tube in process at a speed of about 60 r.p.m. to apply a uniform coating of approximately 0.003 inch thickness over the entire screen surface. This layer is dried with heat.

The next step in the screening process is the application over the image area of a layer of a photoconductive material superposed on the conductive layer. A formulation for this layer which has been successfully employed is as follows:

	ML.
10% solution of polyvinyl carbazole in monochlorobenzene	150
0.154% solution of anthroquinone in monochlorobenzene	30
10% slution of a plasticizer in monochlorobenzene	20
Monochlorobenzene	460

A commercial form of polyvinyl carbazole is obtainable under the designation M-170 from Badische Anilin & Soda Fabrik A.G. A suitable commercially available plas-

ticizer is Plastolein 9066 LT marketed by Emery Industries, Inc.

The photoconductive layer may be applied by spinning, flowing, spraying or the like and the desired viscosity may be obtained by the amount of monochlorobenzene employed. This layer may have a thickness of approximately 0.0003 inch and is preferably air dried.

Having formed the photoconductive layer, the next process step is pretreating that layer to establish a substantially uniform reference charge condition therein. This may be accomplished by a prewash or rinsing the layer with a surfactant preferably the same surfactant solution that is used in the toner employed in developing the charge image to be considered presently. Of course, the surfactant must be compatible with the screening process; in particular, it must not be a solvent for the photoconductor. A formulation for a prerinse that has been successfully employed is as follows:

	ML.
Trifluorotrichloroethane (Freon TF) -----	100
10% solution of a surfactant in Freon TF -----	.5

A suitable surfactant is a polyol as described in U.S. Patent 2,674,619, issued Apr. 6, 1954, and a particularly useful one for the present invention is available commercially under the designation L101 Pluronic marketed by Wyandotte Chemical Company, having a molecular weight of 3250 and containing 10% of polyoxyethylene in the total molecule. After the rinse, the photoconductive layer is air dried and the pretreatment of the photoconductive surface is now completed.

Another prerinse formula that has proved satisfactory is 100 ml. of an aliphatic hydrocarbon such as Shell Sol 71 and 0.5 ml. 1% Pluronic L101 in Freon TF.

The remainder of the screening process may be in accordance with any of the procedures disclosed in the aforesaid Lange application. Briefly, a corona charging device is placed in close proximity to the photoconductive surface and energized to establish a uniform high charge over the photoconductive layer to condition the layer for the establishment of a charge image. If the color tube is of the dot triad type, the charge image is established by exposing the charged photoconductive layer to actinic light through the shadow mask. This exposure takes place in a lighthouse with a source of actinic energy or light that is positioned to simulate the center of deflection of the electron gun that is to energize the phosphor elements of the particular color instantaneously being applied and a correcting lens may be interposed in the optical system to compensate for possible errors of registration of the beam relative to the phosphor elements as disclosed in Patent 3,003,874, issued Oct. 10, 1961 in the name of S. H. Kaplan.

For convenience, it will be assumed that the first exposure is for the green phosphor and the light source is, therefore, positioned to simulate the green electron gun of the tube. The portions of the photoconductive layer upon which the actinic light impinges are discharged, that is to say, these areas of the photoconductor lose the charge they have previously been given, whereas the other areas of that layer retain their charged condition. As a consequence of the exposure, there is established on the photoconductive layer a latent negative charge image of the elemental areas of the screen that are to be assigned to green.

The next step is the development of that image with a developer or toner comprising a carrier liquid, green phosphor and a surfactant which preferably is the same as that employed in the rinse of the pretreating step of the process. The surfactant is selected to establish a charge on the phosphor particles which is of the same polarity as the charge of the photoconductive layer so that the phosphor ingredient of the developer is rejected from the charged portions of the layer and deposited in the uncharged areas. In this fashion, the deposit of green phosphor

dots takes place and they may be fixed by heat or a fixing agent as described in the Lange application.

The panel in process is now ready to receive the second series of color phosphor dots and essentially the same process is repeated. Of course, it is not necessary to reapply the conductive and photoconductive layers since they will have been retained throughout the processing of the green phosphor and remain in a condition to be charged once more by the corona device preparatory to establishing the charge image necessary for the next phosphor application. While it is not necessary, it is desirable to pretreat the photoconductive layer before processing with the second color phosphor. After the second family of phosphor dots has been deposited, with the light source suitably displaced to represent another of the electron guns of the cathode-ray tube, the process is repeated to form the dots of the third color phosphor. Once more, pretreatment of the photoconductive layer is not essential but is desirable prior to processing for the third series of color phosphor dots.

The mechanism by which the pretreating rinse improves the image producing qualities of the photoconductive layer is not understood but the efficacy of the pretreatment is apparent from comparative results. Without pretreatment, the size and quality of the phosphor dots for the various colors may change with each exposure of the panel even though the same exposure time and intensity is used in screening for each color. Most frequently, without employing the present invention, the dots of the first color phosphor applied are undersized and less dense than the dots of the second and third color phosphors. It may be postulated that the photoconductive layer robs some of the surfactant from the toner employed in processing the first color phosphor and this is overcome by the prerinse since the solvent of the rinse evaporates leaving a surface layer of surfactant. It is found that the pretreatment of the photoconductive layer increases both the size and density of the dots of the first color phosphor and leads to uniformity of the size and density of the dots for all three colors.

Instead of a prerinse as just described, the photoconductive layer may be exposed to actinic energy to establish the desired uniform reference charge condition. For example, the photoconductive layer formed of the composition set forth above is sensitive to ultraviolet light and a uniform pre-exposure to ultraviolet light, before the layer is subjected to the corona device preparatory to establishing a charge image, has much the same effect as the prerinse in that it causes the photoconductive layer to have a reference charge condition. The pre-exposure is particularly effective in cleaning up the background, that is to say, the portions of the photoconductive layer which intervene the dots of the first applied phosphor. Here again, the operative effect of the pre-exposure is not thoroughly understood but it is expected that this results in establishing the electrons of the photoconductive layer in a more uniform energy state than is otherwise the case. This reference charge condition of the photoconductive layer prevents scattering of the phosphor and improves the background e.g. the regularity of dot shape. In practicing this type of pretreatment, use has been made of four 20 watt black light lamps supported about 12 inches above the tube panel in process and with an exposure of the layer for 30 seconds.

The photoconductive layer may be subjected to both pretreatment steps and this is the preferred process of the invention. In practicing this embodiment, the photoconductive layer is first rinsed with a solution containing the surfactant and is then subjected to pre-exposure with actinic light. This is found to increase the size and density of the first applied color dots leading to uniformity of these characteristics, and also, a prevention of phosphor spreading which yields a clear background or improved dot shape.

Still further improvement may be realized if the photo-

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toconductive layer is precharged just before its pre-exposure. For this purpose, the corona device employed in charging the layer preparatory to establishing the charge image may be used to bring the photoconductor to a uniform initial charge.

Experience has also proved the feasibility of a pre-rinse that may be used without requiring any discrete drying time. The formulation is as follows:

	MI.
High boiling aliphatic hydrocarbon (such as Shell Sol 71) -----	100
Polypropylene glycol 2010 (Wyndotte Chemical Co.) -----	0.002

In the use of this rinse, the electrostatic process is carried out in the customary fashion through the charging and exposing steps to establish a latent charge image on the image area of the tube panel. At this time, the panel is rinsed with the prerinse solution and while still wet it is treated with a developer to develop the latent image.

Of course, all three pretreatment steps of rinsing, pre-charging and pre-exposure may be adopted in the electrostatic screening process.

Illustrative formulations for the conductive and photoconductive layers and for suitable developers are set forth in the aforesaid Lange application, Serial No. 481,316. These matters constitute no part of the present invention and need not be repeated here.

While particular embodiments of the invention have 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.

I claim:

1. In the process of electrostatically screening the image area of a color cathode-ray tube, in which a conductive layer and a superposed photoconductive layer are applied to said area and in which a plurality of different phosphor materials are deposited seriatim upon respective and non-overlapping portions of said photoconductive layer by electrostatic deposition in which said photoconductive layer is first charged and, for each of said phosphor materials, is then exposed by actinic energy through the color-selection electrode of the tube to establish a latent image of the deposition pattern for the phosphor material under process which image is thereafter developed by a toner including particles of the

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phosphor under process and a polymeric, non-ionic surfactant for establishing a charge of a predetermined polarity on said phosphor particles, the improvement which comprises:

5 rinsing said photoconductive layer, prior to the deposition of one of said phosphor materials, with a solution of said surfactant which is compatible with said photoconductive layer in that it does not adversely affect the physical or electrical properties of said layer.

10 2. The improvement in the process of electrostatically screening a color tube in accordance with claim 1 in which said photoconductive layer is further pretreated by uniformly exposing said layer to actinic energy.

15 3. The improvement in the process of electrostatically screening a color tube in accordance with claim 2 in which said photoconductive layer is sensitive to ultraviolet light and in which said layer is pretreated by uniform exposure to ultraviolet light.

20 4. The improvement in the process of electrostatically screening a color tube in accordance with claim 2 in which said photoconductive layer is further pretreated by initially charging said layer to a predetermined charge level and then uniformly exposing said layer to actinic radiation to establish a reference charge condition therein.

25 5. The improvement in the process of electrostatically screening a color tube in accordance with claim 1 in which said photoconductive layer is pretreated by uniformly exposing said layer to actinic radiation after rinsing with said surfactant.

30 6. The improvement in the process of electrostatically screening a multi-color cathode-ray tube in accordance with claim 1 in which said photoconductive layer is pretreated after the development of the image of the deposition pattern for one of said phosphor materials and prior to establishing a charge image representing the deposition pattern for another of said phosphor materials.

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U.S. Cl. X.R.

50 96—1.2, 1.5; 117—37, 33.5, 17.5; 313—92