United States Patent

[11] 3,615,459

[72] Inventor **Sam H. Kaplan**
Chicago, Ill.

[21] Appl. No. **773,833**
[22] Filed **Nov. 6, 1968**
[45] Patented **Oct. 26, 1971**
[73] Assignee **Zenith Radio Corporation**

[54] **METHOD OF SCREENING A COLOR IMAGE REPRODUCER**
6 Claims, 1 Drawing Fig.

[52] **U.S. Cl.** **96/36.1,** 96/29, 96/45, 111/33.5, 313/109
[51] **Int. Cl.** **H01j 9/22**
[50] **Field of Search** 96/36, 36.1, 29, 35; 117/33.5; 313/109

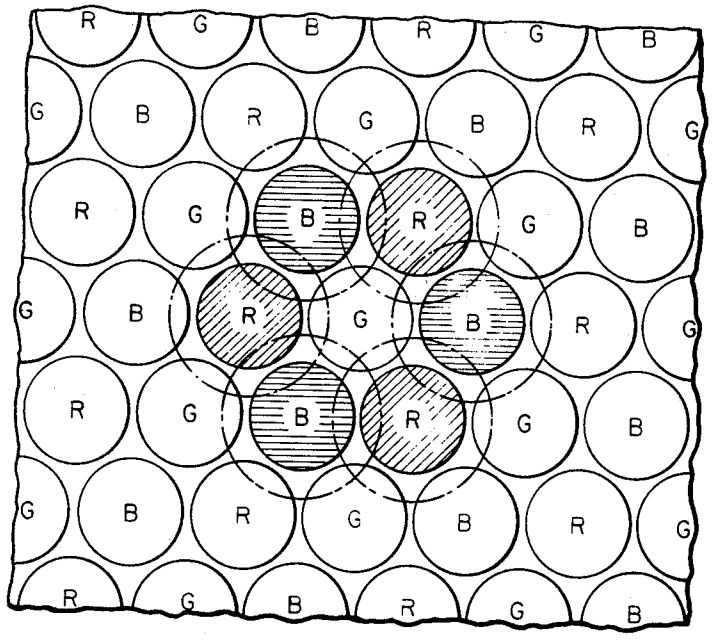
[56] **References Cited**

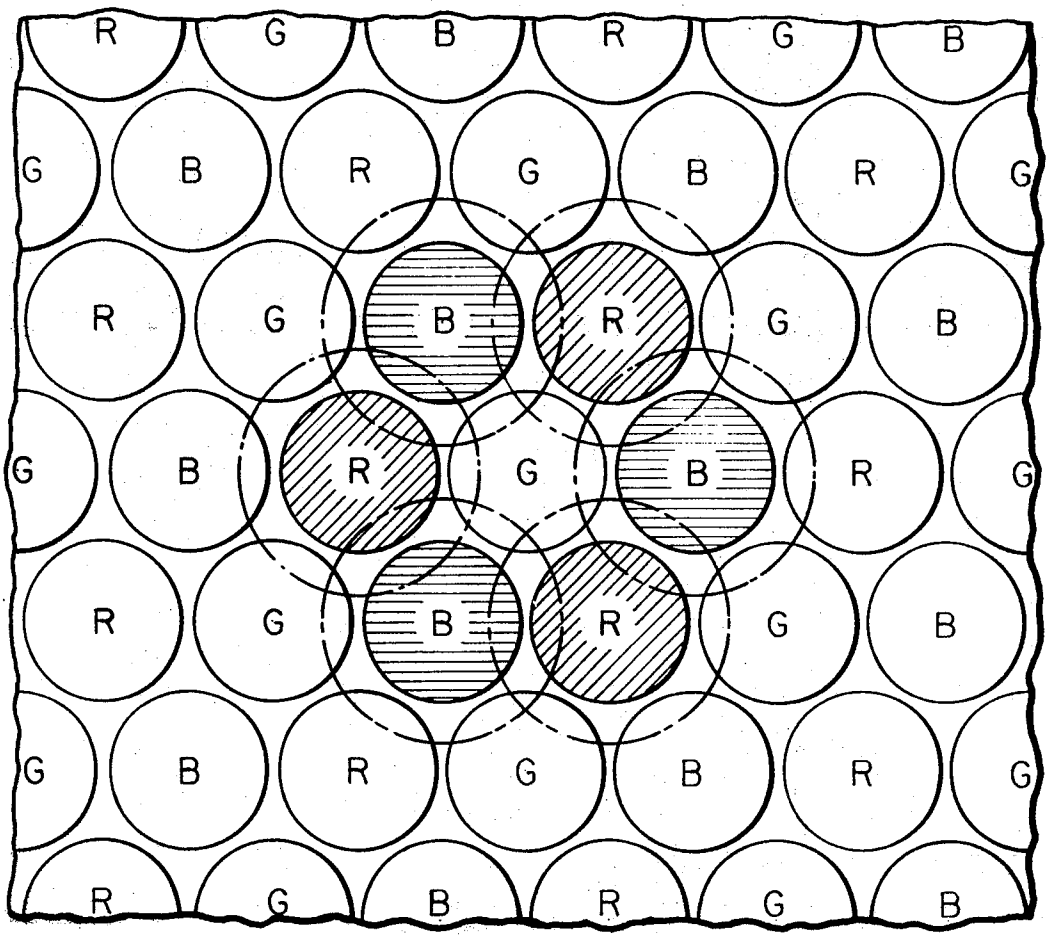
UNITED STATES PATENTS

3,146,368	8/1964	Fiore et al.	96/36.1
3,152,900	10/1964	Kaus et al.	96/36.1
3,365,292	1/1968	Fiore et al.	96/36
2,961,314	11/1960	Amdursky et al.	96/36.1

Primary Examiner—William D. Martin
Assistant Examiner—William R. Trenor
Attorney—Francis W. Crotty

ABSTRACT: The faceplate section of a tricolor cathode-ray tube of the shadow mask type is coated with a photosensitive layer and is exposed through the shadow mask from positions of the light source that represent two of the three colors. For example, in screening the green phosphor, the exposure is made with the light source positioned to simulate the red and the blue electron guns. The exposure interval is extended so that the unexposed elemental areas of the screen, the areas to receive the green phosphor, are made smaller in size than the apertures of the shadow mask, this control of size taking advantage of the penumbra effect. Thereafter, the unexposed elemental areas of the screen are developed in green phosphor. In similar fashion, the screen is coated with red and blue phosphor materials.





Inventor
Sam H. Kaplan
By Francis W. Crosby
Attorney

METHOD OF SCREENING A COLOR IMAGE REPRODUCER

BACKGROUND OF THE INVENTION

The present invention is directed to a method of coating the screen of a color image reproducer, such as a cathode-ray tube, with a plurality of at least three different phosphor materials.

While the method is of general application, it is especially advantageous in the fabrication of color tubes that require the elemental phosphor deposits to be smaller in size than the transparent portions of the color selection electrode. More specifically, where the tube is of the three-color shadow mask variety, it is necessary that the phosphor dots forming the dot triads conventionally screened on such a tube be smaller than the apertures of the shadow mask where the tube employs either postdeflection focus or black surround-type construction. Each of these features is attractive.

Postdeflection focusing has the advantage of focusing the electron beams to the end that more electrons are permitted to impinge upon the elemental phosphor areas of the screen than otherwise and this leads to enhanced brightness. Black surround, on the other hand, is the expression used to define a color tube in which the elemental phosphor dots are surrounded by a light absorbing material, such as manganese dioxide. This material greatly improves the contrast of the picture tube and has the further benefit of obviating the need of a darkened or filter-type implosion plate. By rendering the filter unnecessary, black surround likewise substantially increases the brightness of the color tube. A picture tube having the black surround property is described and claimed in U.S. Pat. No. 3,146,368, issued Aug. 25, 1964 to Joseph P. Fiore et al. and a particularly attractive method for establishing the black surround is the subject of U.S. Pat. No. 3,365,292, issued Jan. 23, 1968 to the same inventors, both such patents being assigned to the assignee of the present invention.

Difficulty has been experienced heretofore in screening a shadow mask tube to have phosphor dots smaller in size than the apertures of the shadow mask. One approach, described in U.S. Pat. No. 3,152,900, issued to P. E. Kaus et al. on Oct. 13, 1964, features the use of a ring-type light source. The faceplate is first coated with a photosensitive resist bearing a phosphor and of such nature that it becomes soluble when exposed to actinic energy whereas otherwise it is insoluble. Projecting an image of the ring light source onto an elemental area of such a screen leaves a small dot of material that is insoluble and the image of that dot may be developed by washing the screen in a solvent after exposure. Some control of the size of the dot is available by controlling the duration of the exposure interval. This would appear to be an acceptable method of screening except for the fact that the desired annular shape of the light source is truly experienced only at those areas of the screen which are essentially along the longitudinal axis of the tube. Because of the geometry of the arrangement, including the curvature of the faceplate and the fact that the light source is not positioned at the center of curvature, an elliptical distortion is encountered which manifests itself in a similar distortion of the phosphor deposits, especially at the edges of the screen. An improvement in the exposure process of this method, which obviates such elliptical distortion, is described and claimed in a copending application of Howard Lange, Ser. No. 755,156 filed Aug. 26, 1968 and assigned to the assignee of this invention.

Another approach to this problem is one in which the apertures of the mask are temporarily reduced in size as by coating the mask with a glue or partially filling the mask openings with a metal that may subsequently be removed, say, by etching. The mask with its apertures reduced in size is used in laying down phosphor dots in the usual way so that the desired small-sized dots are realized. Thereafter, the apertures are opened to the normal size in which case the desired size of elemental dots, smaller than the apertures of the shadow mask, shall have been attained.

It would be desirable to achieve the required dot size without suffering elliptical distortion introduced by the use of simple annular exposure light source and without the need for complicating the mask structure by having it present one-sized aperture for screening purposes and another for color selection. Such an objective is obtainable with the present invention.

Accordingly, it is an object of the invention to provide a novel method of coating the screen of a color image reproducer, such as a cathode-ray tube, with at least three different phosphor materials.

It is a particular object of the invention to provide a method of screening such a tube to attain elemental phosphor deposits which are smaller in size than the color selection electrode.

More specifically, it is an object to provide a new method of screening a shadow mask type of color tube with phosphor dots that are smaller than the apertures of a shadow mask.

SUMMARY OF THE INVENTION

The method of the invention is for coating the screen of a color image reproducer, such as a cathode-ray tube, with a plurality of at least three different phosphor materials for selective energization by a corresponding plurality of electron beams having access to the screen through the transparent portions of a color selection electrode. In accordance with the method there is formed over the screen a layer of a material having a surface characteristic that is subject to change in response to impingement by actinic energy. All of the screen is exposed with actinic energy through the color selection electrode, except those elemental areas assigned to a particular one of the phosphor materials, and the exposure interval is selected to cause the excepted areas to be smaller in size than the transparent portions of the color selection electrode. Finally, the unexposed or excepted elemental areas of the screen are developed in the aforesaid particular phosphor material to the exclusion of the exposed areas of the screen.

DESCRIPTION OF THE DRAWINGS

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 by reference to the following description taken in connection with the accompanying drawing, the single FIGURE of which shows an enlarged fragmentary portion of the screen of a tricolor cathode-ray tube processed in accordance with the subject invention.

DESCRIPTION OF PREFERRED EMBODIMENT

Color picture tubes have been proposed in which the screen is an interlaced repeating pattern of phosphor dots that may occur in groups of three or four. Where three dots constitute the group or triad, the members of the triad are deposits of green, red, and blue phosphor materials. Where there are four elements to a group, the fourth is generally a deposit of white phosphor. The first described arrangement is the more popular in commercial use and, for convenience, is the one that will be described in detail although either may be screened by the present invention.

In addition to the choice of the number of different phosphor materials employed, the configuration of the elemental phosphor deposits is also subject to a variety of forms but usually the deposits are stripes or dots. While both are well known and may be formed using the invention, it is convenient to focus attention of the dot configuration since that is the one used with the currently popular shadow mask type of color picture tube.

The envelope of such a tube has a cap portion which is normally separate from the remaining part of the structure which facilitates screening. The faceplate is screened in accordance with the method of the present invention by first forming over the screen a layer of material having a surface characteristic that is subject to change in response to impingement by actinic

energy. Here again, a choice is available depending on the nature of the screening process desired to be employed. Two general forms are known; in one the screen is coated with a photosensitive material or resist having a solubility in a solvent that is readily changed by exposure to actinic energy. In the other, the coating of the screen is first a conductive layer and then a superposed photoconductive layer which is uniformly changed and is selectively discharged in response to the impingement of light.

Let it be assumed initially that the layer applied to a clean faceplate as the first step of the screening process is a so-called positive photosensitive material, here the expression "positive" is intended to define material which is rendered soluble upon exposure to ultraviolet light whereas otherwise it is insoluble. Photosensitive positive working materials having this property are well known, for example, AZ resists which are available from the Shipley Company of Newton, Mass. It is also convenient to include phosphor in particulate form as an ingredient of the coating composition.

After the entire screen area has been covered with a layer of such material and after that layer has been permitted to dry, the screen is exposed with actinic energy through the color selection electrode or shadow mask. It is necessary to expose the entirety of the screen except the elemental areas thereof assigned to the particular phosphor material included in the coating that is being exposed. For simplicity, let it be assumed that the coating includes green phosphor in which case the other elemental areas of the screen assigned to blue and red phosphors are to be exposed. This is easily accomplished through the well known exposure chamber of lighthouse having a source of ultraviolet light and a suitable collimator by means of which the light is directed to the screen through the apertures of the shadow mask. In the first exposure step, the light source is positioned to simulate the electron gun of the tube that is assigned to excite the blue phosphor and this results in exposure of all elemental areas of the screen that are to receive a deposit of blue phosphor. Following this first exposure step, a similar step is undertaken differing from the first only in that the light source is now positioned to simulate the electron gun of the tube that is assigned to excite the red phosphor. As a consequence, all elemental areas of the screen to receive a deposit of red phosphor shall have been exposed. Mechanically, these two exposures are easily achieved by arranging that the point light source is mounted for displacement between three positions each of which simulates one of the three guns of the picture tube. In screening with green phosphor, the light source is positioned to simulate the red and blue guns as stated above. Alternatively, the light source may be fixed in position and the faceplate with its shadow mask may be angularly adjustable.

The conditions of the screen at this juncture will be more easily understood by reference to the drawing. In this FIGURE, each of the circles designated B represents the initial image of the light source upon the coated screen area with the light source simulating the electron beam assigned to excite the deposits of blue phosphor. Similarly, the circles designated R indicate the images projected on the screen through the shadow mask with the light source simulating the gun assigned to energize the red phosphor. It will be observed that each circle or elemental area designated G is surrounded by similar elemental areas alternately designated R and B. The dash-dot circles around each of these latter areas represent that the exposed elemental areas R and B, giving due regard to the penumbra effects of the light source, are sufficiently large if the exposure is made adequately long to partially overlap the elemental area G that these areas R and B surround. Collectively, they cause the nonoverlapped portion of the surrounded elemental area G to have a hexagonal configuration with the hexagon inscribed within the circle designated G. In short, the exposure interval is selected to cause the unexposed area G to be smaller in size than the transparent portions or apertures of the shadow mask which, for convenience of representation in the drawing, may be thought to be of essentially the same size as the crosshatched circles R and B. In other words, the unexposed elemental area G within the hexagonal outline is indeed smaller than the apertures of the shadow mask and this is true for all similarly designated elemental areas of the drawing even though, for convenience, the drawing has been developed simply to show this decrease in size for a single elemental area G located centrally of the fragmentary portion of the screen. By way of further example, if the coating composition be Shipley Resist AZ-111 in the amount of 75 percent, having green phosphor suspended therein in the amount of 25 percent, an exposure interval in the order of 8 minutes will produce small-sized green phosphor dots.

The next step of the process is to develop in the green phosphor the elemental areas G of the screen that have not been exposed. This is done simply by washing the screen in a solvent for the photosensitive coating after the aforedescribed two exposure steps. The washing develops an image of the unexposed elemental areas of the screen to the exclusion of the exposed areas which, per force of the nature of the photosensitive material, are soluble in the solvent and, therefore, wash off in the developing step. The process of the invention thus far establishes over selected elemental areas of the screen deposits of green phosphor in areas that are smaller in size than the apertures of the shadow mask.

In similar fashion deposits of blue phosphor are established by first coating the screen with a photosensitive composition including blue phosphor as an ingredient and exposing elemental screen areas R and G. Again, control of the exposure time permits controlling the size of the deposits of the blue phosphor. In like fashion, the deposits of red phosphor are made and the screening, at least so far as the phosphor materials are concerned, shall have been completed. Obviously, if the exposure intervals in processing each of the three colors are the same, than the deposits of the various phosphor materials are approximately of the same dimension although they may be weighted, should that be desired, by variations in the exposure times devoted to processing with the various phosphors.

It will be apparent from the drawing, especially the portion depicting a green phosphor element of hexagonal configuration that in screening with any given phosphor all of the material is removed from the screen except for the deposits in the elemental screen areas assigned to the phosphor in process and the elemental areas of the various phosphors may be separated from one another over the screen. This permits utilization of black surround and if that is desired the light-absorbing material may now be deposited in the spaces between the elemental phosphor-coated areas in accordance with the disclosures of the aforeidentified Fiore et al. patents. The remaining processing of the screen is conventional, including filming of the phosphor deposits and aluminizing. Since these portions of the screening process constitute no part of the present invention, they will not be described further.

Where the screening is electrophotographic or electrostatic, the process is similar to that described although the coating of the faceplate, as stated above, is initially a conductive layer and a superposed photoconductive layer. Having charged the coated screen to a uniform level, it is exposed twice and in each exposure step elemental areas of the screen are discharged and the discharge area is controlled in size by the duration of the exposure interval. In other words, a situation fully equivalent to that represented in the drawing and discussed above is established by screening electrophotographically. In this case, however, the central and unexposed elemental area G has retained the charge initially established on the photoconductive layer whereas the surrounding and exposed elemental areas B and R shall have become discharged. The charged elemental area is now developed in the appropriate phosphor by flowing over the screen a developer or toner which comprises a carrier liquid having the phosphor material in suspension and a binder such as a resin. The developer may also have a surfactant to facilitate establishing

a charge for the developer such that it is attracted to the unexposed area G to the exclusion of the exposed elemental areas R and B. In this way, the image is developed in the appropriate color. Details of electrophotographic screening of this type are disclosed in a copending application of Howard Lange, Ser. No. 481,316, filed Aug. 20, 1965, now U.S. Pat. No. 3,475,169 issued Oct. 28, 1969, and assigned to the assignee of the present invention. The photoconductor layer may be formed from a 5 percent solution of polyvinyl carbazole in chlorobenzene, charged to approximately −600 volts, and exposed for an interval of about 10 seconds in practicing the invention.

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. The method of coating the screen of a color image reproducer with at least three different phosphor materials arranged in an interlaced pattern with a deposit of any one phosphor surrounded by like deposits of the remaining phosphors for selective energization by at least three electron beams having access to the phosphor deposits of said screen through transparent portions of a color selection electrode, which method comprises the following steps:

forming over said screen a layer of material having a surface characteristic that is subject to change in response to impingement by actinic energy;

exposing two sets of elemental areas of said pattern, assigned to two of said phosphor materials and surrounding a third set of elemental areas of said pattern assigned to a third one of said phosphor materials, with actinic energy from two sources which simulate the sources of those of said electron beams assigned to excite said two phosphor materials and which direct actinic energy to said two sets of elemental areas through said transparent portions of said color selection electrode for an exposure interval of such duration that the portions of said layer that experience a change in said surface characteristic because of said exposure, overlap one another and reduce said elemental areas of said third set to a size that is smaller in area than said transparent portions of said color selection electrode, thereby to create in said layer a latent image of said third set;

and developing in said one phosphor said latent image of said third set of elemental areas of said pattern.

2. The method of screening in accordance with claim 1 in which the material of said layer is light sensitive and its solubility in a predetermined solvent is a function of its exposure to actinic energy;

and in which said latent image is developed by treating said screen with said solvent subsequent to said exposure.

3. The method of screening in accordance with claim 2 in which said color selection electrode is a shadow mask, in which said transparent portions thereof comprise a field of circular apertures, and in which said step of exposing said screen through the apertures of said mask causes elemental portions of said layer which are circular in configuration and individually larger in diameter than the individual apertures of said electrode, to experience a change in solubility in said solvent and causes the size of the elemental portions of said layer that do not experience a change in solubility to be smaller than the size of the apertures in said mask.

4. The method of screening in accordance with claim 1 in which the material of said layer is photoconductive;

which includes the step of uniformly charging said photoconductive layer;

and in which the step of exposing said screen discharges said photoconductive layer except the portions thereof that cover said third set of elemental areas assigned to said particular phosphor material;

and in which said image is developed by applying a toner, having said particular phosphor as an ingredient, to said photoconductive layer.

5. The method of screening in accordance with claim 1 in which said two sets of elemental areas are exposed, seriatim, by their respective sources of actinic energy.

6. The method of screening in accordance with claim 1 in which the material of said layer is light sensitive, includes said third phosphor material as an ingredient, and is rendered soluble in a particular solvent in response to exposure to actinic energy;

and in which said latent image is developed by washing said screen in said solvent subsequent to its exposure to actinic energy.