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METHOD OF FABRICATING IMAGE DISPLAY SCREENS

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This invention relates to image reproduction devices and more particularly to a method of forming screens for such devices.

Image display screens of the type adapted to be employed in color television apparatus generally comprise a transparent viewing panel having a large number of discrete patterns formed thereon. Each pattern may consist of bars, dots or stripes of red, green and blue color fluorescing materials. A screen of this type may be fabricated by a photographic printing technique wherein a photosensitive material is used to bind the fluorescent material to the panel. In such a process, the transparent viewing panel is first coated with a thin film of a photosensitive substance and a fluorescent material. The panel is then exposed to light through an appropriate negative to cause the photosensitive substance to harden and adhere to the panel. Those portions of the screen which are not exposed to light are subsequently removed by dissolving the substance with a suitable solvent. This procedure is repeated for each fluorescent material pattern used in the display device to complete formation of the fluorescent screen.

An image display device of the type described above may use an aperture mask or grid which is positioned behind the screen for the purpose of masking, deflecting or focusing the electron beam or beams employed in the device. The electrons are directed to pass through the mask or grid apertures to impinge upon the appropriate color fluorescing material areas. During operation of the device, a given percentage of the electrons in the beam strike the surfaces of the grid which define the apertures, and are deflected therefrom in random directions toward the screen. In addition to these deflected primary electrons, a considerable number of secondary electrons are emitted from the mask or grid surfaces due to bombardment by the primary electrons, some of which also proceed toward the mask from random directions. Impingement upon the screen of these deflected primary and secondary emissive electrons, which have a lower velocity than the directly impinging primary electrons, tends to desaturate the reproduced color image. Such an effect is more noticeable on a color field produced by a low efficiency color fluorescing material such as one of the red phosphor materials, zinc phosphate. In this instance, de-saturation occurs when the random electrons strike screen areas other than the desired areas, such as those covered by green and blue phosphor materials, to cause dilution of the red field. Since it is the aim of television manufacturers to provide means for reproducing a color image having the same color characteristics as the transmitted image, any observable de-saturation of one or more of the color fields is highly undesirable.

Accordingly, it is an object of the invention to reduce color de-saturation in an image display device.

A further object is to improve the fabrication of image display screens.

The foregoing objects are achieved in one aspect of the invention by the provision of a process for making image display screens which utilizes the addition of a fluorescent material or phosphor "poisoning" agent to reduce the surface efficiencies of pre-selected ones of the fluorescent materials used to form the screen. The lower

velocity electrons in the display device will not penetrate into the "poisoned" phosphor crystals sufficiently far to cause excitation thereof. However, the high velocity primary electrons will penetrate the crystals to provide normal illumination. By selectively lowering the surface efficiencies of the phosphors, a reduction in color de-saturation can be achieved.

Briefly, the screen pattern may be produced by a photographic printing operation wherein the viewing panel of the display device is coated with a light hardenable substance and an appropriate phosphor. Subsequently this coating is exposed to light through a mask or negative having the desired bar, dot or stripe configuration. This exposure operation causes the coating to harden and adhere to the viewing panel. The unexposed portions of the coating are then removed from the panel by washing with a suitable solvent for the light hardenable substance. The above described process may be repeated for each color fluorescing material used in the screen, with proper offsetting of the negative relative to the light source during each exposure operation.

The phosphor "poisoning" agent may be applied to the phosphor material before application in the screening process, or it may be introduced at some stage in the process. For instance, the light hardenable material may serve as a carrier for the agent, or it may be applied as a separate step after one or more of the fluorescent material patterns have been formed to selectively lower one or more of the phosphor surface efficiencies. It has been found advantageous to heat the screen after this treatment to aid in the diffusion of the "poisoning" agent into the surface of the phosphor crystals.

The fluorescent materials employed in the screen may be any type of electric field and/or electron-responsive inorganic material such as those formed from sulfides, oxides, tungstates, aluminates, borates, selenides, phosphates or silicates of one or more metals included in the group of zinc, cadmium beryllium, magnesium, manganese, calcium, strontium and others well known in the art. These materials may be activated by such metals as silver, copper and manganese.

The photosensitive or light hardenable substance used in the process may comprise any well known formulation which is rendered non-dispersible or substantially insoluble after being exposed to light. Among the materials suitable for use in the production of image display screens are photographic gelatins, polyvinyl alcohol, polyvinyl pyrolidone, polyvinyl acetate, etc. sensitized with such substances as ammonium, potassium or sodium dichromates, monomeric type dye-sensitized polymers, and a variety of lacquers such as Kodak Photosensitive Lacquer (KPL) and Kodak Photoresist (KPR), which have incorporated therein a volatile sensitizer.

The solvent or developing fluid used to dissolve the unexposed portions of the light hardenable material is dependent upon the particular photosensitive substance employed. For instance, an organic solvent such as trichlorethylene or a ketone may be used with commercial photosensitive lacquers and with polyvinyl acetate whereas other substances such as polyvinyl alcohol are soluble in water.

The phosphor "poisoning" agent employed in the process may include one or more of the metals included in the group comprising iron, cobalt, or nickel. The application of these metals may be made in the form of a salt solution e.g. sulfates, chlorides, nitrates, etc. of the metals.

In detail, one process for forming image screens employing phosphors with pre-selected surface efficiencies utilizes the application of a water solution of a light hardenable substance such as polyvinyl alcohol sensitized with ammonium dichromate to the transparent viewing

panel to form a thin tacky coating thereover. A first fluorescent material such as the green phosphor, zinc orthosilicate, which may be in powdered form, is then deposited upon the coating by a dusting operation. This phosphor adheres to the tacky surface of the sensitized polyvinyl alcohol coating. If desired, the phosphor and sensitized alcohol may be applied to the panel together in the form of a slurry. An aperture mask, grid or other type of appropriate pattern negative which will produce the desired array of dots, bars or stripes is then positioned relative to the coated panel to shadow those portions of the coating which are intermediate the desired green phosphor pattern configuration. Subsequently, the coated panel is exposed through the negative to light emanating from a point source. The exposed portions of the polyvinyl alcohol are hardened by the light and thereby adhere to the viewing panel to provide a binding agent for the phosphor. The pattern is thereafter developed by washing the panel with a suitable solvent such as deionized water, which removes the unexposed portions of the polyvinyl alcohol and phosphor.

In order to lower the surface efficiency of the zinc orthosilicate phosphor, the panel is then washed with a "poisoning" agent such as a water solution of ferric nitrate ranging in concentration from .1 percent to .00005 percent by weight. The iron, or any of the other "poisoning" agents mentioned above, tend to decrease the surface efficiency of practically all of the known phosphors.

After the panel has been washed with ferric nitrate, it is again coated with a layer of polyvinyl alcohol and a blue fluorescing material such as zinc sulfide. The panel is then exposed to light through the negative to harden the coating in accordance with the form and position of the desired blue phosphor pattern relative to the previously formed green phosphor pattern. Offsetting the light source and the negative relative to one another during exposure provides proper displacement of these patterns. The unexposed portions of the coating are again removed by application of a solvent such as deionized water, and the remaining coating is subsequently rinsed with the ferric nitrate solution to lower the efficiency of the blue phosphor also.

The image display screen is completed with the application of polyvinyl alcohol and a red color fluorescing material such as zinc phosphate, followed by exposure and development operations. During the exposure operation, the light source and negative are again off-set from one another so that a screen may be produced having a large number of triads of green, blue and red color fluorescing dots, bars or stripes. Since most of the presently known red fluorescent materials have a lower efficiency than the green or blue fluorescent materials, and since color de-saturation is more noticeable on the least efficient color field, the red phosphor pattern is not subjected to the ferric nitrate treatment. Therefore, by using the process described above, the green and blue phosphor surface efficiencies are reduced while the red phosphor efficiency is not altered.

Accordingly, during operation of the image display device, any low velocity electrons impinging upon the screen will not excite the green and blue phosphors, and de-saturation of the red color field will be minimized. However, high velocity primary electrons will excite the green and blue phosphors in the normal manner so that there will be no loss in image brightness. Due to the relatively low efficiency of presently available red phosphors, any excitation thereof by low velocity electrons has practically no observable de-saturation effects on the other color fields.

The "poisoning" agent used in the process may be applied in a manner other than that which is described above. For instance, the phosphor crystals can be coated with the agent prior to their application to the panel, or the light hardenable material may have the iron, nickel or cobalt incorporated therein. It is to be understood that any screen forming process which selectively lowers the surface efficiency of one or more phosphors is contemplated as being within the scope of this invention, and that "poisoning" agents may be applied to any or all of the phosphors in concentrations sufficient to minimize color de-saturation.

As a final step in the screen forming process, the panel may be baked above 400 degrees centigrade to remove volatile impurities which exist in the face panel and in the screen forming materials, and to aid in the diffusion of the ferric nitrate into the surface of the phosphor crystals.

Although several embodiments of the invention have been shown and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. In a process of making an image display screen on the viewing panel of an image reproduction device, the steps comprising forming on the panel discrete areas of a given color fluorescing material having a given electron excitable light output efficiency level, surface treating said given fluorescing material by washing with from .1 to .00005% by weight of a solution of a salt of a metal selected from the group consisting of iron, cobalt and nickel, removing any of said solution remaining after surface treatment forming on the panel discrete areas of another color fluorescing material having an electron excitable light output efficiency level lower than said given fluorescing material level, and heating the panel to induce diffusion of said metal into the surface only of said given color fluorescing material to selectively reduce the surface light output efficiency thereof.

2. In a process of forming an image display screen on the viewing panel of an image reproduction device, the steps comprising depositing upon the panel a layer of a given color fluorescing material having a given electron excitable light output efficiency level and a solution of a light hardenable substance containing an additive of from .1 to .00005% by weight of a salt of a metal selected from the group consisting of iron, cobalt and nickel, said solution coating the given fluorescing material to provide surface treatment thereof, exposing given discrete areas of said given material layer to light whereby the exposed areas become hardened and adhere to said panel, removing the unexposed portions of said given material layer, depositing upon the panel a layer of another color fluorescing material having an electron excitable light output efficiency level lower than said given level and a light hardenable substance free from said additive, exposing discrete areas of said other fluorescing material layer to light whereby the exposed areas thereof become hardened and adhere to said panel, removing the unexposed portions of said other fluorescing material layer, and heating the panel to induce diffusion of said metal into the surface only of said given material to selectively reduce the surface light output efficiency thereof.

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