

PATENT SPECIFICATION

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(54) A METHOD OF FORMING THE FLUORESCENT SCREEN OF A COLOUR CATHODE RAY TUBE

- (71) We, HITACHI LIMITED of 1-5-1 Marunouchi, Chiyoda-ku, Tokyo, Japan, a body corporate organized according to the laws of Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- The present invention relates to a method of forming a fluorescent screen of a colour cathode ray tube.
- It is known that a commercial colour picture tube for colour television receiving, or a colour kinescope as it is sometimes called, is a cathode ray tube which includes a viewing screen having a multiplicity of red-emitting, green-emitting and blue-emitting phosphor elements. These three colours are known as the primary colours. These elements are usually arranged on the screen of a faceplate panel of the tube in a regular array. In a colour cathode ray tube having a colour selecting mask, the phosphor elements are usually dots, or strip pieces arranged in groups of threes or triads. Each triad is associated with a particular perforated aperture in the colour selecting mask (also called a mask).
- Recently, it has been preferable to use a colour cathode ray tube whose screen comprises a light absorbing matrix lying in the space between the phosphor elements.
- Depositing the phosphor elements on the screen of the colour cathode ray tube presents difficult problems in manufacture. One useful processing technique involves the covering of the entire screen with the phosphor of one of the primary colours, and a photosensitive resist. After the screen has been coated with such materials, it is placed in a so-called "lighthouse" in which a high intensity light exposes the screen through the mask that ultimately is assembled with the screen in the completed tube. By positioning the light source to simulate the action of an electron gun associated with the phosphor being processed, there is produced an exposure pattern which corresponds to the desired location of the elements of the phosphor being processed. After exposure, the screen may be developed (washing) to remove the unexposed coating and leave as a residue the phosphor elements of one of the primary colours.
- Repetition of the same general process enables elements of the other phosphors to be deposited although it will be understood that the coating in each step of the process includes a phosphor of a given colour and its exposure in the lighthouse is by means of a light source properly positioned, so as to simulate the electron gun assigned to that colour.
- This type of processing could be satisfactorily employed, except that there are certain difficult problems involving the adhesion of the elements to the faceplate panel of the tube. If the exposure time is lengthened, adhesion will be increased, but the undesired enlargement of certain of the phosphor elements will result.
- In a process for forming the light absorbing matrix on the faceplate panel, difficult problems equivalent to those of forming phosphor elements occur when preparing the removable elements, these elements being usually of photosensitive material. In this process the removable elements act to provide spaces in the light absorbing matrix. In other words, it is required that the removable elements be the same size as the phosphor elements to be formed, because the spaces in the light absorbing matrix determine the size and position of the phosphor elements of a completed fluorescent screen of the tube.
- Another exposure process technique (back exposure) has also been proposed. In this back exposure the screen is not only exposed from that side of the faceplate panel



bearing the coating, but also from the side of the faceplate panel opposite to that side which bears the screen coating. Since the back exposure increases to some extent, the effect of forward exposure through the mask, it may lessen the problem of poor adhesion in forward exposure but it may also introduce an undesired phosphor deposit on those portions of the screen onto which certain phosphor elements are to be deposited thereafter, thus resulting in the deterioration in colour purity of the phosphor elements. The back exposure may cause an undesired enlargement of the certain phosphor elements. Thus, this technique has been, as yet, impractical.

It is an object of the present invention to provide a method of forming a fluorescent screen of a colour cathode ray tube, which which overcomes, partially or wholly, some or all of the problems associated with the prior art discussed above.

According to the present invention there is provided a method of forming a fluorescent screen of a colour cathode ray tube or a method applied to the formation of a light absorbing matrix forming part of such a fluorescent screen, in which a photo-sensitive layer coated on an inner surface of a panel of the tube is made into a predetermined mosaic pattern by forward and backward exposure techniques, said method including the steps of:—

(a) coating a filter layer on an inner surface of the panel of the tube;

(b) coating a photosensitive layer over said filter layer;

(c) forwardly exposing said filter layer through a colour selecting mask to ultraviolet radiation for rendering the exposed portions of the filter layer transparent to visible radiation and for rendering the exposed portions of the photo-sensitive layer insoluble;

(d) backwardly exposing the photo-sensitive layer through the panel and the forwardly exposed portions of the filter layer to said visible radiation; and

(e) developing the photo-sensitive layer to remove all portions thereof except those which have been rendered insoluble, thereby providing said mosaic pattern.

The present invention will now be described in greater detail, by way of example, with reference to the accompanying drawings, wherein:—

Figure 1 is a schematic view of the exposure device for use with the method of the present invention;

Figure 2 is a sectional view of the light source means which is used in back exposure according to the present invention;

Figures 3 to 8 are cross-sectional schematic views representing various steps of the screening process pertaining to one

embodiment of the present invention;

Figures 9 to 15 are cross-sectional schematic views representing various steps of the screening process pertaining to another embodiment of the present invention; and

Figures 16 and 17 are cross-sectional views, which assist in the explanation of a further embodiment of the present invention.

Referring to Figure 1, the exposure device (lighthouse) utilized in the method of the present invention, comprises a housing 1 on which is positioned a faceplate panel 2 of a colour cathode ray tube to be manufactured. A mask 3 comprising a pattern of perforated apertures 4 is provided in the faceplate panel 2. The faceplate panel 2 has a coating 5, which comprises a filter coating and screen coating thereon. The pattern of perforated apertures 4 is projected onto the coating 5 by means of forward exposure means 6 which emits ultraviolet radiation 7. The coating 5 is also exposed through the panel 2 to visible radiation 8 from back exposure means 9. The exposure device includes a correction lens means 10, which ensures that the radiation 7 arrives at substantially the same angle to, and at the same point on the coating 5 as electrons would do, if said electrons had been emitted from a completed colour cathode ray tube.

Referring to Figure 2, a modified source means for back exposure comprises a concave reflecting surface 21 for reflecting the radiation emitted from the radiation source 22.

In the method of the present invention the desired portion of the screen coating is exposed through the filter coating interposed between the faceplate panel and the screen coating to particular actinic radiation of the back exposure. More specifically, a filter layer is coated on the inner surface of the faceplate panel. The layer is prepared from a mixture containing an organic die, for example a cyanic or azodye, a vehicle, for example nitrocellulose, and a solvent, for example acetone. After the coating has dried, the filter layer is opaque to actinic radiation whose wavelength is 4,000 to 5,000 angstroms being in the visible region of the spectrum, but the layer may be made transparent to such visible radiation by subjecting it to actinic radiation whose wave length is 3,500 to 4,000 angstroms being in the ultra-violet region of the spectrum. It has been found that this phenomenon is due to an action taking place between the ultra-violet ray and the cyanin radical present in the cyanin dyes or the azo radical present in the azo dyes. The cyanin dye is, for example, a dimethyl - dicarbocyanin - paratoluene - sulphonate, and the azo dye is, for example, a diazo-stilbene

or tetrazo-stilbene. The screen coating is coated on the filter layer. The screen coating is the compound of the slurry of phosphor of one of the primary colours, and a photo-resist comprising polyvinyl alcohol (PVA) and ammonium dichromate. Otherwise, in preparing a light absorbing matrix, the screen coating comprises a photo-resist without phosphor material. After the screen coating has dried, the coating is exposed through the mask to the ultra-violet radiation emitted from the forward exposure device. At the same time, the filter layer is exposed together with the selected portion of the screen layer, so that the exposed portions of the filter layer are made transparent to visible radiation. Then the screen layer is successively exposed through the faceplate panel, via the filter layer having portions transparent to the visible radiation emitted from the back exposure means. It is possible and practical to obtain the visible radiation from an incandescent bulb or a fluorescent lamp. The exposure time may be reduced by carrying out the forward exposure during the back exposure. It is also possible to start both exposures at the same time. After exposure, the screen layer is developed to remove the unexposed layer and leave as a residue the elements corresponding to one of the primary colours.

Repetition of the same general process from the step of coating of the slurry to the step of developing the screen layer, enables elements of the other phosphors to be deposited, although it will be understood that in each step of the process the coating includes a phosphor of a given colour and its forward exposure in the exposure device (lighthouse) is by means of a radiation source properly positioned to simulate the electron gun assigned to that colour.

The filter layer is then decomposed and vapourized by heat treatment, which will be described hereinafter:

Example 1

Referring to Figure 3, firstly the screen of the faceplate is chemically cleaned, if necessary. It is coated with a filter coating 31 on the inner surface of the faceplate panel 2. The filter coating comprises 0.5 percent by weight of dimethyl-dicarbocyanin-paratoluene-sulphonate, 3 percent by weight of nitrocellulose serves as the vehicle, and acetone serves as the solvent. It is preferable that the filter coating 31 is 1,000 to 4,000 angstroms thick. After the filter coating 31 has dried, it is coated with a slurry 32. The slurry comprises a phosphor of one of the primary colours and photo-resist such as the aqueous solution of polyvinyl alcohol (PVA) and ammonium dichromate.

Referring to Figures 4 and 5, after the slurry coating has dried, the coating is for-

wardly exposed through the holes 4 in the mask 3 to the ultraviolet ray 7. This exposure lasts for about three minutes with the intensity of illumination of 500 lux at the phosphor layer 32. The exposed portions 311 of the filter coating 31 are then transparent to the backward exposure radiation. Then, the phosphor layer 32 is backwardly exposed through the faceplate panel 2 and the transparent portion 311 of the filter coating 31 to the visible radiation 8. This back exposure lasts for about one minute with the intensity of illumination 2,000 lux at the phosphor layer.

Referring to Figure 6, after these exposures the screen is developed to remove unexposed portions of the phosphor layer 32, and leave as a residue the phosphor elements 321 of one of the primary colours.

Referring now to Figure 7, the same process from the step of coating with slurry to the developing step is used to produce phosphor elements 322 and 323 of the other primary colours. Referring to Figure 8, the completed fluorescent screen is obtained by decomposing the filter layer by the application of heat at 400 to 430°C.

A metal layer, such as aluminium, may be deposited on the fluorescent screen of the faceplate panel to form a metalized fluorescent screen.

Using the filter coating to prepare a light absorbing matrix on the screen will be now explained in Example 2.

Example 2

Referring to Figures 9 and 10, the screen of the faceplate panel may be chemically cleaned, if necessary. A similar filter layer 31 to that mentioned hereinabove, and a removable layer 91 of photo-resist of polyvinyl alcohol (PVA) and ammonium dichromate are prepared on the screen 2. The removable layer 91 is forwardly exposed through the holes 4 in the mask 3 to ultraviolet radiation 7. The exposed portions correspond to those positions where the phosphor elements need to be deposited. Forward exposure is also used for the other elements corresponding to other phosphors of the respective primary colours, the respective radiation sources being properly positioned to simulate the electron gun which would be assigned to that colour. Referring to Figure 11, after the forward exposures are completed, the removable layer 91 is backwardly exposed through the faceplate panel and the transparent portions 311 of the filter coating 31 to the visible radiation 8. Referring to Figure 12, the removable layer 91 is then developed to remove unexposed portions thereof and leave elements in the positions of the primary colour phosphors to be subsequently deposited. As shown in Figure 13, the light absorbing

coating 13, which has carbon black or graphite as a constituent, is coated on the screen. Referring to Figures 14 and 15, when the light absorbing coating is dry the screen is made porous with an aqueous solution of hydrogen peroxide to remove the removable elements 911 together with the light absorbing layer 13 lying on the removable elements 911 and to leave the light absorbing layer 131 as a residue forming a light absorbing matrix 16 with a plurality of holes 14 in which the phosphors are to be embedded. The suitable light absorbing matrix 16 is obtained by decomposing the filter coating by the application of heat at a temperature of 400 to 430°C.

The use of the filter coating to deposit phosphor elements on the screen provided with a light absorbing matrix will now be explained in Example 3.

Example 3

After the formation of a light absorbing matrix, the preparation of the filter coating and the deposition of phosphor of the primary colours are performed in the same way as described in Example 1. Referring to Figures 16 and 17, the filter coating 31 and photo-sensitive phosphor layer 32 of one of the primary colours are formed on the screen of the faceplate panel 2 provided with the light absorbing matrix 16, whose formation is not limited by the process described in Example 2. The photo-sensitive phosphor layer 32 is forwardly exposed through the holes 4 in the mask 3 to ultraviolet radiation 7 and then, backwardly exposed through both the faceplate panel 2 and the forwardly exposed portions of the filter layer 31 to a visible radiation 8. After the exposures, the photo-sensitive phosphor layer 32 is developed to remove unexposed portions of the photo-sensitive phosphor layer and leave as a residue the phosphor elements.

Using the same process of deposition for the other phosphors of the primary colours, there is obtained the completed light absorbing matrix type fluorescent screen in which respective phosphor elements 321, 322 and 323 of the primary colours are embedded in in spaces in the light absorbing matrix 16.

As may be appreciated, the back exposure is carried out by means of the filter coating selectively intercepting the radiation. Thus, the disadvantages of the methods of the prior art can be lessened and the advantages of back exposure can be enhanced. Thus, the emitted colours from respective phosphor elements are more realistic. Another advantage is that undesired enlargement of the phosphor elements can be avoided. Further, lower exposure times and good element adhesion is possible.

WHAT WE CLAIM IS:—

1. A method of forming a fluorescent screen of a colour cathode ray tube or a method applied to the formation of a light absorbing matrix forming part of such a fluorescent screen, in which a photo-sensitive layer coated on an inner surface of a panel of the tube is made into a predetermined mosaic pattern by forward and backward exposure techniques, said method including the steps of:—

(a) coating a filter layer on an inner surface of the panel of the tube;

(b) coating a photo-sensitive layer over said filter layer;

(c) forwardly exposing said filter layer through a colour selecting mask to ultraviolet radiation for rendering the exposed portions of the filter layer transparent to visible radiation and for rendering the exposed portions of the photo-sensitive layer insoluble;

(d) backwardly exposing the photo-sensitive layer through the panel and the forwardly exposed portions of the filter layer to said visible radiation; and

(e) developing the photo-sensitive layer to remove all portions thereof except those which have been rendered insoluble, thereby providing said mosaic pattern.

2. The method according to claim 1, wherein the steps (b) to (e) are repeated for each primary colour, the respective photo-sensitive layers containing predetermined amounts of phosphor material responsive to the three primary colours.

3. The method according to claim 1, wherein the step (c) is repeated three times; one for each primary colour before step (d), the photo-sensitive layer not containing any phosphor.

4. The method according to claim 1, wherein the filter layer includes an organic vehicle and an organic dye material.

5. The method according to claim 4, wherein said organic vehicle comprises nitrocellulose.

6. The method according to claim 1, 4 or 5, wherein the mosaic pattern of the photo-sensitive layer is used to form a light absorbing matrix layer.

7. A method of forming a fluorescent screen of a colour cathode ray tube or a method applied to the formation of a light absorbing matrix forming part of such a fluorescent screen, carried out in accordance with any one of the three examples herein described with reference to the accompanying drawings.

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coating 13, which has carbon black or graphite as a constituent, is coated on the screen. Referring to Figures 14 and 15, when the light absorbing coating is dry the screen is made porous with an aqueous solution of hydrogen peroxide to remove the removable elements 911 together with the light absorbing layer 13 lying on the removable elements 911 and to leave the light absorbing layer 131 as a residue forming a light absorbing matrix 16 with a plurality of holes 14 in which the phosphors are to be embedded. The suitable light absorbing matrix 16 is obtained by decomposing the filter coating by the application of heat at a temperature of 400 to 430°C.

The use of the filter coating to deposit phosphor elements on the screen provided with a light absorbing matrix will now be explained in Example 3.

Example 3

After the formation of a light absorbing matrix, the preparation of the filter coating and the deposition of phosphor of the primary colours are performed in the same way as described in Example 1. Referring to Figures 16 and 17, the filter coating 31 and photo-sensitive phosphor layer 32 of one of the primary colours are formed on the screen of the faceplate panel 2 provided with the light absorbing matrix 16, whose formation is not limited by the process described in Example 2. The photo-sensitive phosphor layer 32 is forwardly exposed through the holes 4 in the mask 3 to ultra-violet radiation 7 and then, backwardly exposed through both the faceplate panel 2 and the forwardly exposed portions of the filter layer 31 to a visible radiation 8. After the exposures, the photo-sensitive phosphor layer 32 is developed to remove unexposed portions of the photo-sensitive phosphor layer and leave as a residue the phosphor elements.

Using the same process of deposition for the other phosphors of the primary colours, there is obtained the completed light absorbing matrix type fluorescent screen in which respective phosphor elements 321, 322 and 323 of the primary colours are embedded in in spaces in the light absorbing matrix 16.

As may be appreciated, the back exposure is carried out by means of the filter coating selectively intercepting the radiation. Thus, the disadvantages of the methods of the prior art can be lessened and the advantages of back exposure can be enhanced. Thus, the emitted colours from respective phosphor elements are more realistic. Another advantage is that undesired enlargement of the phosphor elements can be avoided. Further, lower exposure times and good element adhesion is possible.

WHAT WE CLAIM IS:—

1. A method of forming a fluorescent screen of a colour cathode ray tube or a method applied to the formation of a light absorbing matrix forming part of such a fluorescent screen, in which a photo-sensitive layer coated on an inner surface of a panel of the tube is made into a predetermined mosaic pattern by forward and backward exposure techniques, said method including the steps of:—

(a) coating a filter layer on an inner surface of the panel of the tube;

(b) coating a photo-sensitive layer over said filter layer;

(c) forwardly exposing said filter layer through a colour selecting mask to ultra-violet radiation for rendering the exposed portions of the filter layer transparent to visible radiation and for rendering the exposed portions of the photo-sensitive layer insoluble;

(d) backwardly exposing the photo-sensitive layer through the panel and the forwardly exposed portions of the filter layer to said visible radiation; and

(e) developing the photo-sensitive layer to remove all portions thereof except those which have been rendered insoluble, thereby providing said mosaic pattern.

2. The method according to claim 1, wherein the steps (b) to (e) are repeated for each primary colour, the respective photo-sensitive layers containing predetermined amounts of phosphor material responsive to the three primary colours.

3. The method according to claim 1, wherein the step (c) is repeated three times; one for each primary colour before step (d), the photo-sensitive layer not containing any phosphor.

4. The method according to claim 1, wherein the filter layer includes an organic vehicle and an organic dye material.

5. The method according to claim 4, wherein said organic vehicle comprises nitrocellulose.

6. The method according to claim 1, 4 or 5, wherein the mosaic pattern of the photo-sensitive layer is used to form a light absorbing matrix layer.

7. A method of forming a fluorescent screen of a colour cathode ray tube or a method applied to the formation of a light absorbing matrix forming part of such a fluorescent screen, carried out in accordance with any one of the three examples herein described with reference to the accompanying drawings.

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