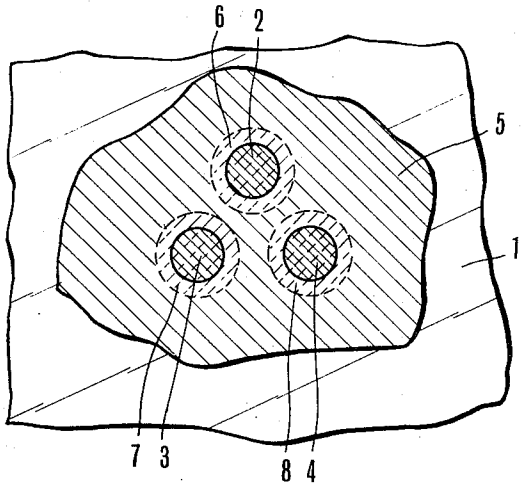
Sept. 5, 1972 TAKAO KAWAMURA 3,689,266

METHOD OF MANUFACTURING FLUORESCENT SCREENS OF COLOR PICTURE TUBES

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FIG. 1



INVENTOR

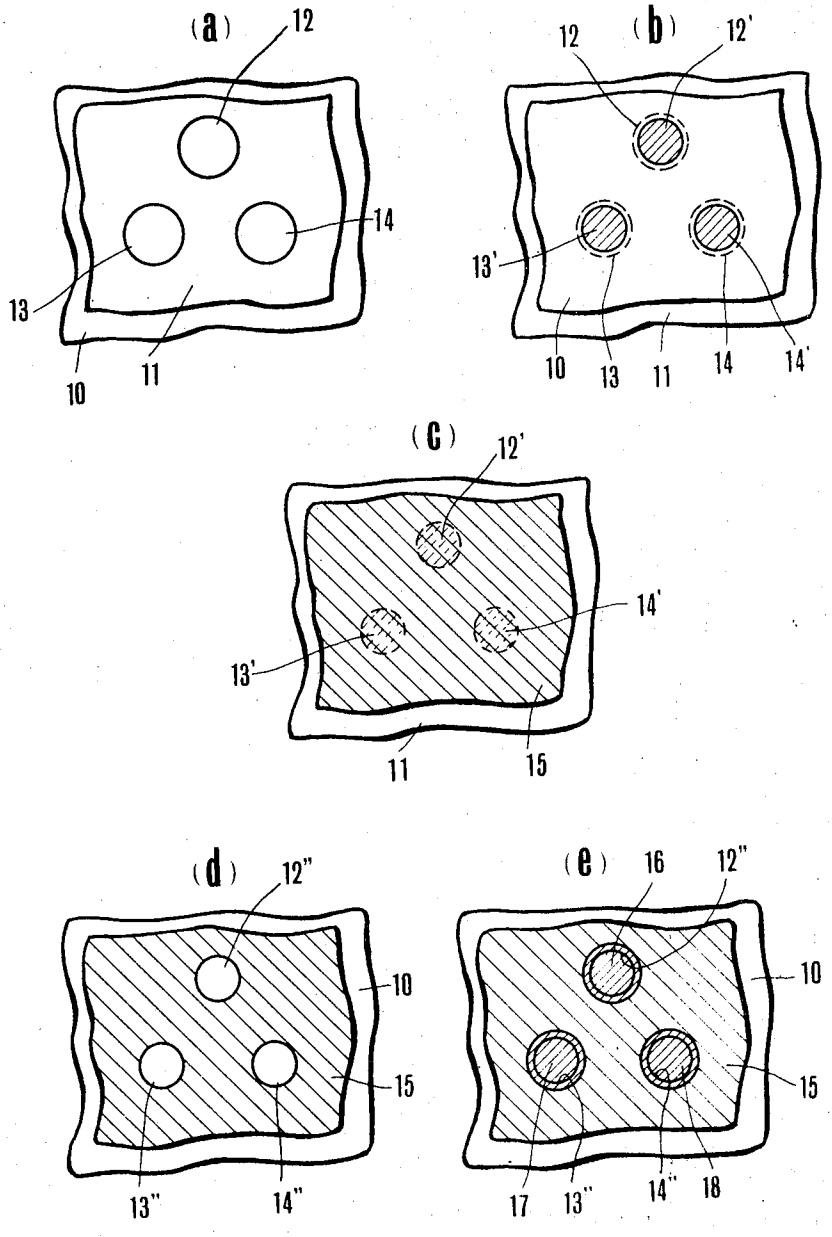
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FIG. 2



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3,689,266

METHOD OF MANUFACTURING FLUORESCENT SCREENS OF COLOR PICTURE TUBES

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U.S. Cl. 96—36.1 21 Claims

ABSTRACT OF THE DISCLOSURE

A fluorescent screen of a color picture tube is manufactured by the method of forming a photosensitive coating on the inner surface of a face plate of the picture tube; exposing the photosensitive coating to light through perforations of a shadow mask; removing portions of the coating that have been exposed to the light, thus leaving the spots of the coating that have been exposed to the light; shrinking the spots of the coating; applying a coating of a nonluminous substance over the entire area of the inner surface of the face plate including the shrunk spots; removing the shrunk spots together with portions of the coating of the nonluminous substance applied thereon thus exposing portions of the inner surface of the face plate on which the shrunk spots have been applied; applying a coating of a phosphor onto the entire surface of the remaining nonluminous substance as well as the exposed portions of the inner surface of the face plate; applying a coating of photosensitive material onto the phosphor coating; exposing the coating of the photosensitive material to light beams passed through the perforations of the shadow mask thus forming phosphor dots.

BACKGROUND OF THE INVENTION

This invention relates to a method of manufacturing a fluorescent screen of a color picture tube, more particularly a matrix type color picture tube wherein the effective luminous area of the phosphor dots is smaller than the cross sectional area of the electron beam impinging upon the dots.

The fluorescent screen of the shadow mask type color picture tube comprises a plurality of closely adjacent trios of phosphor dots, each trio including a red phosphor dot, a blue phosphor dot and a green phosphor dot which are disposed on the apices of a triangle. In such a fluorescent screen, if the cross-sectional area of the electron beam passed through a perforation of the shadow mask were smaller than the area of one of the phosphor dots, the contrast of the reproduced picture would be decreased by the reflection of the external light. To obviate this problem, there has recently been proposed a matrix type color picture tube in which the area of each phosphor dot is made smaller than the cross-sectional area of the electron beam and wherein the regions between adjacent dots are coated with a nonluminous substance such as graphite. With this type of picture tube, in order to make the cross-sectional area of the electron beam larger than the area of the phosphor dots, it is necessary to make the area of each perforation of the shadow mask equal to or larger than the area of the phosphor dot. However, since it is the common practice to use the shadow mask to form the phosphor dots, in order to satisfy above described relationship between the areas, it is necessary to enlarge the diameter of the perforations of the shadow mask to the desired size after the phosphor dots have been formed or to use a special source for light exposure at the time of forming the phosphor dots. However, use of the special source for light exposure or enlargement of the shadow mask perforations after forming the phosphor dots increases the number of manufacturing steps, as well as the cost of manufacturing.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an improved method of manufacturing a fluorescent screen for a color picture tube according to which the cross-sectional area of the electron beam can be made larger than the effective luminous area of each phosphor dot without the necessity of enlarging the diameter of the shadow mask perforations after the phosphor dots have been formed or of using a special source of light.

Another object of this invention is to provide an improved method of manufacturing a fluorescent screen for a color picture tube capable of making the cross-sectional area of the electron beam larger than the effective luminous area of each phosphor dot and of applying a nonluminous substance onto the regions between adjacent phosphor dots without the necessity of enlarging the diameter of the shadow mask perforations after the phosphor dots have been formed or of using a special source of light.

According to this invention, these and further objects can be accomplished by providing a method of manufacturing a fluorescent screen comprising the steps of forming a photosensitive coating on the inner surface of a face plate of a color picture tube; exposing the photosensitive coating to light through perforations of a shadow mask; removing portions of the coating that have been exposed to the light, thus leaving the spots of the coating that have been exposed to the light, shrinking the spots of the coating; applying a coating of a nonluminous substance over the entire area of the inner surface of the face plate including the shrunk spots; removing the shrunk spots together with portions of the coating of the non-luminous substance applied thereon, thus exposing portions of the inner surface of the face plate on which shrunk spots have been applied; applying a coating of a phosphor onto the entire surface of the remaining nonluminous substance as well as the exposed portions of the inner surface of the face plate; applying a coating of a photosensitive material to light beams passed through the perforations of the shadow mask and removing the portions of the coating of said photosensitive material that have not been exposed to said light beams, thus forming phosphor dots.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a plan view to explain the relationship between a trio of phosphor dots on a fluorescent screen of a matrix type color picture tube and

FIGS. 2(*a*) to 2(*e*) show plan views to explain the successive steps of manufacturing a fluorescent screen according to the teaching of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1 a trio of a blue phosphor dot **2**, a red phosphor dot **3** and a green phosphor dot **4** is formed on the inner surface **1** of the face plate of a matrix type color picture tube. These dots are positioned on the apices of a small equilateral triangle. A plurality of such trios of three phosphor dots are regularly formed on the entire surface of the fluorescent screen. A non-luminous substance **5** such as graphite is applied onto the regions between phosphor dots **2**, **3** and **4**. The relationship between the phosphor dots of the fluorescent screen and the electron beam is represented by electron beam spots **6**, **7** and **8** which are concentric with respective phosphor dots **2**, **3** and **4** having larger cross-sectional areas than the effective luminous areas of the phosphor dots.

The invention contemplates the provision of a novel method for manufacturing a fluorescent screen by which the relationship metioned above can be assured. With reference to FIGS. 2(a) to 2(e), a solution of polyvinyl

alcohol and a photosensitive material such as ammonium dichromate is coated upon the inner surface **10** of the face plate of a picture tube and the coating is then dried to form a coating of the photosensitive material **11** over the entire inner surface of the face plate. The coating is then exposed to light beams passed through the perforations of the shadow mask to form exposed spots **12, 13** and **14** on the photosensitive coating. Portions of the photosensitive coating not exposed to the light beams are then dissolved away to leave exposed spots **12, 13** and **14** which are arranged on the apices of an equilateral triangle. While these spots are still wet and swollen, they are treated, as by dipping, with a solution containing a quantity of an organic salt or an inorganic salt effective to shrink the polyvinyl alcohol component of the coating, for example, about 5% by weight of ammonium sulfate or natrium acetate, for about one minute and then the face plate is dried. As a result of this treatment, the areas of the spots **12, 13** and **14** are reduced from the areas shown by dotted lines to those shown by solid lines **12', 13'** and **14'**, as shown in FIG. 2(*b*). These shrunk spots of coating are restored to their original areas when they are wetted by water or an aqueous solution. For this reason, in order to preserve the reduced areas of these shrunk spots, these portions are set by heating them to an elevated temperature ranging from 80° C. to 110° C. Alternatively, about 0.2%, by weight, of a photosensitive bonding agent for polyvinyl alcohol, for example ammonium dichromate, is incorporated into the solution of the photosensitive material adapted to be coated on the inner surface of the face plate to form the shrinkable coating in the step shown in FIG. 2(a). Then, the shrunk spots of the coating **12', 13'**, and **14'** are irradiated with ultraviolet rays or an electron beam to set the same. The resulting shrunk spots will not swell when wetted by water.

After the shrunk spots of coatings **12', 13'** and **14'** have been rendered waterproof as above described, the inner surface of the face plate is cleaned to prepare for the step of coating graphite, to be described later. Where the diameter of the perforations of the shadow mask is selected to be 0.38 mm., for example, the diameter of the spots **12, 13** and **14** becomes 0.38 mm. and that of the shrunk spots **12', 13'** and **14'** 0.3 mm.

A small quantity of ammonium is added to an aqueous solution of potassium silicate containing about 5% graphite to prepare graphite solution of pH 10.4 to 10.6. The solution is applied to the entire inner surface of the face plate as shown in FIG. 2(*c*). The shaded portion represents a graphite coating **15** which is applied onto the entire surface of the inner side of the face plate including shrunk spots **12', 13'** and **14'**. The face place coated with the graphite coating is then immersed in hydrogen peroxide for two minutes to cause the hydrogen peroxide to permeate the graphite coating **15** thus swelling and embrittling the shrunk spots. Under these conditions, when a jet of warm water is ejected against the graphite coating, the embrittled shrunk spots will be peeled off together with the overlying portions of graphite coating **15**. Then the graphite coating will be formed with perforations **12'', 13''** and **14''** corresponding to the shrunk spots **12', 13'** and **14'** as shown in FIG. 2(*d*). Thus, a matrix-shaped or mesh-shaped coating of graphite, a nonluminous substance, is formed on the inner surface of the face plate.

Thereafter, a phosphor is applied onto the entire surface of the mesh shaped graphite coating and the regions of the face plate exposed in perforations **12'', 13''** and **14''**. A second phosphor is coated upon the coating of the first phosphor and these coatings are exposed to light beams projected through the perforations of the shadow mask. Since these steps of coating the phosphors and light exposure are well known in the art, it is believed unnecessary to describe them in detail.

FIG. 2(*e*) is a plan view of a fluorescent screen after the phosphor dots have been formed. The size of the phosphor dots **16, 17** and **18** formed in this manner is equal to that of the spots of coatings **12, 13** and **14** shown in FIG. 2(*a*). Thus, these dots completely cover respective perforations **12'', 13''** and **14''** and the portions of the dots in these perforations are bonded to the inner surface of the face plate. FIG. 2(*e*) shows a portion of the fluorescent screen manufactured by the method of this invention.

In the operation of the fluorescent screen, the effective luminous regions of respective phosphor dots as viewed from the front side of the face plate correspond to perforations **12'', 13''** and **14''**, respectively, whereas the cross-sectional areas of the electron beam spots equal the areas of the spots **12, 13** and **14** exposed to light, that is phosphor spots **15, 17, 18**, respectively. Consequently, the cross-sectional areas of the electron beam spots are always larger than those of the perforations, that is, the areas of the effective luminous regions of the phosphor dots. In this manner, in accordance with this invention it is possible to establish the desired relationship between the matrix type fluorescent screen and the electron beam even when the diameters of the perforations of the shadow mask, when it is used to form the fluorescent screen and the diameters of the perforations of the shadow mask when it is used to shape the electron beams are equal. In other words, it becomes unnecessary to enlarge the diameters of the perforations of the shadow mask or to use special source of light exposure.

While the invention has been shown and described in terms of a preferred embodiment thereof, it will be clear that many changes and modifications will occur to one skilled in the art within the scope of the invention as defined by the appended claims.

I claim:

1. A method of manufacturing a fluorescent screen of a color picture tube comprising the steps of forming a photosensitive coating on the inner surface of a face plate of said picture tube; exposing said photosensitive coating to light through perforations of a shadow mask; removing portions of said photosensitive coating that have not been exposed to said light, thus leaving the spots of said coating that have been exposed to said light; shrinking said spots of said coating to reduce their areas; applying a coating of a nonluminous substance over the entire area of the inner surface of said face plate including said shrunk spots of said coating; removing said shrunk spots of said coating together with portions of said coating of said nonluminous substance applied thereon thus exposing portions of said inner surface of said face plate on which said shrunk spots have been applied; applying a coating of a phosphor onto the entire surface of the remaining nonluminous substance as well as said exposed portions of the inner surface of said face plate; applying a coating of a photosensitive material onto said phosphor coating; exposing said coating of said photosensitive material to light beams passed through the perforations of said shadow mask and removing the portions of the coating of said photosensitive material that have not been exposed to said light beams, thus forming phosphor dots.

2. The method according to claim **1** wherein said shrinkage of said spots of said coating is performed by dipping said face plate in a solution containing about 5% of ammonium sulfate and then drying said face plate.

3. The method according to claim **1** wherein said shrinkage of said spots of said coating is performed by dipping said face plate in a solution containing about 5% of sodium acetate and then drying said face plate.

4. The method according to claim **1** wherein said coating of nonluminous substance is immersed in about 4% solution of hydrogen peroxide to cause said hydrogen peroxide to permeate said coating of nonluminous substance to reach said shrunk spots of said coating thus swelling and enbrittling said spots and thereafter a jet of warm water is ejected upon said coating of nonlumi-

nous substance so as to peel off said shrunk spots of said coating together with portions of said coating of said nonluminous substance applied thereon from the inner surface of said face plate.

5. A method of manufacturing a fluorescent screen of a color picture tube comprising the steps of forming a photosensitive coating on the inner surface of a face plate of said picture tube; exposing said photosensitive coating to light through perforations of a shadow mask; removing portions of said coating that had not been exposed to said light, thus leaving the spots of coating that have been exposed to said light, shrinking said spots of said coating; imparting waterproof property to said shrunk spots of said coating; applying a coating of a nonluminous substance over the entire area of the inner surface of said face plate including said spots imparted with water proof property; removing said shrunk spots of said coating together with portions of said coating of said nonluminous substance applied thereon, thus exposing portions of said inner surface of said face plate on which said shrunk spots have been applied; applying a coating of a phosphor onto the entire surface of the remaining nonluminous substance as well as said exposed portions of the inner surface of said face plate; applying a coating of a photosensitive material onto said phosphor coating; exposing said coating of said photosensitive material to light beams passed through the perforations of said mask and removing the portions of the coating of said photosensitive material that have not been exposed to said light beams, thus forming phosphor dots.

6. The method according to claim 5 wherein said shrunk spots of said coating are imparted with waterproof property by heating said shrunk spots at a temperature ranging from 80° C. to 100° C.

7. The method according to claim 5 wherein said photosensitive coating is incorporated with a photosensitive bonding agent and said shrunk spots of said coatings are rendered waterproof by drying and irradiation with light energy.

8. The method according to claim 5 wherein said photosensitive coating is incorporated with a photosensitive bonding agent and said shrunk spots of said coating are rendered waterproof by drying and irradiation with an electron beam.

9. A method according to claim 5, wherein said step of forming said photosensitive coating on the inner surface of said face plate comprising a solution of polyvinyl alcohol and ammonium dichromate on said inner surface and allowing said solution to dry.

10. A method according to claim 9, wherein said step of shrinking said spots of said coating comprises dipping said face plate into a solution containing 5% by weight of ammonium sulfate for a period of about 1 minute.

11. A method according to claim 9, wherein said ammonium dichromate comprises 0.2% by weight in said solution and wherein said step of shrinking consists of irradiating said face plate with said electromagnetic energy.

12. A method according to claim 11, wherein said electromagnetic energy is in the form of ultraviolet rays.

13. A method according to claim 11, wherein said electromagnetic energy is in the form of an electron beam.

14. A method according to claim 9, wherein said step of shrinking said spots on said coating comprises dipping said face plate into a solution containing 5% by weight of sodium acetate for a period of about 1 minute.

15. A method according to claim 10, wherein said step of imparting said waterproof property comprises heating said spots to a temperature in the range of 80° C. to 100° C.

16. A method according to claim 5, wherein said step of applying a coating of nonluminous substance over said spots comprises applying a solution of 5% graphite contained in an aqueous solution of potassium silicate and immersing the face plate coated with a graphite coating in hydrogen peroxide for a period of about 2 minutes.

17. A method according to claim 14, wherein said step of applying a coating of nonluminous substance over said spots comprises applying a solution of 5% graphite contained in an aqueous solution of potassium silicate and immersing the face plate coated with a graphite coating in hydrogen peroxide for a period of about 2 minutes.

18. A method according to claim 15, wherein said step of applying a coating of nonluminous substance over said spots comprises applying a solution of 5% graphite contained in an aqueous solution of potassium silicate and immersing the face plate coated with a graphite coating in hydrogen peroxide for a period of about 2 minutes.

19. A method according to claim 16, wherein said step of removing said shrunk spots of said coating together with portions of said coating of said nonluminous substance applied thereon comprises ejecting a jet of warm water against said graphite coating.

20. A method according to claim 17, wherein said step of removing said shrunk spots of said coating together with portions of said coating of said nonluminous substance applied thereon comprises ejecting a jet of warm water against said graphite coating.

21. A method according to claim 18, wherein said step of removing said shrunk spots of said coating together with portions of said coating of said nonluminous substance applied thereon comprises ejecting a jet of warm water against said graphite coating.

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