United States Patent [19]

Miura et al.

[11] **3,761,756**

[45] **Sept. 25, 1973**

[54] **FLUORESCENT SCREENS FOR USE IN CATHODE RAY TUBES**

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[22] Filed: **Dec. 28, 1971**

[21] Appl. No.: **213,028**

[52] **U.S. Cl.** ..... **313/92 R**

[51] **Int. Cl.** **H01j 29/32**

[58] **Field of Search** ..... 313/92 R

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Assistant Examiner—James B. Mullins
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[57] **ABSTRACT**

In a fluorescent screen for use in a cathode ray tube used for image formation of the class including a phosphor film coated on the surface of a face plate, there are provided a plurality of hills and valleys on one surface of the face plate, and a phosphor film coated on the tops of the hills. The side walls of the valleys are inclined such that they reflect the light emanated from the phosphor film toward the other surface of the face plate.

8 Claims, 9 Drawing Figures

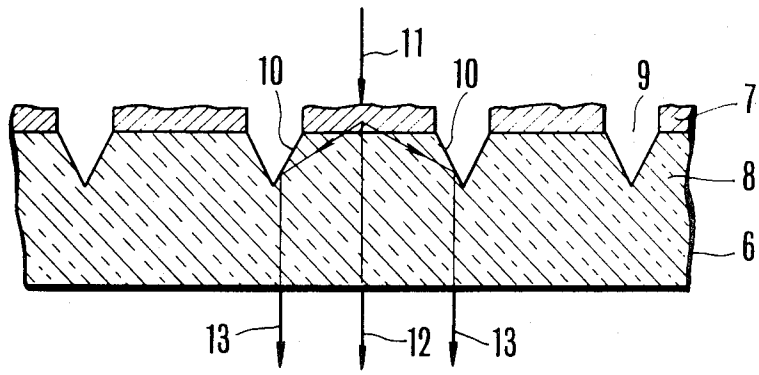


FIG. 1

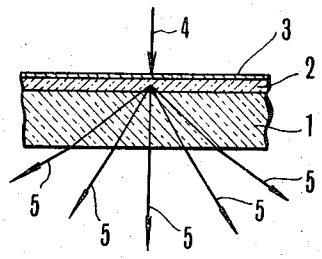


FIG. 2

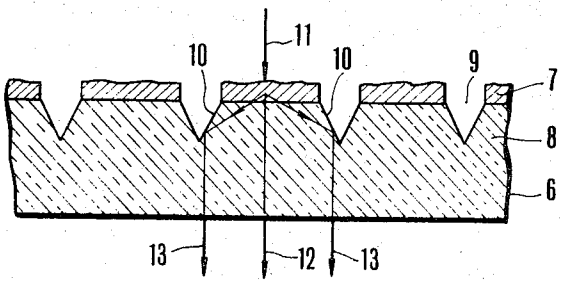
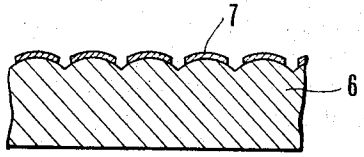


FIG. 3



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FIG. 4a

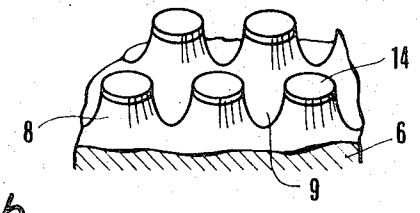


FIG. 4b

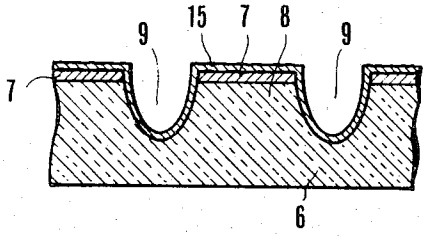


FIG. 4c

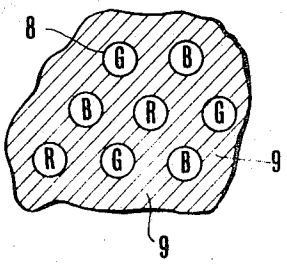


FIG. 5a

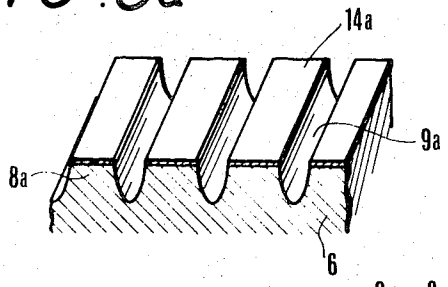


FIG. 5b

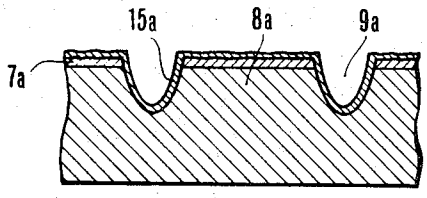
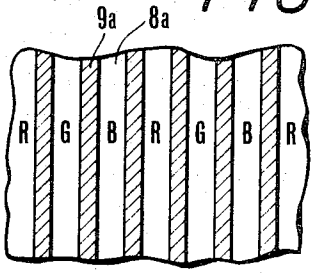


FIG. 5c



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FLUORESCENT SCREENS FOR USE IN CATHODE RAY TUBES

BACKGROUND OF THE INVENTION

This invention relates to a new and improved fluorescent screen for use in a cathode ray tube used for image formation.

A conventional fluorescent screen for use in a cathode ray tube used for image formation comprises a face plate having a smooth inner surface, a phosphor film applied on the inner surface of the face plate, and an aluminum film applied on the phosphor film to act as a metal back. The phosphor film fluoresces when an electron beam impinges thereupon. Since the inner surface of the face plate is flat smooth, the light emanated from the phosphor film radiates to the front side of the fluorescent screen.

More particularly, as shown in FIG. 1, the conventional fluorescent screen comprises a glass face plate 1 having a flat inner surface, a phosphor film 2 applied on the inner surface of the face plate 1, and an aluminum film 3 applied on the phosphor film 2 to act as a metal back. The fluorescent screen fluoresces when impinged upon by an electron beam 4 from an electron gun, not shown. The light emanated in this manner radiates in the radial direction toward the front side of the fluorescent screen at substantially uniform intensity so that only a portion of the radiated light enters into the eye of the viewer seated in front of the screen. Thus, a substantial portion of the light emanated from the fluorescent screen is radiated in vain without contributing to the brightness.

BACKGROUND OF THE INVENTION

Accordingly, it is an object of this invention to provide a novel fluorescent screen for use in a cathode ray tube used for image formation wherein the inner surface of the face plate is finished coarse so as to utilize the light which would otherwise be emanated in vain for improving the brightness of the image.

Another object of this invention is to provide an improved fluorescent screen for use in a cathode ray tube used for image formation wherein portions of the inner surface of the face plate onto which the phosphor film is applied are flat, whereas another portions are formed to act as reflecting surfaces for converting the light emanated from the phosphor film into useful parallel beams.

The term "brightness" used herein means the brightness of the light coming from the image formed on the face plate and sensed by a viewer or a photosensitive element situated apart from the face plate.

According to this invention there is provided a fluorescent screen for use in a cathode ray tube of the class including a phosphor film coated on the surface of a face plate, characterized in that a plurality of hills and valleys are formed on one surface of the face plate, that a phosphor film is coated on the tops of the hills, that the side walls of the valleys are inclined such that they reflect the light emanated from the phosphor film by the impingement of the cathode ray toward the other surface of the face plate.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a sectional view of a portion of a conventional fluorescent screen showing the manner of radiating the light emanated from the phosphor film.

FIG. 2 shows an enlarged section of a portion of the fluorescent screen constructed according to this invention;

FIG. 3 is view similar to FIG. 2 but illustrating a slightly modified form;

FIG. 4*a* shows a perspective view of a portion of the face plate glass with hills coated with photoresist dots;

FIG. 4*b* shows a sectional view of the completed fluorescent screen for use in shadow mask type color picture tube;

FIG. 4*c* is a plan view of the fluorescent screen shown in FIG. 4*b*;

FIG. 5*a* shows a perspective view of a Chromatron (Trade Name) type fluorescent screen with the stripe shaped hills coated with a photoresist;

FIG. 5*b* shows a section of a fluorescent screen for use in chromatron type color picture tube embodying the invention and

FIG. 5*c* is a plan view of the fluorescent screen for chromatron type color picture tubes shown in FIG. 5b.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The fluorescent screen embodying this invention and shown in FIG. 2 comprises a glass face plate 6 having an inner flat surface. A plurality of flat topped hills 8 coated with a phosphor film 7 and valleys 9 between hills 8 are formed on the inner surface of the face plate, the inclined surfaces of the valleys forming highly reflective surfaces 10. When an electron beam 11 impinges upon the phosphor film 7, the eyes of the viewer in front of the fluorescent screen receive not only the light component 12 coming straightforwardly toward the viewer from the phosphor film but also the light components 13 which are radiated at an angle with respect to the normal and then reflected by the reflecting surfaces 10 toward the viewer, whereby the brightness of the fluorescent screen is greatly improved over the prior art fluorescent screen shown in FIG. 1.

The flat tops of the hills 8 coated by the phosphor film may be arranged in the form of either dots or a grid or any other desired form. A most suitable configuration is selected to meet the condition of use and the construction of the cathode ray tube. It is advantageous to make the size of the phosphor film coated upon the flat tops of the hills 8 to be smaller than the diameter of the electron beam for the purpose of increasing the brightness and to prevent decrease in the resolution. Usually, in the case of dots, the diameter thereof, whereas in the case of a grid, the width thereof are selected to be smaller than several hundred microns.

It is advantageous to select the area of valleys 9 such that the ratio thereof to the entire surface of the fluorescent screen is as far as possible small. However, this condition is not critical so that larger ratio can also be used. For example, in the shadow mask type colour television receiving tube since 50 percent of the area of the fluorescent screen is occupied by a non-luminous substance so that if such non-luminous substance is applied onto all reflective surfaces 10 of respective valleys the total area of the luminescent phosphor film would not be decreased, the advantage of providing the reflecting surfaces would not be impaired.

The inclination of the side walls or reflective surfaces or respective valleys is important for efficiently reflecting the light toward the viewer in front of the fluorescent screen. It was found that the angle of inclination of the reflecting surfaces with reference to the normal to the fluorescent screen is desirable to be from 10° to 40°, and that smaller inclination angles decrease the effect of light reflection.

Also it is desirable that the depth of valleys **9** is sufficiently deep to efficiently reflect the light emitted from phosphor film **7**, for example, at least more than **10** microns. These valleys act as shielding surfaces to prevent external light from reaching the phosphor film **7** thereby improving contrast of the reproduced picture which has not been attained by the fluorescent screen of the conventional construction. However, too deep valleys decrease the accuracy of the working, so that depth from several microns to several hundred microns is ordinarily suitable.

The degree of improving the brightness obtainable by the improved construction varies dependent upon the configurations of the hills and valleys as above described but many constructions other than that illustrated in FIG. **2** can be used. For example, in the modification shown in FIG. **3**, the upper surface of the face plate **6** is corrugated and the phosphor film **7** is applied onto curved top portions of the corrugation.

Such corrugation of hills and valleys may be provided by a well known etching technique or precise machining.

The desired reflection by the inclined surfaces **10** of the valleys **9** may be afforded by the reflective property of the inclined surfaces **10** themselves. However it is desirable to provide thin aluminum or silver films having a thickness of 1,000 to 6,000 Angstrom units which are formed by vapour deposition or plating or films of a highly reflective powder, such as magnesium oxide or aluminum oxide, having a thickness of about **10** microns and coated on the inclined surfaces, or the phosphor film coated thereon. The reflecting surface is not always to be mirror finished but may be somewhat roughly finished to provide random reflection. However, of course minor finish is more effective.

One example of manufacturing the fluorescent screen of this invention is as follows. First, the inner surface of a face plate glass is roughened by a well known photoetching technique. More particularly, an acid proof photoresist, for example KMER (trade name of a metal etching resist sold by Eastman Kodak Co.) or FSR (trade name of Fuji super resist) or a mixture of KMER and aluminum stearate is applied on the surface of the face plate glass to a sufficient thickness, for example, more than 25 microns. Then the portions of the photoresist corresponding to electron spot beam trios are exposed to ultraviolet rays or electron beams, and then the exposed photoresist is developed to form photoresist dots each having a diameter of about 0.27 mm. Then the photoresist dots are etched with a suitable etchant containing hydrofluoric acid, for example, a mixture containing **50** parts of hydrofluoric acid, 25 parts of phosphoric acid and **25** parts of hydrochloric acid to remove portions of the glass not covered by the photoresist dots **14** thus forming a plurality of hills **8** and a plurality of valleys **9** having a depth of about 100 microns and an inclination angle of the inclined side walls of about 30°. Then the photoresist dots **14** remaining on the hills are removed. Thereafter, according to a well known method of forming the fluorescent screen of the colour television receiving tube phosphor dots are formed on the top of the hills and a film is formed. Then an aluminum film is vapour deposited on the entire surface of the fluorescent screen and the assembly is then baked. FIG. **4***b* shows a cross-section of a portion of the completed fluorescent screen. The upper surfaces of the hills are flat and are coated by the phosphor film **7** and aluminum film **15** is applied to cover the phosphor films and inside walls of the valleys **9**. FIG. **4***c* shows a plan view of the fluorescent screen of a shadow mask type colour television receiver wherein R, G and B show the phosphor film on the hills **8**, and **9** shows valleys **9**. While in this invention, the hills are shown as frustums of cones, they can take any other configuration.

It was confirmed by experiment that the shadow mask type fluorescent screen illustrated in this example showed a brightness two times as large as that of the conventional fluorescent screen shown in FIG. **1**.

An application of this invention to a fluorescent screen for use in the Chromatron type colour television receiver will be described hereunder. In the type fluorescent screen of chromatron type color picture tubes, instead of using phosphor dots of three colours as, in the shadow mask type fluorescent screen, the phosphor films are formed in the form of stripes of three original colours and the reflective surfaces are formed between the stripes. This type of fluorescent screen can be manufactured by the same method as that for the fluorescent screen of shadow mask type color picture tubes except that the photoresist is exposed through a stripe shaped grid instead of a shadow mask. FIGS. **5***a* to **5***c* correspond respectively to FIGS. **4***a* to **4***c* in which FIG. **5***c* shows a perspective view of a face plate coated with stripes of photoresist **14***a*, FIG. **5***b* a sectional view showing an aluminum film **15***a* applied on the stripes of phosphor **7***a* and on the inner surfaces of valleys **9***a* between raised stripes **5***a* and FIG. **5***c* a plan view of the completed fluorescent screen.

In the above described method of manufacturing the fluorescent screen, after forming hills and valleys on the surface of the face plate glass, coarse particles of black substance having a diameter of more than 15 microns, for example, may be loosely packed in the valleys. Then the black particles contact the side walls of the valleys with small contact areas so that the side surfaces of the valleys act as totally reflective surfaces for the light emanated from the phosphor film. On the other hand, since external lights impinge upon the walls of the valleys at large incident angles substantially all of the external light transmitted through the walls is absorbed by the black substance thereby increasing the brightness of the fluorescent screen and decreasing reflection of the external light thus assuring high quality of the reproduced picture.

Although the invention has been described in terms of colour television receiving tubes, it should be understood that the invention can also be applied to other types of cathode ray tubes as well as to electro luminescence panels. For example, in the case of a white and black cathode ray tube, the phosphor film is applied on raised stripes of the face plate glass having a spacing of about 50 microns.

What is claimed is:

1. In a fluorescent screen for use in a cathode ray tube used for image formation of the class including a

phosphor film coated on the inner surface of a light transmissive face plate the outer surface of which forms the viewing screen of said tube, the improvement which comprises a plurality of hills and valleys interconnected by sloping side wall surfaces formed on said inner surface of said face plate, and a phosphor film coated on the tops of said hills and adapted to emit light upon being impinged by a cathode ray, said side wall surfaces of said valleys being inclined such that they internally reflect the portions of light emanated from said phosphor film and transmitted within said face plate to be intercepted by said side wall surfaces, the internal reflection directing said portions toward said outer surface of said face plate with more nearly normal incidence.

2. The fluorescent screen according to claim 1 wherein said side walls of said valleys are inclined from 10° to 40° with respect to the normal perpendicular to said phosphor film.

3. The fluorescent screen according to claim 1 wherein at least the reflective side walls of said valleys are coated with a reflective film.

4. The fluorescent screen according to claim 1 wherein said valleys have a depth of from several microns to several hundred microns.

5. The fluorescent screen according to claim 3 wherein said reflective film is an aluminum film having a thickness of about 1,000 to 6,000 A.

6. The fluorescent screen according to claim 3 wherein said reflective film is a film of a powder of aluminum oxide having a grain size of about 10 microns.

7. A fluorescent screen for use in shadow mask type color picture tubes comprising a light transmissive face plate, a plurality of hills and valleys interconnected by sloping side wall surfaces formed on the inner surface of said face plate, phosphor dots of three original colours applied on the tops of said hills, said side wall surfaces of said valleys being inclined so as to internally reflect the portion of light emanated from said phosphor film and intercepted by said side wall surfaces toward the other surface of said face plate, and a reflective film of metal covering said phosphor film on said dots and the inner surfaces of said valleys.

8. A fluorescent screen for use in Chromatron type color picture tubes comprising a face plate, raised stripes and valleys interconnected by side walls formed on the inner surface of said face plate, a phosphor film of three original colours coated on the tops of said raised stripes, said side walls of said valleys being inclined so as to internally reflect the portion of light emanated from said phosphor film and intercepted by said side walls toward the other surface of said face plate, and a reflective film of metal covering said phosphor film and the inner surfaces of said valleys.

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