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CATHOHE RAY TUBES

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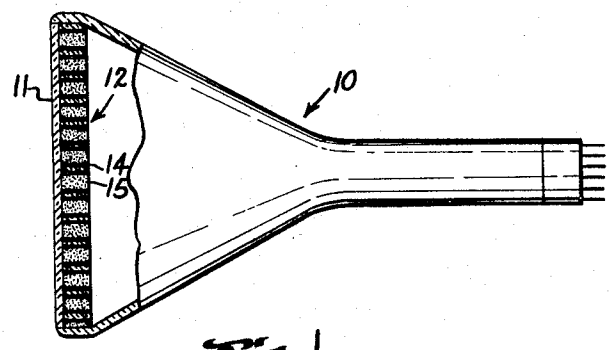

Fig. 1

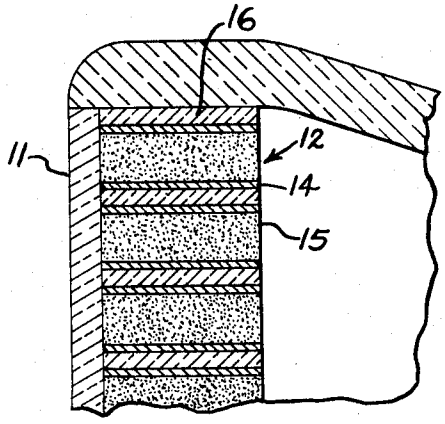

Fig. 2

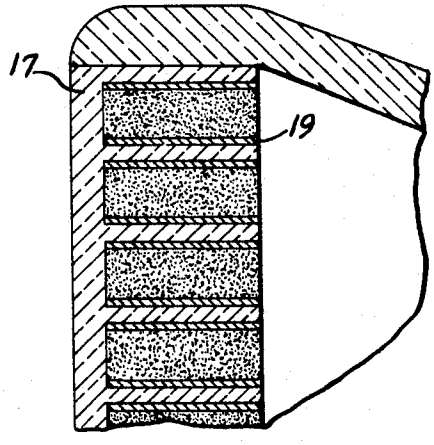

Fig. 3

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This invention relates to improvements in image-forming face plates for cathode ray tubes or the like and has particular reference to improved means and method for forming optical images of increased brilliance and definition.

In devices employing the use of cathode ray tubes, there has long been a need for tubes which are capable of producing optical images of increased brilliance without deterioration of image resolution or contrast.

It is well known that one can observe increased brightness from a phosphor layer excited by an electron beam by increasing the thickness of the phospor layer and simultaneously increasing the voltage of the electron beam. The optimum situation is that in which the phosphor thickness and beam voltage are such that the electrons are just stopped by the phosphor. In this way, light is generated throughout the entire thickness of the phosphor during the slowing down of the electrons by said phosphor.

Since the size of the light spot increases rapidly with the thickness of the phosphor layer, the thickness of the layer must not be allowed to exceed an amount of the order of magnitude of the desired spot diameter. Therefore, in conventional cathode ray tubes, a limitation is imposed upon the increasing of the thickness of the phosphor layer and electron beam voltage by the degree of light spreading within the phosphor layer itself. That is, in order to produce images which are of acceptable resolution and contrast, it has been necessary heretofore in conventional cathode-ray tubes to restrict the thickness of the phosphor layer and, accordingly, the voltage of the electron beam so as to prevent an excessive lateral spreading of the light spots formed by the electrons striking the phosphor, which spreading, when excessive, causes an unacceptable overlapping of the light which tends to greatly reduce image contrast and definition.

The present invention overcomes the problems previously encountered in increasing the brilliance of images formed by cathode ray tubes by providing novel means and method for permitting the thickness of phosphor and the voltage of the electron beam of such tubes to be increased as desired without detriment to image resolution or contrast.

It is, therefore, a primary object of this invention to provide optical image-forming means on face plates and method of making the same wherein images of high quality resolution and brilliance may be obtained.

Another object is to provide novel means on face plates of the above character for producing spots of image-forming light when bombarded electronically and for controllably restricting the lateral spreading of the light from said spots.

Another object is to provide image-forming means on face plates of the above character which in effect are formed of an assembly of a great number of coated or clad rodlike elements of phosphorescent material in connected adjacent side-by-side relation with each other with their ends in contact with one side of the face plate and of precontrolled length, whereby the coating or cladding on said elements when the phosphorescent material is electronically bombarded, will prevent image-forming light produced by said material from spreading laterally beyond the limits of the rods.

Another object is to provide means on a face plate of

the above character wherein the brilliance of the light produced by the phosphor may be controlled in accordance with the increased thickness to which the phosphor may be made as a result of limiting the lateral spreading of the light produced by said phosphor.

A further object is to provide relatively simple, yet highly efficient, image-producing means on face plates which when used in conjunction with cathode ray tubes or the like is adapted to improve the image-producing capabilities of such tubes by providing means for producing images of a high degree of resolution which are considerably more brilliant than has heretofore been possible.

Other objects and advantages of the invention will become apparent from the following description when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a partially cross-sectioned diagrammatic side elevational view of a cathode ray type of electronic tube embodying the invention;

FIG. 2 is a greatly enlarged fragmentary cross-sectional view of the image-forming face part of the cathode-ray tube illustrated in FIG. 1; and

FIG. 3 is a greatly enlarged cross-sectional view of a modified form of the device of the invention.

Referring more particularly to the drawings, there is illustrated in FIG. 1 a cathode ray type of electronic tube **10** having a clear glass image-transmitting face plate **11** and a rearward image-forming structure **12** disposed within the evacuated body of the tube **10** and in contact with the rear surface of the face plate (see FIGS. 1 and 2). The structure **12** is in the form of a cellular structure having the side walls of the cells coated with an opaque reflective material **14**. The individual cells are filled with a phosporescent material **15** of the well known type commonly used to produce image-forming light in conventional cathode ray tubes thereby producing in effect a plurality of adjacently related rodlike members of said material in end contact with the rear of the face plate of the tube. When bombarded by electrons, the phosporescent material will become luminous and being in contact with the face plate **11**, the light produced by the material **15** will be visible through said face plate.

It is pointed out that other than the section **12**, the cathode ray tube **10** is strictly conventional in nature and may be of any shape, size or design to fulfill the requirements of the particular apparatus with which it is to be used and the face plate **11** of this invention is formed to an outer contour shape and size in accordance with that required for the particular tube to which it is to be applied.

It should be understood that the face plate assembly forms an airtight seal for the end of said envelope thereby permitting the usual necessary vacuum to be provided within the interior of the tube **10**.

The opaque reflective coatings **14** enable the thickness of the phosphorescent material or length of the rodlike portions formed thereby to be increased as compared with conventional phosphorescent coatings and also enable the voltage of the electron beam to be increased, thereby producing a higher intensity and more brilliant image with no stray light passing from one section or rod of phosphorescent material to another as might be the case if a continuous layer of phosphorescent material of the thickness or length of rods were used without said reflective coatings.

Various methods may be employed for the fabrication of the cellular structure **12** or of producing the isolated rods of phosphorescent material mentioned above. For example, as illustrated in FIGS. 1 and 2, a sheet of glass designated as a whole by the numeral **16** may be provided with a plurality of adjacently related openings, resulting

in the cells, the side walls of said cells or openings may thereafter be plated with opaque reflective coatings by any suitable known method such, for example, as by gas plating, evaporation, chemical silvering or the like of a relatively thin opaque reflective material throughout said inner side walls of said cells or opening and a phosphorescent material may thereafter be placed in said cells or openings throughout the length thereof. This, in effect, produces a plurality of adjacent rodlike members of phosphorescent material having opaque reflective coatings thereon.

The thickness of the sheet of glass **16** is controlled in accordance with the thickness or length of rod of phosphorescent material desired. The cells or openings are preferably filled level full with the phosphorescent material. This may be done either before or after the resultant rear image-forming structure **12** is placed in contact with the inner surface of the face plate **11**. The face plate is secured in said position by any suitable means either adhesively or by fusion or the like with care being taken that the inner ends of the phosphorescent material will be in contact with the rear surface of said face plate **11**.

Another method of fabricating is that of forming an initially thick face plate **17**, as shown in FIG. 3, of a photosensitive glass of a commercially known type which if portions thereof are exposed to ultra-violet light and the plate is thereafter heated, the exposed portions will devitrify and become susceptible to acid etching. In accordance with the present method the face plate is provided on one side thereof with an opaque shield or negative having a plurality of adjacent openings or transparent areas simulating dots of the diameter of the openings desired to be formed in the face plate. The face plate is then exposed to ultra-violet light passing through said openings or transparent areas whereupon the exposed portions of the glass upon subjecting the same to heat of a temperature approaching the annealing point of the glass will change the properties of the glass at said exposed areas and render them more susceptible to acid etching than the unexposed areas. The glass plate, after the above treatment, is placed in a solution of hydrofluoric acid or the like for a time interval sufficient to permit said acid to eat away the glass at said exposed areas to the depth desired of the openings. The face plate is then placed in water to stop the acid etching and is thereafter permitted to dry.

In a manner similar to the forming of the construction of FIGS. 1 and 2, the walls of the openings are provided with an opaque reflective coating **19**. The phosphorescent material is then placed in said openings, preferably level full, thereby producing a cellular or rodlike assembly of phosphorescent material of a thickness or length equal to the depth of the openings. The resultant construction produces the same desired result to that of the rear image-forming structure **12**. The face plate **17** is fused or otherwise secured to the envelope of the tube **10** in a conventional manner so as to provide the necessary vacuum seal.

The opaque reflective surfaces **19** function in a manner similar to the opaque reflective surfaces **14** of the construction of FIGS. 1 and 2 in order to prevent the escape and scattering of light from one of said sections or rodlike members of phosphorescent material into another thereof thereby producing an assembly which will enable the obtaining of increased brilliance and definition of image described above without the spreading of light.

It is to be understood that the openings or cells may be filled with the phosphorescent material in the usual manner whether by forming a liquid or pastelike mixture of phosphor powder and water glass and thence filling the cells or openings therewith and according to common practice in the art or by using a vapor deposition technique or other known methods of filling the cells with phosphor. It is to be understood that the usual care is

taken to prevent the trapping of air, dirt, dust, etc., within said openings during the filling thereof.

While the above methods of fabrication call for the forming of openings in an auxiliary glass sheet or in the face plate itself, it is within the scope of this invention that small rods of phosphorescent material might initially be formed. One of the ends of each rod is attached to the rear surface of the face plate with the various rods in adjacent spaced relation with each other and disposed in a direction substantially normal to the face plate. The rods are thereafter coated with an opaque reflective material in which instance the opaque reflective material may fill in the space between said rods and permanently support them in desired spaced relation with each other and in attached relation with the face plate in a manner similar to the combined glass and opaque reflective materials between the constructions of FIGS. 1, 2 and 3, which in effect produce combined spacer means and opaque reflective coating means. It is to be understood, of course, that the rods may be coated with the opaque reflective material without necessarily filling in the space between said rods.

The resultant image-forming structure would function similar to the previously described constructions with the exception that no glass would be in between the opaque reflective coatings and the rods of phosphorescent material can thereby be placed in more compact adjacent relation with each other.

It is to be understood that with any of the above described structures, a thin transparent reflective layer of aluminum may be placed over the rear surface of the phosphor in a known conventional manner and for the known conventional purpose of making full use of the light from the phosphorescent material. That is, to cause the major portion of the light generated by the phosphor when bombarded by the electron beam to be reflected in a direction toward the outer face of the tube.

From the foregoing it will be seen that simple, efficient and economical means and method have been provided for accomplishing all of the objects and advantages of the invention. Nevertheless, it should be apparent that many changes in the details of construction, arrangement of parts or steps of the method may be made without departing from the spirit of the invention as expressed in the accompanying claims.

Having described my invention, I claim:

1. A cathode ray tube comprising a face plate having a front and rear surface, a transparent plate-like member having a plurality of adjacently related openings therein of substantially the same diameter and length extending throughout the thickness of said member, means on the inner side walls of said openings for preventing the passage of light therethrough and phosphorescent material substantially filling said openings to form, in effect, a plurality of light-insulated rod-like members of phosphorescent material in end contact with said rear surface of said face plate.

2. A cathode ray tube comprising a face plate having front and rear surfaces, a cellular structure on the rear surface thereof, said cellular structure having a plurality of adjacently related openings of substantially equal sizes and each being of a controlled depth, phosphorescent material substantially filling said openings throughout the major portion of the length thereof and opaque light-reflective means between said phosphorescent material and the side walls of each of said openings, said resultant phosphorescent material being, in effect, individually light-insulated rod-like members lying internally of said openings with said opaque light-reflective means extending throughout the length of said rod-like members.

3. A face plate for a cathode ray tube, said face plate having a continuous surface on the front side thereof and a cellular structure on the rear side thereof, said cellular structure having a plurality of adjacently related

openings of substantially equal size and depth therein, phosphorescent material substantially filling said openings throughout the major portion of the length thereof and means in the form of a layer of material opaque to light between said phosphorescent material and the side walls of each of said openings for preventing the passage of light through said side walls, said phosphorescent material being, in effect, individually light-insulated rod-like members lying internally of said openings with said material opaque to light extending throughout the length of said rod-like members.

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