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(54) Color cathode ray tube and manufacture for contrast improvement

(57) The invention relates to a method of manufacturing a colour cathode-ray tube, in which a graphite coating (22) of variable thickness is interposed between the glass faceplate (2) of the tube and the phosphors (25, 26, 27) intended to reproduce a colour image. The purpose of the coating (22) is to reduce the transmission of the glass, of which the faceplate is composed, to a defined value.

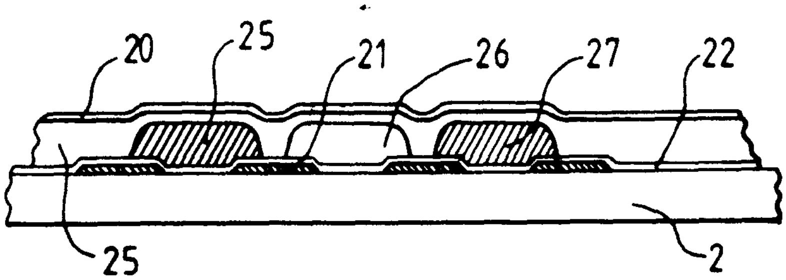

FIG.3

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Description

[0001] The invention relates to a process for manufacturing a screen for colour cathode-ray tubes and to the tube incorporating the said screen. The invention is more particularly intended for improving the contrast of the image formed on the screen by reducing the reflectivity of the faceplate of the tube.

[0002] In order to make the visibility of an image formed on a cathode-ray tube screen possible and comfortable, under all illumination conditions that might arise in a domestic environment, it is necessary to be able to have a screen with a high contrast.

[0003] In order to improve the contrast of the image formed on the screen of a cathode-ray tube, one solution commonly employed consists in using, between the lines of luminescent materials making up the screen, a matrix of bands of carbon particles opaque to light. This structure has been improved by the introduction of screen faces manufactured in a glass having a low transmission coefficient; moreover this type of faceplate has a dark appearance when the tube is switched off, this corresponding to the taste of the viewer. However, the use of a glass with a low transmission coefficient presents many problems in practice.

[0004] For example, the coefficient must be tailored to the size of the tube and to the type of electron gun used.

[0005] Moreover, the current trend is moving towards cathode-ray tubes with increasingly plane faceplates; in order to mechanically withstand the vacuum existing in the tube, the thickness of the faceplate is therefore increased, more particularly in the corners. There is therefore a large difference in thickness between the centre of the faceplate and its corners. The consequence is that, for this type of tube, it is not possible to use glass with too low a transmission coefficient since the difference in light yield of the screen between the centre and the edge would become too apparent to the viewer.

[0006] Other techniques are used to increase the contrast of the image; for example, the use of layers of filtering materials between the inside of the screen and the luminescent materials, as described in United States Patent US 4,135,112, a process which is complicated to implement and is expensive, or else the coating of the outside of the screen with a layer of filtering materials, as described in United States Patent US 4,987,338, a process which is also expensive and applicable only when the tube is finished, the coating being, moreover, sensitive to attack by chemicals or abrasives.

[0007] The invention aims to provide a solution which is simple to implement and inexpensive, allowing the reflectivity of the faceplate of a cathode-ray tube to be reduced to a defined value. To do this, the colour cathode-ray tube according to the invention comprises a glass faceplate over the internal surface of which are placed arrays of phosphors in order to form a screen,

characterized in that a coating of light-absorbent material is placed between the phosphors and the internal surface of the faceplate so as to reduce the transmission coefficient of light passing through the said faceplate.

[0008] The invention and its advantages will be more clearly understood with the aid of the description below and of the drawings among which:

- Figure 1 shows a cathode-ray tube according to the invention, seen in partially exploded view;
- Figure 2 illustrates a sectional view of an image screen according to the prior art, produced on the internal surface of the glass faceplate of the tube;
- Figure 3 shows a sectional portion of an image screen according to the invention;
- Figure 4 is a view from above of the internal surface of the glass faceplate of the cathode-ray tube according to the invention;
- Figure 5 is a sectional view of the same internal surface in the context of the invention.

[0009] As illustrated in Figure 1, a cathode-ray tube 1 according to the invention comprises an approximately plane faceplate 2 and a peripheral skirt 3. The faceplate is connected to the funnel-shaped rear part 4 of the tube by a glass-frit seal. The end part 5 of the tube surrounds the electron gun 6, the beams from which illuminate the screen of luminescent phosphors 13 through the colour selection mask 8. Metal supports 19, 10, 11, 12 support this mask inside the tube at a precise distance from the screen.

[0010] Conventionally, a colour cathode-ray tube consists of an array of phosphors which, once they have been excited by the electron beams emitted by the gun 6, will emit light. This array comprises red, green and blue phosphors representing the primary colours from which a colour image is produced. The phosphors are arranged either in successive columns or in dots of different colours placed in a triangular configuration. The technique for making the phosphors adhere to the internal face of the glass panel is of the photolithography type, in which the arrays of three-colour phosphors are formed by exposing a photoresistant layer to light passing through holes in the selection mask 8. Each array is developed and cured by firing so as to obtain perfect adhesion to the glass substrate. To improve the contrast and obtain good colour separation, it is usual beforehand to deposit a matrix of light-opaque material, for example carbon particles, on the glass face, the arrays of phosphors then being deposited in the open parts of the matrix. Figure

2 illustrates such a construction in a sectional view. A matrix of carbon bands 21 is deposited on the internal surface of the faceplate 2, followed by columns of red phosphors 25, green phosphors 26 and blue phosphors 27; next, the entire assembly is covered with a film of organic material serving as a substrate for a very thin metal coating 20. This coating, generally made of aluminium, has the function of reflecting, by mirror effect, the light emitted by the luminescent materials in the direction of the viewer so as to increase the brightness of the screen. In a subsequent step of the manufacturing process, the film of organic material is removed by being burnt off in a high-temperature oven. Application of the conventional technique again poses problems in the context of novel screens of which the outer surface of the faceplate is virtually flat. In order to mechanically withstand the vacuum which will be created in the tube at the end of manufacture, the flatter the faceplate the thicker the glass has to be. To avoid having to use excessively large amounts of glass, for reasons of cost or excessive weight, whilst still maintaining sufficient mechanical strength, it is possible to vary the thickness of the faceplate, with a thickness at the centre smaller than the thickness at the edges. The use of glass with a low light transmission coefficient means that the transmission of light through the various regions of the screen then becomes very heterogeneous. This is because the centre of the screen will have a much smaller attenuating effect than at the edges, where the thickness is greater. It follows that the screen will not have a uniform brightness, the edges and corners appearing darker for the same energy provided by the phosphors.

[0011] In the context of the invention, it is possible to use as base a highly transparent glass and to modify its appearance for the viewer by depositing a coating of light-absorbent material before the phosphors are deposited. In this way, the light transmission coefficient of the faceplate is modified, bringing it to a desired value, which is that of a face made of dark glass.

[0012] The use of such a coating is illustrated by Figures 3, 4 and 5.

[0013] The coating 22 is deposited on the glass faceplate 2 before the phosphors are deposited. This coating may be placed on the matrix array 21 of light-opaque carbon columns or on the bare glass if the screen does not comprise a matrixed array 21. The solution used for producing this coating is an aqueous solution of graphite in suspension. It is preferable for the particles in solution to have a small diameter as this has several advantages:

- fine control of the thickness of the layer, allowing the light transparency of the faceplate to be adjusted precisely and brought to the desired value depending on the said thickness;
- the graphite particles fill up the pores in the matrix 21, the carbon particles of which have a larger diameter. As a result, the contrast of the screen improves, the graphite bands then appearing blacker;
- the interface created by this graphite layer 22 leads to a smooth surface to which the deposits of phosphors adhere better than directly to the carbon bands of the matrix 21. As a result, it is possible to increase the weight of phosphor used so as to increase the brightness of the image on the screen without fear of fluorescent material becoming detached because of its weight.

[0014] For these reasons, it is preferred to choose a suspension in which the size of the graphite particles lies within a distribution which does not exceed 300 nm. The graphite used is, for example, chosen from the group of CB products sold by Acheson Colloids. The solution used also includes conventional dispersants and surfactants, normally used in the manufacture of screens for cathode-ray tubes.

An example of a solution used for creating the coating 22 is illustrated in the following table:

[0015]

TABLE 1

Material concentration	Amount x 10 kg	% in the solution
Graphite, 10%	500	0.5
Deionized water	8800	99.25
Dispersant, 1%	500	0.05
Surfactant, 10%	200	0.2

[0016] Various means may be used for depositing the solution on the internal surface of the faceplate. Spraying may be used and, in this case, the flow rate and the number of passes over the surface will determine the final thickness of the said coating. This may be achieved by depositing at the centre of the screen an amount of solution which will be dispersed over the internal surface of the screen by centrifuging, the initial amount of product and the centrifuging speed and time then defining the distribution of the thickness of the layer over the screen.

[0017] After being deposited, the graphite suspension is dried, for example using heating heads producing infrared radiation, so as to form the coating 22.

[0018] In one advantageous embodiment, the thickness of the coating 22 is not homogeneous over its entire surface on the internal face of the screen, but is thicker at the centre than at the edges and at the corners of the screen. As illustrated in Figures 4 and 5, in the case in which the thickness of the glass faceplate 2, denoted by 53 and 51 respectively, is greater in the corners than in the central part of the screen, the thickness of the coating 22, denoted by 50 and 52 respectively, is then greater at the centre of the screen than at the edges. In this way, the light transparency of the faceplate 2 is homogeneous and the brightness of the screen in operation is uniform.

[0019] The ratio between the light energy transmitted through the faceplate to the square root of the reflectivity coefficient of the said faceplate, known as the BCT (Brightness/Contrast Performance), generally measured in the central part of the screen, is an index that has to be maintained at a high enough value. It measures the compromise between the fact that the faceplate must be sufficiently transparent to the light energy that passes through it and the reflectivity of the screen which must be low enough to provide a contrasted image.

[0020] The measurements given in Table 2 below show that the use of a coating layer 22 does not affect the BCP. This is because, although the luminous efficiency of the image screen decreases with the graphite concentration of the said coating, because of the resulting reduction in the transmission coefficient of light through the faceplate, this reduction is compensated for by an increase in the contrast resulting from the reduction in the reflectivity of the said faceplate. It follows that the said BCP varies only very slightly with the concentration of graphite put into solution in order to produce the coating 22, this being so in a graphite concentration by weight of the order of 0.03% to 0.9% approximately.

TABLE 2

Graphite concentration	% Transmission of the faceplate		Luminous efficiency of the tube	BCP
[% by weight]	Centre	Corner	[lumen/W]	
0.00	42.7	38.3	28.3	265
0.30	24.1	33.7	21.8	263
0.70	12.8	16.8	17.2	266

[0021] After drying the coating 22, the phosphors of each primary colour are successively deposited in a conventional manner on top of the said coating. This method of manufacture provides a particular advantage stemming from the successive deposition of the green, then blue and then red phosphors. This is because these phosphors do not have the same efficiency and, for the same energy provided by the corresponding electron gun, the green phosphors have the highest efficiency, followed by the blue phosphors and finally the red phosphors. It follows that the electron beams must be corrected in terms of energy so as to faithfully reproduce a colour image, for example in order to obtain a white colour close to reality. This correction is based on the ratios between the currents for the beams coming from the electron guns in order to obtain a faithful image and is made by means of additional electronic circuits.

[0022] The invention makes it possible to obviate the correction to be made to the beam current values since, in the context of the manufacturing process, the green phosphors are deposited first, and then developed, followed in a successive and approximate identical manner by the deposition of the blue and then the red phosphors. After each development, the coating 22, exposed to the development phases, thins slightly. It follows that, in the same screen region, the coating 22 will be thicker beneath the green phosphors then beneath the blue phosphors, and thicker beneath the blue phosphors than beneath the red phosphors. These thickness differences make it possible to obtain an approximately identical light yield for all the phosphor types with a given beam current. It follows that the ratio of the beam currents for producing the white colour is in practice close to 1, thus avoiding the need for a circuit to correct the beam intensities.

[0023] Moreover, the invention affords other advantages and solutions to related problems.

[0024] The fact of being able to use more transparent glass faceplates is an advantage for the environment and the end-of-life recycling of the tube since the glass used contains fewer heavy metals which are normally used for darkening the glass.

[0025] From the industrial standpoint, the invention allows several types of tube to be manufactured from the same glass, thereby providing flexibility and manufacturing cost reduction. Previously, each type of faceplate had to have a transparency, for example, tailored to its size and the technology used inside the tube. Henceforth, the final transparency is obtained by adjusting the thickness of the coating 22. As a result, it is accordingly easier to manage the stock of faceplates.

[0026] Moreover, the invention is not limited to the use of a solution of graphite in suspension for producing the coating 22, graphite being chosen a *priori* for convenience since this raw material is commonly employed in the phases of manufacturing the tube. Any other material having the property of absorbing light may be used as an alternative.

Claims

1. Colour cathode-ray tube (1) comprising a glass faceplate (2) over the entire surface of which are placed arrays of phosphors (25, 26, 27) in order to form a screen (13),
characterized in that the phosphors are deposited on a coating (22) of light-absorbent material intended to reduce the transmission coefficient of light passing through the faceplate.

2. Cathode-ray tube according to the preceding claim, characterized in that the coating (22) of light-absorbent material is placed on top of an array (21) intended to form a light-opaque matrix.

3. Cathode-ray tube according at least one of the preceding claims, characterized in that the coating (22) of light-absorbent material is thicker at the centre of the screen surface than around its periphery.

4. Cathode-ray tube according to at least one of the preceding claims, characterized in that the light-absorbent coating is made of graphite particles.

5. Cathode-ray tube according to the preceding claim, characterized in that the majority of the graphite particles have a size of less than 0.3 µm.

6. Process for manufacturing a screen for a cathode-ray tube, characterized in that it comprises the following steps:

   - cleaning of the internal surface of the front face of the tube;
   - deposition of a suspension of particles of a light-absorbent material on the said internal surface;
   - drying of the said suspension so as to form a continuous coating of light-absorbent material;
   - deposition of at least one layer of luminous material on the said coating.

7. Manufacturing process according to the preceding claim, characterized in that the light-absorbent material is graphite.

8. Manufacturing process according to the preceding claim, characterized in that the suspension of graphite particles comprises dispersants and surfactants, which are diluted in water, preferably deionized water, and an amount of graphite of between 0.03% and 0.9% by weight.

9. Manufacturing process according to Claim 7 or 8, characterized in that the majority of the graphite particles have a size of less than 0.3 µm.

10. Manufacturing process according to one of Claims 7 to 9, characterized in that the suspension of graphite particles is applied by spraying it onto the internal face of the tube.

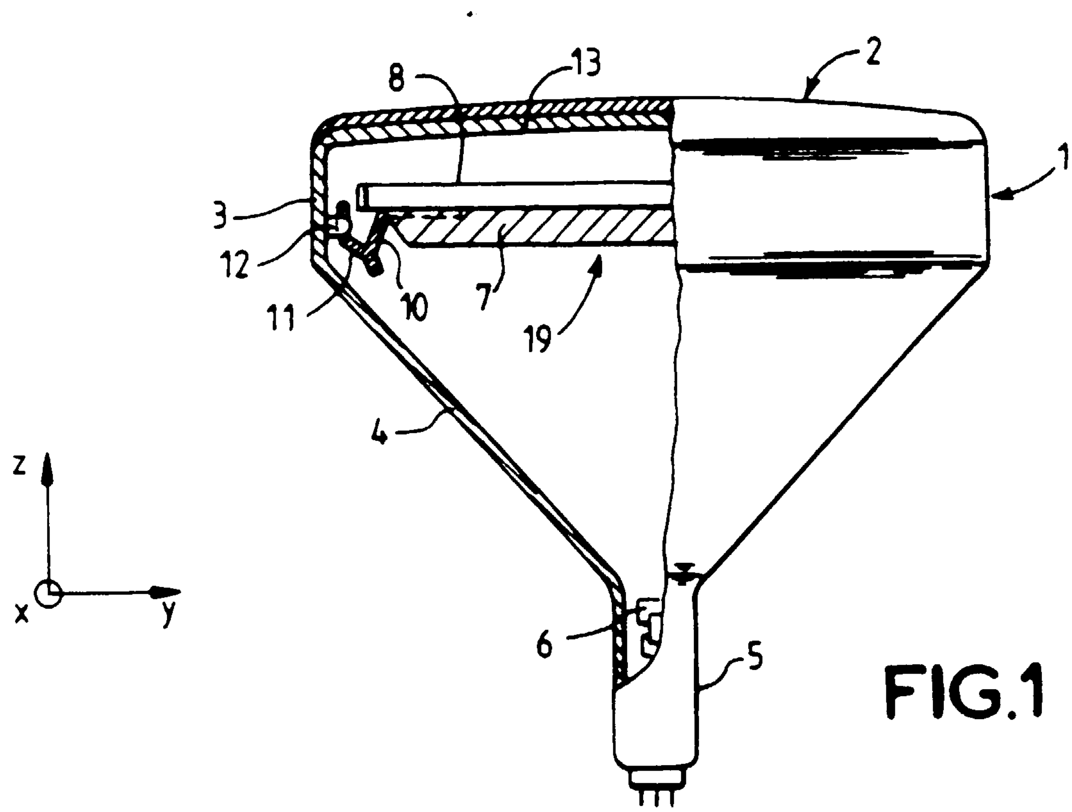


FIG.1

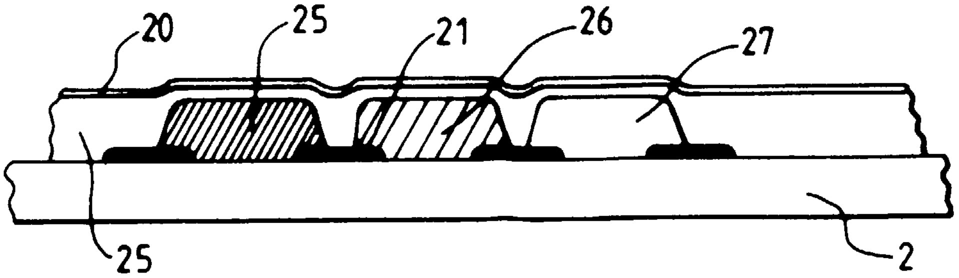


FIG. 2

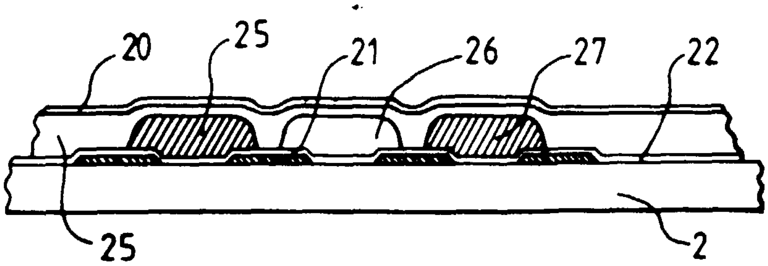


FIG.3

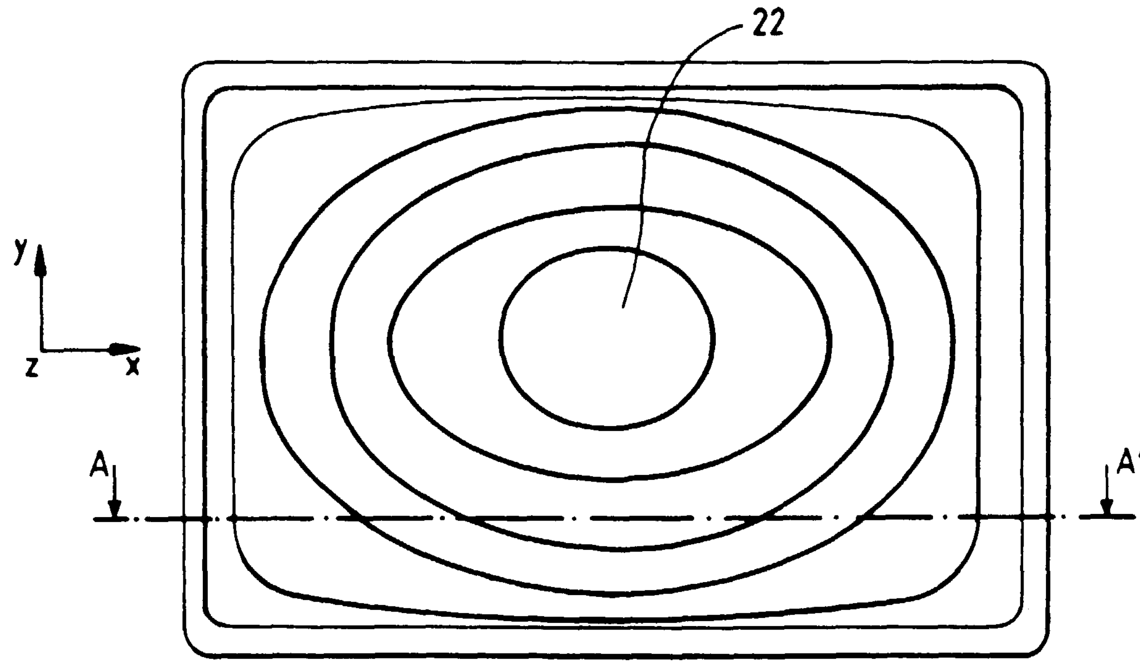
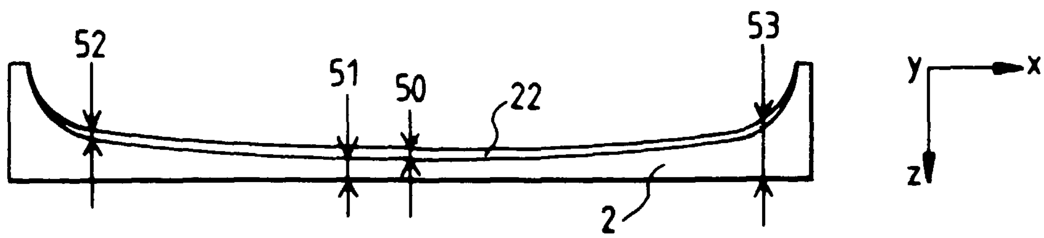


FIG.4



COUPE AA'

FIG. 5