

COLOUR CATHODE RAY TUBES

This invention relates to colour cathode ray tubes.

5 In a colour cathode ray tube in which three electron beams are emitted from electron guns and energise respective phosphors R, G and B on the display surface, then unless each of these electron beams is converged on a predetermined point of a colour-selective electrode, so called colour shift occurs.

10 In colour cathode ray tubes used for high accuracy display on a so-called colour monitor, it has been suggested that a so-called automatic convergence unit be provided. This would prevent colour shift by correcting the sweeping position of the electron beams on the basis of the light emitted when the electron beams sweep across index elements formed on the reverse surface of the colour-selective electrode facing the electron guns.

15 These cathode ray tubes are provided with index elements formed by coating index phosphors on the reverse surface of the colour-selective electrode in a predetermined pattern. See, for example Japanese Patent Applications KOKAI 58/24186, 58/25042 and 61/156623.

20 For forming these index elements, the reverse surface of the colour-selective electrode is masked with the predetermined pattern and spray-coated with a paste containing index phosphors, such as P46 or P47. Such paste may include the index phosphors as a mixture with a binder, such as nitrocellulose dissolved in an organic solvent system.

25 When this paste is dried in situ, the organic solvent is evaporated, so that there remain only the index phosphors and the binder on the electrode surface. Since the index phosphors are adhered to the colour-selective electrode only weakly by the binder, they peel off when accidentally contacted by hands or fingers. The index elements may also be peeled off when air blowing, for example, is used for removing index phosphors from slits in the colour-selective electrode. In addition, when the colour cathode ray tube in its entirety, inclusive of the aforementioned paste, is heated to a
30 temperature of 380° to 450°C, during a step following the coating, such as for baking or frit sealing the tube bulb, the binder is burned and scattered, so that only the index phosphors remain on the index elements. Since the

index phosphors do not have any intrinsic adhesion they may peel off easily due to vibration or shock.

If the index elements peel off, the signal output level resulting from the light emitted from the index elements is lowered, so that the sweeping positions of the electron beam cannot be corrected accurately. Also, if the index phosphors thus peeled off settle, for example, on the electron guns, electrical discharge may occur, making it difficult to produce a high quality image.

Moreover, since organic solvent is contained in the paste, special ventilation is required during manufacture of the index elements.

According to the present invention there is provided a colour cathode ray tube comprising a tube bulb having means for producing electron beams;

deflecting means outside said tube bulb for controlling the direction of the electron beams emitted by said electron beam producing means;

a colour-selective electrode in said tube bulb for colour-selecting said electron beams and directing them onto a phosphor surface formed on the inner surface of said tube bulb;

index element means formed on the surface of said colour-selective electrode facing said electron beam producing means;

means for sensing signals produced when said electron beams impinge on said index element means; and

an automatic convergence unit responsive to output signals of said sensing means to control said deflecting means;

wherein said index element means comprises a paste containing a mixture of index phosphors, an inorganic adhesive and water, and is formed by being coated and dried in situ on said surface, said paste having a composition represented by the formulae:

$$\begin{aligned} M/P &\geq 0.25, \\ 0.6 &\leq P/(m+w) \leq 1.2, \text{ and} \\ m/(m+w) &\leq 0.6 \end{aligned}$$

where P denotes the weight of said index phosphors in grams, M the weight of said inorganic adhesive in grams, m the volume of said inorganic adhesive in millilitres, and w the volume of water in millilitres.

The index elements in an embodiment of the invention, comprising a mixture of index phosphors, inorganic adhesive and water in the form of a paste, which is coated and dried in situ, can have sufficient adhesion to prevent peeling of the index elements.

5 Since no toxic volatile constituents, such as organic solvents, are contained in the paste, there is no requirement for special ventilation.

The invention will now be described by way of example, with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

10 Figure 1 is a perspective view, partially in section, of an embodiment of colour cathode ray tube according to the present invention;

Figure 2 is a diagrammatic view showing the contour of the index elements of the cathode ray tube;

15 Figure 3 is a diagrammatic view illustrating the principle of an automatic convergence unit of the cathode ray tube; and

Figure 4 is a chart for illustrating the composition of the paste employed for the formation of the index elements of the cathode ray tube.

20 Referring to Figure 1, the colour cathode ray tube includes a tube bulb 3 consisting of a panel 1 providing a display surface and a funnel 2 continuous with the panel 1. The tube bulb 3 is formed of a transparent material, such as glass, and has an evacuated interior.

An electron gun 4 for producing electron beams is provided within the tube bulb 3, and is so orientated that the electron beams are directed to a phosphor surface formed on the inner surface of the panel 1.

25 A colour-selective electrode 5 is positioned parallel to and at a prescribed distance from the phosphor surface on the panel 1. The electrode 5 is in the form of a thin plate formed with a predetermined large number of parallel slits. The electrode 5 is secured to a frame 6, and is supported by suitable supporting means, not shown, so that the slits lie parallel to red (R), green (G) and blue (B) phosphor stripes making up the phosphor surface.

30 The cathode ray tube is provided with a so-called automatic convergence system for correcting colour shift caused by relative shift of the arrival points of the three electron beams at the electrode 5.

35 For cooperation with the automatic convergence system, index elements 9 are provided at a number of points on the reverse side of the

electrode 5 facing the gun 4, as shown in Figure 2. Each index element 9 comprises a vertical leg 10 orthogonal to the sweeping direction of the electron beam indicated by the arrow H in Figure 2, and a leg 11 inclined at a predetermined angle θ relative to the sweeping direction.

5 The principle of the automatic convergence system will now be explained. When the index element 9 is swept by the electron beams, the index element 9 emits light. When the electron beams sweep a predetermined position as indicated by the arrow mark h_1 (Figure 3), the distance between the vertical leg 10 and the inclined leg 11 on the sweeping trajectory has a predetermined length l_1 in Figure 3. The arrows H and V in Figure 3 indicate the horizontal and vertical directions on the display screen of the cathode ray tube. If the sweeping velocity of the electron beams is v , there is a lapse of time l_1/v between when the electron beams pass through the vertical leg 10, and when the electron beams pass through the inclined leg 11. Therefore, when the electron beams sweep the predetermined position indicated by the arrow h_1 , light emission occurs twice at an interval of time equal to l_1/v . However, when the electron beams sweep a position indicated by the arrow mark h_2 , which is off the predetermined position, the distance between the vertical leg 10 and the inclined leg 11 on the sweeping trajectory has a length of l_2 . Assuming the sweeping velocity of the electron beams to be constant, it is after a lapse of time l_2/v . Therefore, when the electron beams sweep a position off the predetermined position as indicated by the arrow mark h_2 , light emission occurs twice at an interval of time equal to l_2/v .

25 Such light emission, occurring twice due to the electron beams sweeping the index element 9, is sensed by the sensor 8. When the electron beams sweep the aforementioned predetermined position, the sensor 8 supplies two pulses spaced by the time interval of l_1/v as indicated by a waveform P_1 in Figure 3. When the electron beams sweep a position off the predetermined position, the sensor 8 supplies two pulses spaced by a time interval l_2/v as indicated by a waveform P_2 in Figure 3.

35 Thus, from the difference in the time intervals between the two pulses of the two pulse sets, that is $(l_2-l_1)/v$, the scanning velocity, and the prescribed angle of inclination θ of the inclined leg 11, it is possible to compute the shift of the current sweeping position from the prescribed sweeping position and this is indicated by h in Figure 3. Deflection coils 7

controlling the direction of the electron beams can be moved on the basis of the computed shift to correct the direction of the electron beams to coincide the scanning position with the predetermined position.

When the sweeping position of a prescribed one of the three electron beams adopted as a reference is used as the predetermined position, and the respective scanning positions of the other two electron beams are corrected so as to be coincident with the predetermined position, each of three electron beams is converged at one point on the electrode 5 to prevent colour shift from occurring.

It should be noticed that the index element 9 consists of preselected index phosphors, such as P46 and P47, an inorganic adhesive and water mixed together to a paste which is spray-coated in a predetermined pattern on the reverse surface of the electrode 5, so as to be dried and cured.

The sequence of operations for forming the index element 9 is as follows: a mask is secured by a magnet on the reverse surface of the electrode 5 for masking the predetermined pattern. The electrode 5 is heated to about 110°C by a constant temperature bath. The paste is then spray-coated by a sprayer on the electrode 5 from above the mask, after which the mask is removed. If paste adheres in the slits of the electrode 5, the three electron beams may be interrupted by the paste and cannot reach the phosphor surfaces, so that an optimum image cannot be produced. Paste adhering to the slits and the surface of the electrode 5 is therefore removed. The inorganic adhesive contained in the paste is cured by a baking step, for example, frit sealing, in which the entire colour cathode ray tube is heated to a temperature of 380° to 450°, following the predetermined processing of the inside of the tube bulb 3 inclusive of the electrode 5, for affixing the index phosphor to the electrode 5.

For assuring the adhesion of the index element 9 to the electrode 5 and optimum spray coating, the paste composition is selected to satisfy the following formulae I to III;

$$M/P \geq 0.25 \quad \dots (I)$$

$$0.6 \leq P/(m+w) \leq 1.2 \quad \dots (II)$$

$$m/(m+w) \leq 0.6 \quad \dots (III)$$

wherein P denotes the weight of the index phosphor in grams, M the weight

of the inorganic adhesive in grams, m the volume of the inorganic adhesive in millilitres, and w the volume of water in millilitres.

Inorganic adhesive consisting, for example, of aluminium phosphate, such as that sold under the trade name of monophix, may be employed.
 5 Since the specific gravity of monophix is about 1.5; $m=M/1.5$.

The conditions governing the aforementioned paste composition may be represented by a region indicated A in Figure 4. In this figure, the total volume of the paste, which is the sum of the volume of the inorganic adhesive and that of water, that is, $(m+w)$ in the formulae II and III, is set
 10 so as to be equal to 100 millilitres.

It will be noted that, when the paste composition does not satisfy the formula I, such that:

$$M/P < 0.25$$

and thus the composition is represented by B in Figure 4, the contents of the
 15 inorganic adhesive in the paste are reduced, so that a sufficient adhesive force of the index element to the electrode 5 is not obtained.

Also, when the composition of the paste is such that, in connection with the formulae II and III:

$$P/(m+w) > 1.2$$

20 or:

$$m/(m+w) > 0.6$$

and thus the composition is represented by C in Figure 4, the paste has an increased viscosity, so that there is difficulty in spray coating the composition.

25 In addition, when the composition of the paste is such that, in connection with the formulae II and III:

$$P/(m+w) < 0.6$$

and:

$$m/(m+w) < 0.6$$

30 and thus the composition is represented by D in Figure 4, the viscosity of the paste is lowered, while the total volume of the paste that is applied in order for the required amount of the index phosphor to be affixed to the electrode 5 is increased. Thus, when the paste is spray-coated on the reverse surface of the electrode 5, an increased amount of the paste flows
 35 into the slits and onto the outer surface of the electrode 5, so that difficulties occur in forming the index elements 9 to a predetermined

pattern configuration.

The marks o, Δ , $\blacktriangle$ and $\otimes$ in Figure 4 are used for plotting compositions in accordance with the present invention and those of certain comparative examples. The marks o, Δ , $\blacktriangle$ and $\otimes$ indicate respectively that both the adhesion and the spraying operability is excellent; that the spraying operability is excellent; that the spraying operability is excellent but the adhesion is insufficient; that the adhesion is excellent but the spraying operability is inferior; and that both the adhesion and the spraying operability are inferior.

The inorganic adhesive used is not limited to monophix and any other suitable inorganic adhesive can be used.

Also, the electron gun and the deflection coils are merely illustrative as the electron beam emitting means and deflecting means, and any other type of electron beam emitting and deflecting means may also be employed.

CLAIMS

1. A colour cathode ray tube comprising a tube bulb having means for producing electron beams;
 deflecting means outside said tube bulb for controlling the direction of the electron beams emitted by said electron beam producing means;
 5 a colour-selective electrode in said tube bulb for colour-selecting said electron beams and directing them onto a phosphor surface formed on the inner surface of said tube bulb;
 index element means formed on the surface of said colour-selective electrode facing said electron beam producing means;
 10 means for sensing signals produced when said electron beams impinge on said index element means; and
 an automatic convergence unit responsive to output signals of said sensing means to control said deflecting means;
 wherein said index element means comprises a paste containing a mixture of
 15 index phosphors, an inorganic adhesive and water, and is formed by being coated and dried in situ on said surface, said paste having a composition represented by the formulae:

$$\begin{aligned} M/P &\geq 0.25, \\ 20 \quad 0.6 &\leq P/(m+w) \leq 1.2, \text{ and} \\ m/(m+w) &\leq 0.6 \end{aligned}$$

where P denotes the weight of said index phosphors in grams, M the weight of said inorganic adhesive in grams, m the volume of said inorganic adhesive in millilitres, and w the volume of water in millilitres.
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2. A colour cathode ray tube according to claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

