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Lea

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[54] **LOW DEPTH CATHODE RAY TUBES**
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313/76, 79, 80; 315/22, 18, 21

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Primary Examiner—Robert Segal
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[57] **ABSTRACT**
A cathode ray tube has an evacuated shallow envelope provided with a flat screen, and an electron gun is arranged to direct an electron beam into the envelope from one edge thereof in a direction which is substantially parallel to the plane of the screen. The beam is deflected by controlled deflection electrodes towards the screen to control the distance from said edge at which the beam impinges on the screen. An electrode arrangement is provided in the envelope for deflecting the beam towards the screen by an amount which increases with increasing distance from said edge of the envelope. In this way the angle of attack of the beam on the screen at all positions along the screen is greater than it would be in the absence of the electrode arrangement. A grid may be arranged in the envelope parallel to an immediately behind the screen, the grid being connected to a D.C. source such that the angle of attach of the electron beam relative to the screen is further increased as the beam passes through the grid.

10 Claims, 5 Drawing Figures

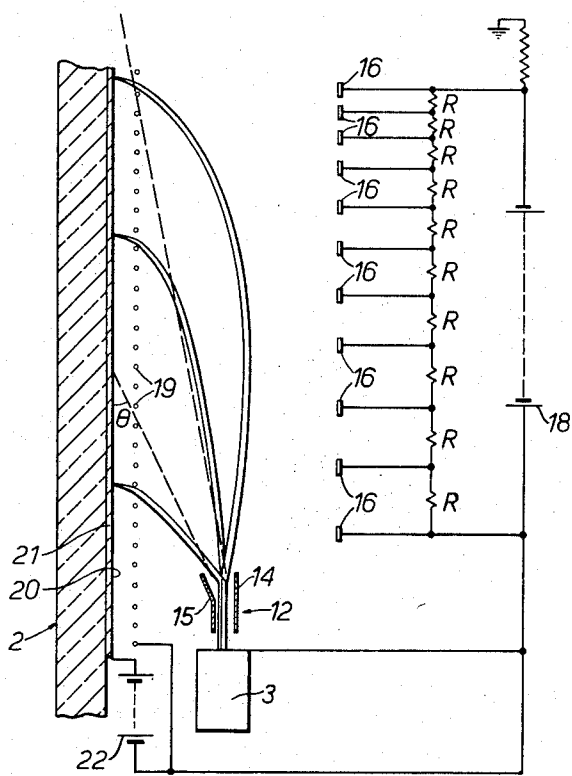


FIG. 1. (PRIOR ART)

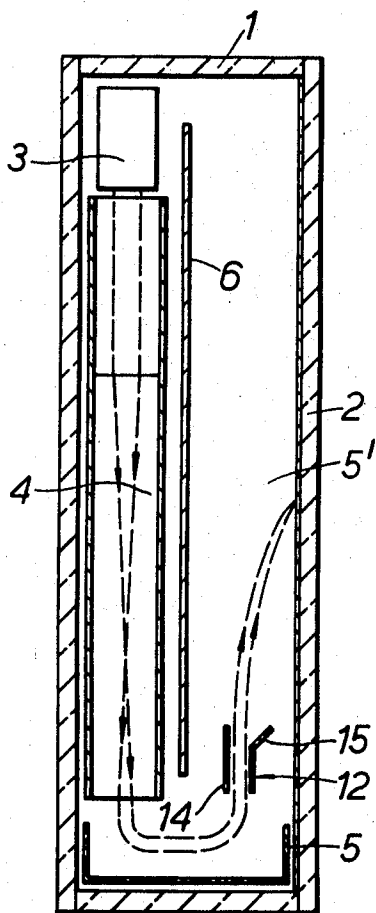
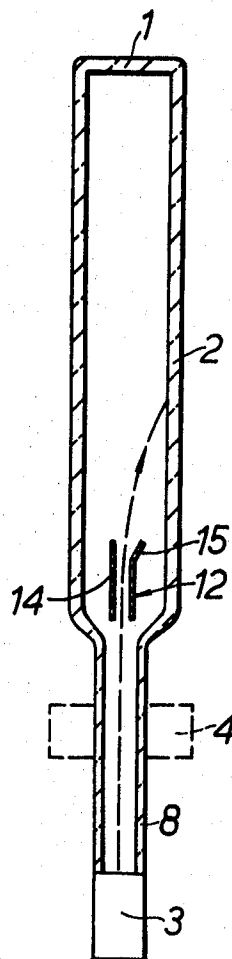


FIG. 2. (PRIOR ART)



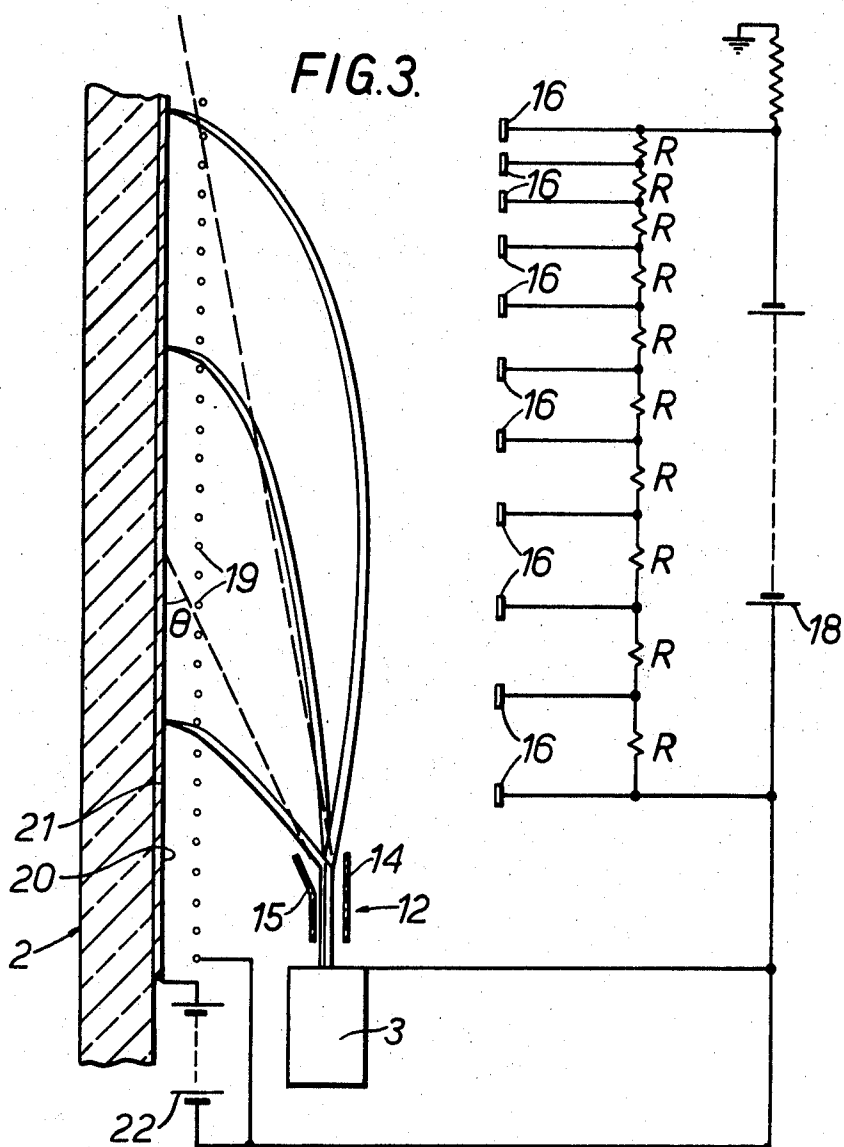
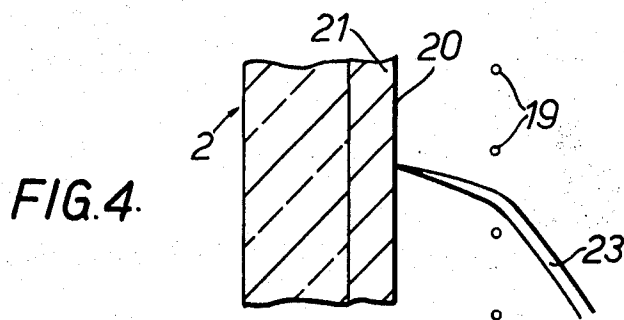
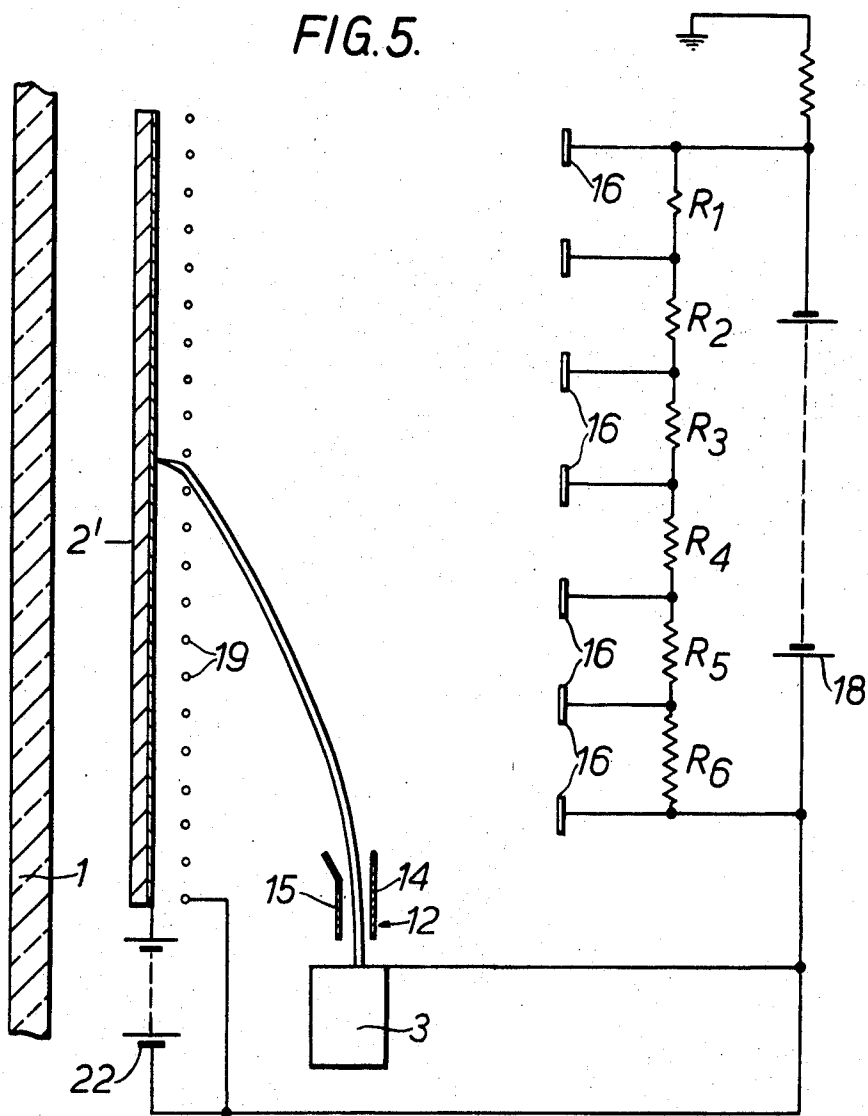


FIG. 5.



LOW DEPTH CATHODE RAY TUBES

This invention relates to cathode ray tubes and is particularly concerned with cathode ray tubes in which the depth of the tube behind the screen is reduced to a minimum.

It has previously been proposed to construct a cathode ray tube in the form of a shallow rectangular box in which the screen is constituted by one of the faces of the box and an electron gun is arranged to direct an electron beam along a path initially substantially parallel to the plane of the screen.

According to the present invention a cathode ray tube comprises an evacuated shallow envelope provided with a substantially flat screen, an electron gun arranged to direct an electron beam into the envelope from one edge thereof in a direction which is initially substantially parallel to the plane of the screen, beam deflection means within the envelope for effecting controlled deflection of the electron beam towards the screen to control the distance from said edge at which the beam impinges on the screen, and an electrode arrangement in the envelope for establishing an electrostatic field such that the electron beam is deflected further thereby towards the screen by an amount which increases with increasing distance from said beam deflection means, whereby the angle of attack of the beam on the screen layer is greater than it would be in the absence of said electrode arrangement.

The screen preferably comprises a phosphor layer deposited upon the internal surface of a transparent substantially flat window forming at least part of one face of the envelope, or may be deposited upon a substantially flat substrate spaced from and preferably parallel to a transparent face of the envelope.

The substrate must of course itself be transparent if the tube structure is such that light produced by excitation of the phosphor must pass through the substrate to reach the transparent face of the envelope.

The tube structure may however be such that the phosphor can be deposited on that face of the substrate which lies adjacent the transparent envelope face, and in this case the substrate can be opaque although the electrode arrangement effective to increase deflection of electrons onto the screen require to be transparent.

In one application of the cathode ray tube according to the invention, the position of incidence of the beam on to the screen can, for example, be selected and can if required be maintained under control of the beam deflection means. This enables random access of the beam to any part of the screen to be obtained and if required to be maintained.

Said electrode arrangement preferably comprises an array of elongated electrodes extending parallel to the screen across a width thereof and spaced apart in a direction parallel to the screen.

Conveniently the electrode arrangement is in the form of a printed circuit of the kind well known in the art deposited on an insulating substrate suitable for use within said envelope of the cathode ray tube.

In a preferred embodiment of the invention, the electrodes of said array are inter-connected electrically by way of a chain of resistors arranged internally or externally of the tube, which is connectable across a source of steady potential difference to establish said electrostatic field. Said field may be arranged to rise from zero

or a low value at the edge of the screen closest to the beam deflection means, to a suitably high value at the opposite edge of the screen in the direction of scan.

In order further to increase the angle of incidence of the beam on to the screen, that is to say to ensure that the beam is incident upon the screen as normally as possible (that is, with as large an angle of attack as possible), a grid may be disposed in the envelope parallel to and immediately behind the screen. This grid, suitably in the form of an array of fine wires, is maintained at beam potential in use of the tube and is effective not only to deflect the beam to a greater angle of attack but also to improve the focussing of the beam onto the screen.

With such an arrangement the screen suitably incorporates an electrically conductive layer which is connectable to a potential above that of the grid and, therefore, that of the electron beam. This enables the accelerating and other potentials used in the tube to be reduced significantly without impairing beam performance and also thereby enables the power required for scanning the beam across the tube screen to be correspondingly reduced. In the tube of the invention the conductive backing can also be arranged to receive a beam modulating potential which is effective to modulate the beam incident upon the screen but which will not alter the position of incidence of the beam on the screen.

The beam deflection means preferably comprise a pair of spaced apart deflection plates extending parallel to the screen and across a width thereof.

In the case where the cathode ray tube is to be used in conjunction with television or other display apparatus, in which the electron beam incident upon the screen is scanned for example in frame and in line directions, the deflection means conveniently are arranged to effect frame scanning of the beam. In this case the tube also includes line scanning means of any convenient type for deflecting the electron beam in a line direction perpendicular to the beam deflection effected by the said deflection means.

The invention will now be particularly described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic edge-on view of one embodiment of a thin cathode ray tube according to one embodiment of the present invention.

FIG. 2 is a diagrammatic edge-on view of a further embodiment of a cathode ray tube according to the present invention.

FIG. 3 is a detailed diagrammatic view of the cathode ray tube shown in FIG. 2.

FIG. 4 is an enlarged view of a portion of the cathode ray tube shown in FIG. 3, and

FIG. 5 illustrates diagrammatically a thin cathode ray tube according to an alternative embodiment of the invention.

The same reference numerals are used throughout the drawings to indicate like components.

The cathode ray tube shown in FIG. 1 is referred to as a folded tube. The tube comprises a shallow rectangular envelope 1 one face of which is constituted by a substantially flat window on the inner surface of which is deposited a phosphor layer forming a screen 2. An electron beam produced by an electron gun indicated

generally at 3 is directed initially in a direction substantially parallel to the plane of the screen 2.

The beam passes through electrostatic line scan deflection plates and a collimating system indicated generally at 4 and is then folded back on its original trajectory by a reversing electrode 5 so that the beam passes, in a direction substantially parallel to the plane of the screen 2, into a narrow space 5' between a magnetic shield 6 and the screen 2. The magnetic shield 6 prevents interaction between the adjacent parts of the folded beam.

A thin cathode ray tube according to an alternative embodiment of the invention is illustrated diagrammatically in FIG. 2, and this is referred to as a planar form of tube. In this tube an electron beam generated by an electron gun 3 in a neck 8 adjoining one edge of the envelope 1 passes through a magnetic or electrostatic line deflection system 4 followed by an electrostatic collimator (not shown) so that the beam entering the envelope 1 is parallel to the axis of the gun 3 but displaced laterally in the line direction. The collimated beam enters envelope 1 in a direction parallel to the plane of a flat screen 2 forming one wall of the envelope 1, without in this case being folded back upon itself.

In both the planar tube of FIG. 2 and the folded tube of FIG. 1 beam deflection means, indicated diagrammatically at 12 in each Figure, are mounted within the envelope 1 adjacent one edge of the screen 2 for the purpose of effecting controlled deflection of the electron beam, which is travelling initially substantially parallel to the plane of the screen 2, towards the screen. As illustrated the beam deflection means 12 are electrostatic, comprising a pair of plates 14, 15 between which the electron beam passes.

The effect of the beam deflection by the deflection means 12 is illustrated more clearly in FIG. 3, which illustrates in purely diagrammatic form some typical beam trajectories in the tube of FIG. 2.

The plates 14, 15 of the deflection means 12 extend parallel to the line-scanning direction along the entire extent of one edge of the screen 2 (not shown in FIG. 3 in the interests of clarity.) The deflection means 12 is spaced a short distance, typically 2 inches, behind the plane of the screen 2. A frame-scanning voltage is applied across the plates 14, 15, causing the electron beam, which in its undeflected state is parallel to the screen 2, to be deflected towards or away from the screen, the angle of deflection being directly dependent on the applied voltage.

In the absence of further electrostatic fields in the envelope, the deflected electron beam leaving the deflection means 12 will follow a linear path (some of which are shown in broken lines) which impinges on the screen 2 at an angle of attack (i.e., the complement of the angle of incidence) which is equal to the beam deflection angle. Clearly as the angle of attack decreases, the beam impinges on the screen 2 further from the deflection means 12. With a typically dimensioned tube the angle of attack of an electron beam impinging on the edge region of the screen 2 remote from the deflection means 12 could be as small as 3°. Such a small angle of attack is unsatisfactory in practice, since it leads to an excessive line width in this region of the screen 2.

In accordance with the present invention, however, the angle of the electron beam on the cathode ray tube screen is increased by establishing within the tube envelope 1 a fixed electrostatic field in a direction perpendicular to the plane of the screen 2 such that the beam is further deflected towards the screen 2 after leaving the deflection means 12 by an amount which increases with increasing distance from the said deflection means 12. Thus as indicated in full lines in FIG. 3, the beam trajectories are in practice curved towards the screen 2, with the result that the angle of attack of the beam at each position on the screen 2 is increased.

Any suitable electrode arrangement may be employed to produce the desired electrostatic field in the envelope. The arrangement shown in FIG. 3 comprises an array of parallel strip-like electrodes 16 extending in the line-scanning direction (i.e., parallel to the plates 14, 15) and disposed in a common plane parallel to the screen 2. The electrodes 16 are spaced apart by distances which increase progressively towards the deflection means 12. Conveniently, the electrodes 16 may be constituted by conductive strips formed on an insulating substrate by the known printed circuit technique.

Externally or internally of the tube envelope 1 the electrodes 16 are interconnected by respective equal resistors R of a chain of resistors connected across a direct-current source 18. Typically, the electrode 16 closest to the deflection means 12 is held at a potential, that is, the potential of the final electrode of the electron gun 3, equal to or close to the beam potential, while the electrode 16 furthest from the deflection means 12 is connected to the negative side of the source 18.

In an alternative, more convenient, arrangement, illustrated in FIG. 5, the electrodes 16 are spaced at equal intervals, and the respective resistors $R_1, R_2, R_3, \dots$ interconnecting adjacent electrodes 16 are suitably chosen or adjusted to give the desired beam-deflection characteristics. Good results are also obtained in practice when all the electrodes 16 are held at the same potential.

Arranged parallel to and immediately behind the screen 2 is a grid 19 comprising an array of fine grid wires. These are arranged, by suitable lead-in wires (not shown) extending through the tube envelope 1, to be connectable to a source of potential which maintains the grid 19 at beam potential. When the voltage on the screen 2 is greater than that on the grid 19 this ensures that the beam is further deflected onto the screen 2, increasing its angle of attack still further and also ensuring improved focusing of the beam onto the screen 2.

Instead of forming one wall of the envelope 1, the phosphor coating may be deposited on a substrate 2' disposed within the envelope 1 and spaced from and parallel to the transparent face of the envelope 1, as shown in FIG. 5.

A preferred construction of the screen 2 is illustrated in FIG. 4. The screen 2 constitutes a transparent envelope wall or substrate upon which a metal backing layer 20, superimposed on a phosphor layer 21, is deposited. The metal backing layer 20 is connectable to a potential source 22 (FIG. 3) which maintains the backing layer 20 at a potential several kilovolts more

positive than that of the grid 19 and, therefore, that of the beam. This ensures that the potentials on the accelerating and other electrodes in the electron gun 3 can be reduced without in anyway reducing beam performance. This enables the power necessary to produce frame and line scanning of the electron beam across the screen of the tube to be correspondingly reduced.

An enlarged view of a part of the trajectory of a typical electron beam 23 is illustrated diagrammatically in FIG. 4. The focusing of the electron beam 23 onto the screen 2 varies with the angle of attack of the trajectory with respect to the screen 2. The application of the potential difference obtained from the source 22 between the grid 19 and the screen 10 also helps to improve focusing of electrons onto the screen 2 as a result of these different angles of attack.

It will be appreciated that the arrangements described with reference to FIG. 3 or FIG. 4 may be utilized both in the planar form of tube illustrated in FIG. 2, as illustrated, and in the folded form of tube illustrated in FIG. 1.

What is claimed is:

1. A cathode ray tube comprising:

an evacuated shallow envelope,

a substantially flat screen having thereon a phosphor layer disposed within the envelope,

an electron gun which directs an electron beam into the envelope from one edge thereof in a direction which is substantially parallel to the plane of the screen,

beam deflection means within the envelope for selectively deflecting the electron beam towards the screen,

an electrode arrangement in the envelope comprising an array of elongated electrodes, electrically separate from the said deflection means, said electrodes extending parallel to said screen across a width thereof and being spaced apart, in a direction parallel to the screen, by respective distances which increase progressively towards the beam deflection means, and

a source of steady potential connected to said electrode arrangement to deflect the electron beam further towards said screen, the amount of said further deflection increasing with increasing distance from said beam deflection means.

2. Cathode ray tube as claimed in claim 1, wherein the electrodes are constituted by conductive strips deposited on an insulating substrate which is suitable for use within said envelope.

3. Cathode ray tube as claimed in claim 1, wherein the said beam deflection means comprise a pair of spaced apart deflection plates extending parallel to the screen and across a width thereof.

4. Cathode ray tube as claimed in claim 1, including a grid disposed in the envelope parallel to and immediately behind the screen, and a source of potential connectible to said grid to cause the angle of impingement of the electron beam on the screen to be increased as the beam passes through the grid.

5. Cathode ray tube as claimed in claim 4, wherein the screen incorporates an electrically conductive layer, said source of potential providing a potential above that of the grid.

6. Cathode ray tube as claimed in claim 1, including line scanning means for deflecting the electron beam in a line direction perpendicular to the beam deflection effected by the said deflection means.

7. Cathode ray tube as claimed in claim 1, wherein the envelope has a neck communicating with the envelope at said one edge of the screen, and the electron gun is disposed in said neck, the beam deflection means being located at or adjacent said edge.

8. Cathode ray tube as claimed in claim 1, including electron beam line scanning and collimating means in the envelope and a reversing electrode arranged in the envelope at the opposite edge thereof to reverse the direction of the electron beam to direct the latter parallel to the screen from the opposite edge of the envelope, the beam deflection means being located at or adjacent said opposite edge.

9. Cathode ray tube as claimed in claim 1, wherein said screen comprises a transparent substantially flat window forming at least part of one face of the envelope, the phosphor layer being deposited on the internal surface of said window.

10. Cathode ray tube as claimed in claim 1, wherein the envelope has a transparent face and the screen comprises a substantially flat substrate disposed parallel to and spaced from the transparent face of the envelope, the phosphor layer being deposited on said substrate.

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