Dec. 10, 1968 ISAMU NIWA 3,416,026

CATHODE RAY TUBE

Filed Sept. 21, 1964

3 Sheets-Sheet 1

Fig - 1

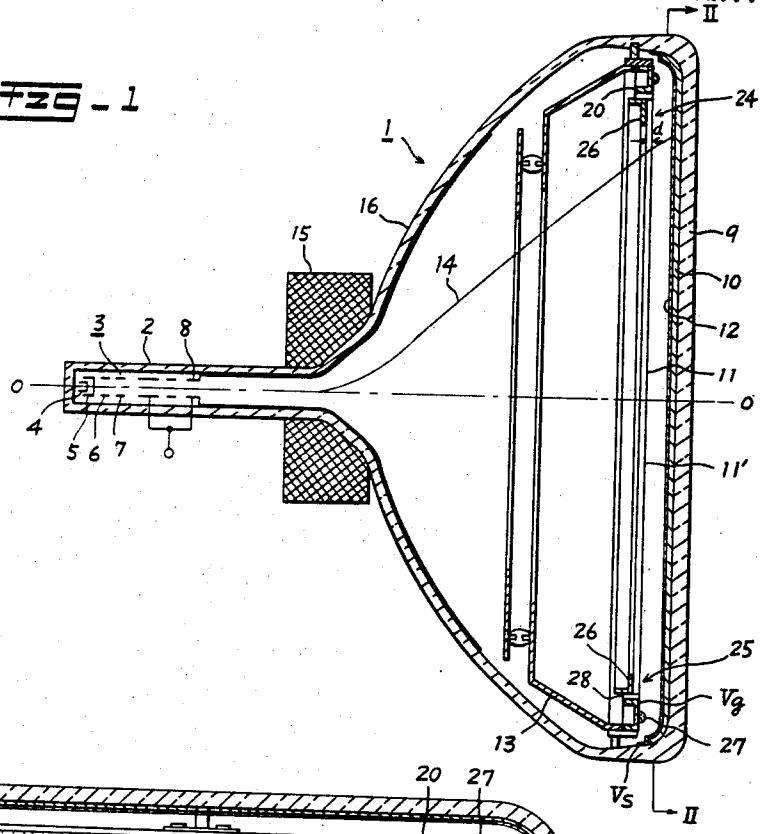
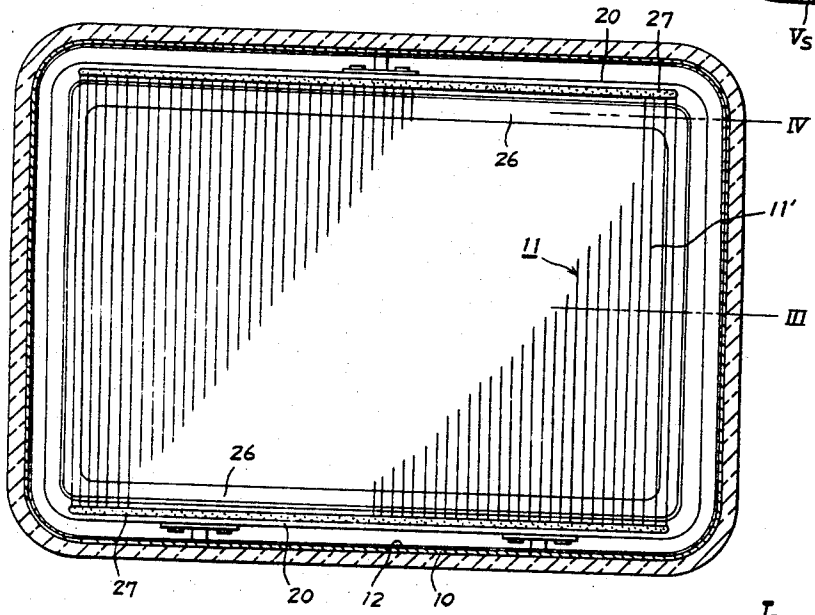


Fig - 2



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Fig - 3

Prior art

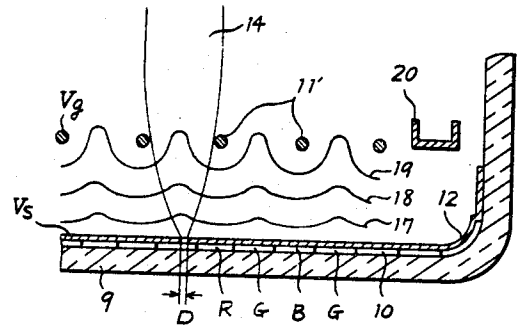


Fig - 4

Prior art

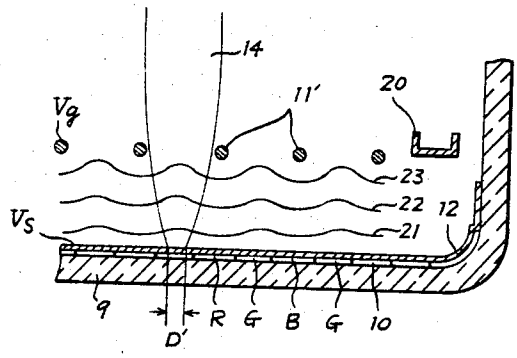
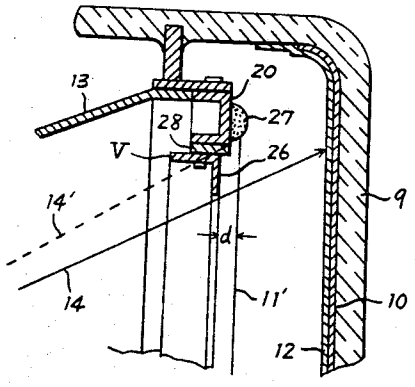


Fig - 7



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Fig - 5

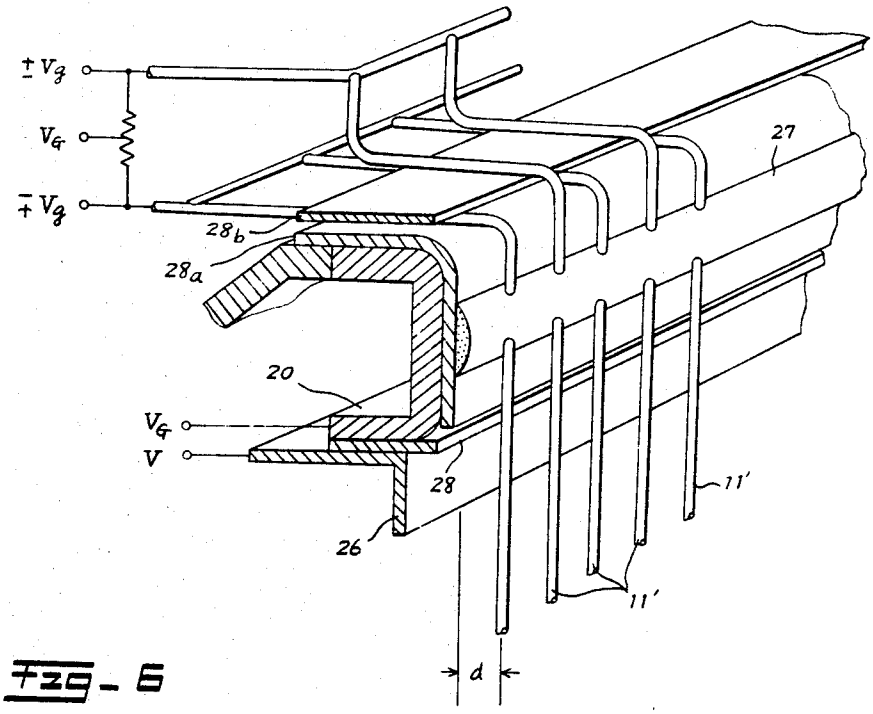
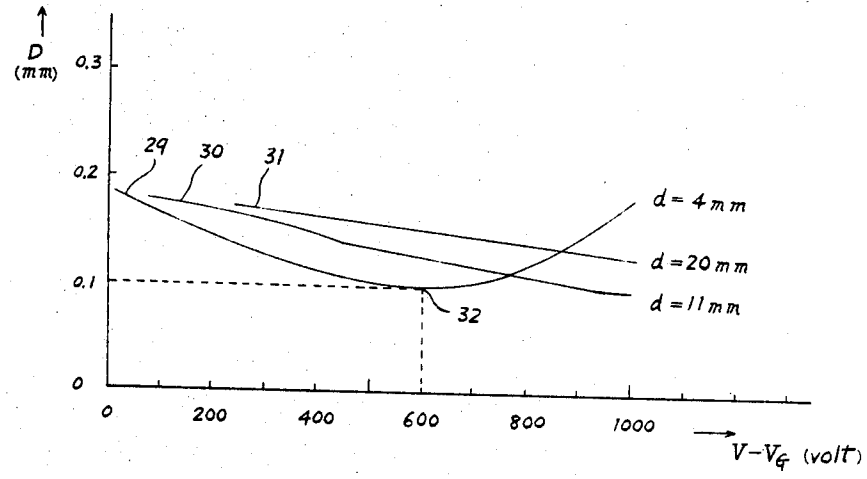


Fig - 6



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CATHODE RAY TUBE

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12 Claims. (Cl. 315—31)

ABSTRACT OF THE DISCLOSURE

In a post-deflecting and focusing cathode ray tube, wherein the grid is supported on a frame, an auxiliary electrode is mounted adjacent to the frame at an edge portion of the grid wires. The auxiliary electrode is provided with a suitable potential and is properly spaced in relation to the grid wires for cancelling a gradient of potential which exists across the grid wires due to the presence of the frame potential which undesirably influences the grid equi-potential lines.

This invention relates generally to cathode ray tubes, and more particularly to a method of post deflecting and focusing an electron beam and to a post deflecting and focusing (PDF) color cathode ray tube such as the chromatron tube.

As is well known in the art, parallel grid wires are utilized in the post deflecting and focusing type of cathode ray tube. A grid frame extends around an inside peripheral portion of the phosphorous screen of the tube and is employed primarily for supporting the grid wires in their respective desired positions. For obvious reasons, the grid frame must be maintained at grid potential. In such a case, however, both end portions of each grid wire are different from the center portion thereof in its potential distribution. As a result, the lens effect in the edge portions of the grid structure is weaker than that obtained in the central portions. The present invention is intended, therefore, to provide a novel method and means for compensating for the edge effect of the grid on the electron stream.

Accordingly, it is a primary object of the present invention to provide an improved cathode ray tube.

It is another object of the present invention to provide a post deflecting and focusing type color cathode ray tube wherein the potential distribution is substantially equal at all points on the grid structure.

It is still another object of the instant invention to provide an improved cathode ray tube for the reconstruction of polychrome images wherein a so-called "color-running" or "fog" is eliminated at the peripheral portions of the phosphorous screen and images of high fidelity are accordingly reproduced thereon.

Still another object of the present invention is to provide an improved cathode ray tube which will illuminate the screen thereof with a constant diameter illuminating spot throughout the entire area thereof.

It is another object of the present invention to provide a method of obtaining a uniform diameter for an electron stream impinging on the screen of a cathode ray tube.

Another object of the present invention is to provide an improved cathode ray tube in which a specific electrode is so positioned with respect to the grid wires and the grid frame and is disposed at a suitable potential with respect to the grid potential to provide a high quality picture representation on the screen.

These and other objects of the present invention will be more fully realized and understood from the following detailed description when taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a semi-schematic and cross-sectional view illustrating a preferred embodiment of a post deflecting and focusing cathode ray tube according to the present invention;

FIGURE 2 is a cross-sectional view of the cathode ray tube taken along line II—II of FIGURE 1;

FIGURE 3 is a partial sectional view taken along line III—III of FIGURE 2 with the electrode structure of the present invention removed therefrom to illustrate the prior art;

FIGURE 4 is a partial sectional view taken along line IV—IV of FIGURE 2 and is also shown with the electrode of the present invention removed therefrom to illustrate the prior art;

FIGURE 5 is a broken out detailed view shown in perspective of the grid structure and electrode of the present invention;

FIGURE 6 is a graph illustrating the relationship of a voltage applied to the electrode of the present invention with respect to the grid voltage and the diameter of the electron stream or beam spot; and

FIGURE 7 is a diagrammatic partial sectional view of the present invention illustrating the masking effect produced thereby.

Like reference numerals throughout the various views of the drawings are intended to designate the same or similar structures.

With reference to the drawings in detail, and in particular to FIGURE 1, there is shown one preferred embodiment of the present invention. A cathode ray tube, generally designated with the reference numeral **1**, includes an electron gun **3** positioned in a neck portion **2** thereof. Various types of electron guns are well known, but the one illustrated by the present exemplification includes an electron-emitting cathode **4**, which in operation is raised to emitting temperature by a heater. A control electrode or grid **5**, in the form of a cup, surrounds the cathode. A second grid **6**, a third grid **7** and an anode **8** are included within the neck portion **2** of the cathode ray tube **1** for additional electron beam control.

Stripe-like phosphor layers **10** of at least two colors are coated on the inner face of a face panel **9** and comprise the screen portion of the cathode ray tube **1**. The screen also includes a conductive coating generally designated with the reference numeral **12** which may, for example, be an aluminum layer. A grid **11** is disposed in spaced relationship and in relatively close proximity to the screen portion. The grid **11** includes a plurality of vertically extended grid wires **11'**, to which are applied switching voltages for proper color selection.

A shield electrode **13** is mounted within the cathode ray tube for reducing the velocity of an electron beam **14** emitted from the electron gun **3**. Furthermore, the electron beam is protected from an external disturbance field and/or a free secondary electron. A deflection coil **15** is mounted at the junction of the neck portion **2** and a funnel portion **16** of the cathode ray tube **1** for providing proper deflection of the electron beam **14** toward the screen portion.

As is well know, the ratio of a voltage V_G applied to the grid **11** and a voltage V_S applied to the phosphor screen **10** is substantially 1 to 4. As a result, the electron beam **14** is re-focused by a static electron lens. Such re-focusing is accomplished by the electric field existing between the grid structure and the screen portion. This static electric field is represented by equal potential lines **17**, **18** and **19** shown in FIGURE 3. In such a case, the electron beam **14** is focused or converged to produce a beam spot having a diameter D which is usually on the order of 0.1 millimeter. However, the equal potential lines illustrated in FIGURE 3 are representative only of the potential distribution at the central portion between the grid and screen.

As illustrated in FIGURES 1 and 2, the grid wires **11'** are supported on a grid frame **20** which extends around the peripheral portion of the screen of the cathode ray tube **1**. The grid frame **20** is maintained at the static grid potential V_G. Therefore, the electric field at the peripheral portions between the grid and the screen is substantially altered as illustrated in FIGURE 4. This effect is especially pronounced at the upper and lower edge sides of the screen, for example, in that area as illustrated in FIGURE 4. In such a case, equal potential lines designated with the reference numerals **21**, **22** and **23** respectively are illustrative of the electric field due to the potential of the grid frame **20**. In this area of the screen, the diameter of the beam spot D' becomes relatively larger and is on the order of between 0.2 to 0.3 millimeter. Therefore, the lens effect at the edge portions of the cathode ray tube is weaker and less pronounced than that at the central portions.

As is more clearly illustrated in FIGURES 3 and 4, the phosphor layer **10** includes a plurality of phosphor stripes for producing red, green and blue color images each respectively designated R, G and B. Each of these color stripes are activated when deflection of the electron beam **14** is accomplished by a switching voltage V_g applied to the grid wires **11'**. Opposite polarities of the switching voltage V_g with respect to the grid potential V_G are applied to alternate grid wires to effect the deflection of the electron beam **14** to the respective color stripes.

In view of the fact that the static potentials produce a gradient of potential and electric field, the diameter of the beam spot on the phosphor stripes will vary between the edge portions and the central portion of the screen. Accordingly, by the present invention, compensation of the gradient of potential is realized to effect a substantially uniform and sufficiently small diameter of the beam spot at all portions of the screen. In the preferred exemplification of the present invention illustrated herein, platelike or annular electrodes **26** are positioned at the edge portion of the grid, particularly in the vicinity of ends **24** and **25** of each grid wire **11'** as is particularly illustrated in FIGURE 1. Electrode **26** is supported in relative proximity to the grid **11** and includes one flange portion thereof extending toward a center axis **0—0** of the cathod ray tube **1**. The grid wires **11'** are secured by means of a cement **27** to the frame **20** and the electrode **26** and shield **13** are secured to the frame **20** through an insulating material **28**.

The exemplified grid structure and the relationship of the electrode **26** thereto is better illustrated in FIGURE 5, since particular minute details could not be illustrated in the other views of the drawings with facility. The grid wires **11'** are insulated from the grid frame **20** by an insulator **28***a* and from one another by an insulator **28***b*. As shown, the alternate grid wires are supplied with opposite polarities with respect to the grid voltage V_G of the switching voltage V_g. The grid frame **20** is maintained at the grid potential V_G and the electrode **26** is maintained at a potential V.

The graph of FIGURE 6 represents the relationship between the diameter D of the beam spot and the potential V of the electrode **26** less the grid potential V_G. The family of curves designated with the reference numerals **29**, **30** and **31** each define a constant parameter of the distance *d* between the grid **11** and the electrode **26**. In the exemplified illustration, the curves **29**, **30** and **31** define distances of 4, 11 and 20 millimeters respectively. As is apparent from the graph, the diameter D decreases with an increase in the potential V of the electrode **26** on the curves **30** and **31**. As shown by the curve **31**, for example, a potential in excess of 1,000 volts is required to obtain a diameter D of about 0.1 millimeter for the electron beam spot on the screen structure.

However, such operating conditions are impractical and when the distance *d* is decreased as illustrated by the curve **29** in FIGURE 6, an optimum point designated with the reference numeral **32** will be obtained wherein the electron beam diameter is relatively small for a potential difference of approximately 600 volts. Although, as apparent from the curve **30**, the electrode **26** may be spaced at a distance of 11 millimeters, it is preferably spaced at a distance of less than 5 millimeters from the grid **11** so that a potential difference between the electrode **26** and the grid frame **20** of less than 1,000 volts may be employed. According to the present experimental results with the exemplified structure illustrated, when the electrode **26** was spaced at a distance *d* of four millimeters from the grid **11**, electron beam diameters of 0.1 millimeters were obtained on the screen structure as shown by the curve **29**.

With the structure of the present invention including the electrode **26**, the edge effect previously mentioned is eliminated and the lens action across the entire grid structure is essentially the same. Therefore, in the present invention, sharp images of good focus can be obtained.

Furhtermore, additional advantages have been realized by the structure of the present invention. That is, when one edge of the electrode **26** projects toward the center axis of the cathode ray tube **1**, it provides a masking effect with respect to the electron beam **14**. Such advantage is better illustrated in FIGURE 7 wherein, if the electrode **26** were removed, an electron beam, illustrated by the dotted line **14'**, would directly impinge the grid frame **20**. Such direct impingement of the electron beam on the grid frame **20** would cause secondary electron emission from the frame structure. In the present invention, however, the beam directed to the frame **20** is masked by the electrode **26**, thereby preventing the occurrence of secondary emission. In view of the foregoing, it is preferable that the electrode **26** disposed at the peripheral portion of the frame **20** be annular in shape.

The principles of the invention explained in connection with the specific exemplifications thereon will suggest many other applications and modifications of the same. It is accordingly desired that, in construing the breadth of the appended claims they shall not be limited to the specific details shown and described in connection with the exemplifications thereof.

What is claimed is:

1. A cathode ray tube comprising

(a) a screen including a plurality of phosphor stripes for emitting respective light color components in response to electron impingement therewith,

(b) a grid mounted adjacent said screen including a frame and wires fixed to said frame in substantially parallel relationship with respect to said phosphor stripes,

(c) an electron gun, and

(d) an electrode disposed substantially perpendicular to said grid and being spaced substantially equally from each of said wires, said electrode being mounted on said frame and projecting toward a center axis of the tube.

2. The cathode ray tube of claim **1** wherein said electrode is spaced a distance of less than 11 millimeters from said grid.

3. The cathode ray tube of claim **1** wherein said electrode is supplied with a voltage of up to 1,000 volts with respect to a voltage applied to said grid.

4. In a cathode ray tube having a screen, an electron gun disposed for emitting an electron stream toward the screen, grid wires disposed in relative proximity to the screen, and a frame supporting the grid wires and disposed for producing a gradient of potential thereon, the improvement therein comprising electrode means disposed in substantial equal proximity to the ends of said grid wires for cancelling the effect of the gradient of potential on the electron stream.

5. The cathode ray tube of claim **4** wherein said electrode means includes an annular plate extending around the entire edge portion of the grid.

6. The cathode ray tube of claim 4 wherein said electrode means is spaced from the edge portion of the grid a distance of less than 11 millimeters.

7. The cathode ray tube of claim 4 wherein said electrode means is disposed at a potential of 600 volts with respect to a potential on the grid.

8. The cathode ray tube of claim 7 wherein said electrode means is spaced from the edge portion of the grid a distance of 4 millimeters.

9. The cathode ray tube of claim 7 wherein said electrode means extends along the entire length of the frame.

10. The cathode ray tube of claim 9 wherein said electrode means extends from the frame toward a center axis of the cathode ray tube.

11. A cathode ray tube comprising

(a) a screen,

(b) an electron gun,

(c) a grid structure including a frame extending about a peripheral portion of said screen and spaced a suitable distance therefrom, said grid structure including a plurality of grid wires supported on said frame,

(d) means for insulating said grid wires from said grid frame and alternate ones of said grid wires from one another,

(e) a signal source disposed at a suitable potential and having opposite signal polarities with respect to said suitable potential connected to respective alternate ones of said grid wires, and

(f) electrode means extending along the entire length of said frame and having a portion thereof spaced substantially equally from the ends of said grid wires and insulated therefrom for cancelling an electric field from said frame and realized on an electron stream emitted from said electron gun and passing through said grid wires.

12. A cathode ray tube comprising

(a) a screen,

(b) a screen including a plurality of phosphor stripes for emitting respective light color components in response to electron impingement therewith,

(c) an electron gun,

(d) means for deflecting an electron stream from said electron gun disposed in relative proximity to said screen and at a suitable grid potential, and

(e) means disposed adjacent to the ends of said wires for focusing the electron stream at an edge portion of said grid, said means being disposed at a distance of substantially 4 millimeters from said grid and at a potential of substantially 600 volts with respect to the grid potential.

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U.S. Cl. X.R.

313—78