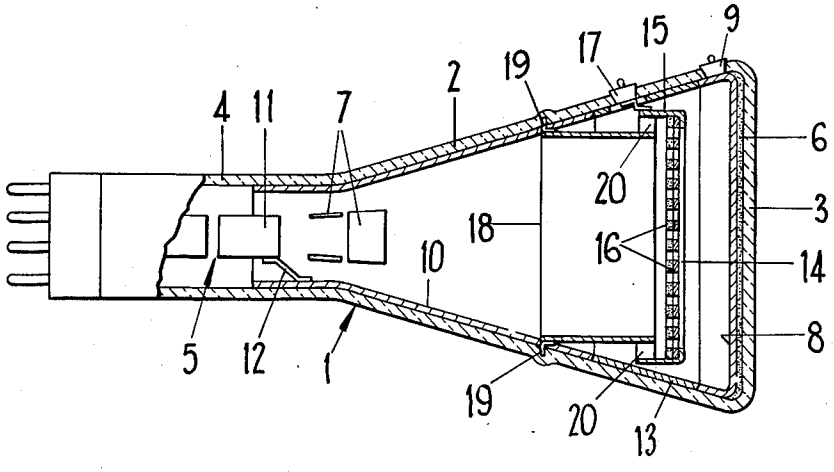
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POST DEFLECTION ACCELERATED TUBE

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INVENTOR
PHILIP HENRY WARNER WHYMAN
BY
Kenderen, Kenderen & Ottinger
ATTORNEYS

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POST DEFLECTION ACCELERATED TUBE

Philip Henry Warner Whyman, London, England, assignor to The General Electric Company Limited, London, England

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This invention relates to cathode ray tubes of the kind incorporating, within a sealed evacuated envelope, an electron gun for generating a beam of electrons which is arranged to be directed towards a target screen, and including, or designed to be associated with, means for deflecting the beam to different regions of the screen in operation of the tube.

The invention is particularly concerned with cathode ray tubes of this kind in which the electrons of the beam are arranged to be deflected whilst travelling at a relatively low velocity and are accelerated towards the screen subsequent to their passage past the deflecting means, such tubes having the advantage of increased deflection sensitivity compared with tubes in which the electrons attain their final velocity before reaching the deflecting means.

The accelerating means in such post-deflection accelerator tubes, as they are generally referred to, has hitherto usually consisted of at least one conducting band formed on the inner surface of the cathode ray tube envelope between the region of deflection of the electron beam and the target screen and arranged to be maintained at a suitably high potential with respect to the final accelerating electrode of the electron gun so that the electric field or fields formed between the deflecting means and the target screen produce the required acceleration of the electrons towards the screen.

However, such tubes suffer from the disadvantage that the accelerating fields which are obtained act in a manner analogous to that of thick lenses in an optical system and as a result the electron trajectories at appreciable angles of deflection are not straight lines but are bent back towards the tube axis. In many cases this causes a considerable deflection loss which offsets the gain in deflection sensitivity resulting from the post-deflection acceleration of the electrons to a marked extent; additional distortion of the electron trajectories might also be introduced by non-uniformity of the accelerating fields, particularly when the electron beam is deflected towards the edges of the screen. As a result the deflection of the electron beam at the screen does not correspond to the forces exerted on the beam by the deflecting means, and in the case of cathode ray tubes of the kind in which the target screen incorporates one or more layers of cathodoluminescent material arranged to be excited to luminescence by the beam this can result in a marked distortion of the luminous image produced on the screen.

In order to reduce or avoid these disadvantages in cathode ray tubes of the kind in which the target screen is electrically conductive, for example in the form of one or more layers of cathodoluminescent material coated with or formed on a conductive film, it has been proposed to place a conducting mesh electrode in the path of the electron beam in the vicinity of the screen and substantially parallel to it, and to maintain the mesh electrode at approximately the same potential as the final accelerating electrode of the electron gun, and the target screen at a high positive potential with respect to the mesh electrode in use of the tube.

In operation of such a tube a substantially field free drift space exists between the deflecting means and the mesh electrode, the electrode trajectories in this space then approximating to straight lines and deflection loss being thereby substantially eliminated, the electrons being accelerated towards the target screen after passing the mesh electrode by the electric field formed between the electrode and the screen.

However, such a form of post-deflector accelerator tube has not hitherto come into widespread use owing to the emission of secondary electrons from the mesh electrode when struck by the electron beam; in general the majority of these secondary electrons are also accelerated towards the target screen by the electric field existing between the mesh electrode and the screen but, owing to the difference between their initial velocity and the velocity of the primary electrons entering the accelerating field, they usually strike the screen in a different position from the primary electrons.

In the case of cathode ray tubes having luminescent screens this can result in a blurring of the images produced on the screen or, in extreme cases, in the formation of double images.

In addition stray electric fields often occur near the edges of the mesh electrode giving rise to distortion of the image at large angles of deflection of the electron beam.

The object of the present invention is to provide a post-deflection accelerator cathode ray tube of the mesh electrode kind in which these disadvantages are largely avoided.

According to the invention in a cathode ray tube of the kind referred to designed to operate with post-deflection acceleration of the electron beam and incorporating an electrically-conducting target screen with a single electrically conducting mesh electrode extending across the path of the electron beam in the vicinity of and substantially parallel to the target screen, the surface of the mesh electrode remote from the screen is coated with a layer of dielectric material whose secondary electron emission properties are such that the layer is charged positively with respect to the mesh electrode in normal use of the tube, and the tube includes an open-ended hollow conducting shield member located on the side of the mesh electrode remote from the screen and through which the electron beam is arranged to pass subsequent to its passage past the deflecting means, the shield member being of appreciable axial length and being disposed with one end adjacent to but insulated from the mesh electrode, and the mesh electrode extending radially outwards beyond the adjacent end of the shield member around the whole of its periphery.

The statement that the hollow conducting shield electrode is open-ended means that it is open to the passage of the electron beam towards the mesh electrode, and in particular is not closed at either end by a grid extending across the electron path between the deflecting means and the mesh electrode.

In use of the cathode ray tube the shield member is arranged to be maintained at the same potential as the final accelerating electrode of the electron gun, the mesh electrode at a slightly negative potential with respect to the shield member, and the target screen at a high positive potential with respect to the shield member. A substantially field free space then exists between the deflecting means and the mesh electrode, so that the tube operates without any significant degree of deflection loss as occurs in the known post-deflection accelerator tubes of the conducting band kind previously referred to, those electrons which pass through the meshes of the electrode being accelerated towards the screen by the electric field existing between the electrode and the screen as previously explained.

However, some of the electrons are incident on the dielectric layer coating the surface of the mesh electrode and, owing to the good secondary electron emission properties of the material forming this layer which causes the

layer to be charged positively with respect to the mesh electrode itself in use of the tube, electric fields are formed within the meshes of the electrode in such a sense as to prevent the secondary electrons emitted by the layer penetrating the electrode and being accelerated towards the screen.

In order for the dielectric layer to be charged positively in use of the tube the material of the layer should have a secondary electron emission coefficient which is greater than unity at an electrical potential equal to that of the final accelerating electrode of the electron gun. Silica, alumina and magnesia have been found to be suitable materials and these can conveniently be deposited on the mesh electrode by an evaporation technique. The potential at which the mesh electrode itself is maintained must not, of course, be such as to reduce to any significant extent the velocity of the primary electrons passing through the meshes of the electrode.

The mesh electrode can conveniently consist of a fine metallic wire mesh carried by an annular frame, and we have found that a mesh formed of wires 0.08 mm. thick, with a spacing of 0.1 mm. between the wires is satisfactory for use in tubes employing a luminescent target screen 120 mm. in diameter. Meshes formed of wires having a different diameter and/or spacing can, of course alternatively be used.

In general it might be preferable for the meshes themselves to extend beyond the shield member, although where the mesh electrode incorporates an annular frame as aforesaid and the frame is formed of conducting material; the frame itself can provide the extending part of the electrode.

The conducting shield member and the extension of the mesh electrode beyond the shield member effectively provide a screen for protecting the path of the electron beam against stray electric fields which might otherwise lead to distortion of the beam particularly at large angles of deflection.

The amount of screening produced will in general depend upon the length of the shield member, the closeness of the spacing between the mesh electrode and the adjacent end of the member, and the amount by which the mesh electrode extends beyond the member, and by suitably constructing and arranging the mesh electrode and shield member the effect of stray electric fields on the electron beam can in most cases be substantially eliminated.

In general the screening effect of the extending part of the mesh electrode can be enhanced by providing the rim of the electrode with an axially directed flange which extends away from the screen and surrounds the gap formed between the electrode and the adjacent end of the shield member.

The end of the shield member further from the mesh electrode preferably extends into contact with the wall of the envelope. In general it will be convenient for the shield member to be in the form of a hollow cylinder or a hollow frustrum of a cone, and where the cathode ray tube envelope includes a frusto-conical bulb portion housing the shield member and the mesh electrode, the shield member can readily be formed of such a length and, in the case of a frusto-conical shield member, of such an angle that the end of the member remote from the mesh electrode makes contact with the inner surface of the bulb portion.

However, the shield member can have any other convenient construction and may for example be of relatively shorter axial length with the end further from the mesh electrode provided with a radially directed flange extending outwards towards the wall of the cathode ray tube envelope.

Preferably the inner surface of the cathode ray tube envelope is coated from the final accelerating electrode of the electron gun to at least the adjacent end of the shield member with a conducting layer, for example of graphite

or silver, the layer preferably being in electrical contact with the final accelerating electrode of the electron gun and the shield member for maintaining the latter at the same potential as the accelerating electrode in use of the tube. This conducting layer is conveniently connected to the conducting layer constituting or forming part of the target screen with a resistive coating on the inner surface of the cathode ray tube envelope, for example of chromic oxide, for tapering the potential gradient which would otherwise exist between the two conducting layers in use of the tube.

The cathode ray tube may be designed for either electrostatic or electromagnetic deflection of the electron beam, and the deflecting means employed can have any suitable known construction.

The target may consist of one or more layers of cathodoluminescent phosphor material coated with or formed on a conducting layer.

By controlling the potential of the conducting layer in such a tube the electron energy and hence the depth of penetration of the electrons into the phosphor material can be varied. Where the screen includes two or more layers of phosphor material arranged to emit light of different colours when excited by the electron beam, the colour of luminescence of the screen can then be varied by the application of appropriate voltage to the conducting layer so as to cause the electrons to penetrate to different ones of the phosphor layers. Such an arrangement is particularly applicable to colour television, the screen then conveniently comprising three superposed phosphor layers arranged to emit say red, blue and green light, or light of other suitable colours, when excited to luminescence, and the tube being arranged to be associated with colour selecting means designed to apply different voltage signals to the conducting layer for causing the electrons to penetrate to each of the phosphor layers in an appropriate sequence.

Such an arrangement has the advantage over previously proposed cathode ray tubes incorporating two or more phosphor layers and a post-deflector accelerator system as previously described, in which one or more conducting layers on the tube wall between the deflector means and the screen are maintained at a high potential for accelerating the electrons towards the screen in that variations in the accelerating potential of a tube in accordance with the invention do not tend to alter the position in which the electron beam strikes the screen, therefore avoiding the necessity for applying a compensating modulation to the deflecting system.

The two phosphor layers on the side of the screen from which the luminous image produced on the screen is arranged to be viewed must, of course, be suitably light-transparent, as must the conducting layer if this is interposed between any one of the phosphor layers and the viewing side of the screen.

If desired, transparent layers of electron energy absorbing materials may be interposed between the phosphor layers to facilitate the selection of the different colours, without any significant degree of light emission from adjoining phosphor layers.

One cathode ray tube constructed in accordance with the invention will now be described by way of example with reference to the accompanying schematic drawing which represents a side view of the tube shown partly in section along the tube axis.

The cathode ray tube comprises a glass envelope **1** consisting of a frusto-conical bulb portion **2**, closed at its wider end by a substantially flat end wall **3**, and continued at its narrower end by a cylindrical neck portion **4** housing an electron gun **5** which is arranged to direct a beam of electrons towards a luminescent screen incorporating a coating **6** of cathodoluminescent phosphor material on the inner surface of the end wall **3**. The electron gun **5** can have any convenient construction and has only been represented diagrammatically in the drawing.

Electrostatic deflecting electrodes 7, which can also be of any convenient construction and which again have only been shown diagrammatically, are located near the junction of the neck and bulb portions of the tube for directing the electron beam to different regions of the screen, in dependence upon applied deflecting voltages.

The luminescent screen also includes a thin electron-permeable aluminum film 8, extending in known manner over the surface of the phosphor layer 6, and for a short distance along the inner surface of the bulb portion 2, as shown. A metal button contact 9, extending hermetically through the envelope wall, and over the inner end of which the aluminium film extends, provides a terminal for enabling the film to be maintained at a high positive potential with respect to the tube cathode in operation of the tube.

The bulb portion 2, and the adjacent part of the neck portion 4, are coated internally with a conducting layer 10, for example of graphite or silver, the layer terminating a short distance from the edge of the aluminium film 8. The final accelerating electrode 11 of the electron gun 5 carries a spring contact 12 which bears against the conducting layer, as shown, so as to maintain the layer at the same potential as the electrode 11 in use of the tube. A resistive coating 13 of chromic oxide connects the aluminium film 8 and the conducting layer 10.

A fine metallic wire mesh electrode 14, circular in shape and of slightly smaller diameter than the screen 6, lies parallel to the screen at a short distance from it, the periphery of the electrode being provided by a cylindrical metal frame 15 which acts as a support for the wires, the wires being attached to one end of the frame and the frame being disposed coaxially within the bulb portion 2, with its opposite end directed towards the electron gun 5. The mesh part of the electrode is coated on the surface facing the electron gun with a film 16 of dielectric material having a secondary emission characteristic greater than unity at an electrical potential equal to that of the final accelerating electrode 11 of the electron gun 5 in normal operation of the tube, for example silica, alumina or magnesia, the film conveniently being deposited on the electrode by an evaporation technique as previously explained.

A further contact 17, also sealed into the side of the bulb portion 2, is connected to the ring 15 and provides a terminal by which an operating voltage can be applied to the electrode 14.

A cylindrical metal shield 18, of slightly smaller diameter than the frame but of greater axial length, is also mounted coaxially within the bulb portion 2 of the cathode ray tube envelope 1, with the end nearer the screen 6 located within the frame 15 and closely spaced from the wires of the mesh, and shield being held in position within the envelope by means of outwardly-protecting metal support members 19 sealed into the envelope wall and electrically connected to the conducting layer 10. The frame 15 carrying the mesh electrode 14 is conveniently mounted on the shield 18 by means of a number of insulating support members 20 extending between the shield and the frame at spaced points around the circumference of the shield.

The diameter of the wires forming the mesh is approximately 0.08 millimetre, the spacing between the centres of adjacent wires being 0.18 millimetre, and the distance of the mesh from the screen being approximately 20 millimetres.

In use of the cathode ray tube the mesh electrode 14 is arranged to be maintained at a slightly negative potential with respect to the layer 10, and hence the shield 18, whilst the aluminium film is maintained at a much higher potential than the layer 10. In practice we have found that with the aluminium film 8 maintained at a potential of 10 kv. positive with respect to the cathode, and the shield 18 and final accelerating electrode 11 maintained at a potential of 1 kv. positive with respect to the cathode, a satisfactory potential for the mesh electrode 14 is 50 volts negative with respect to the shield 18. The electrons which pass through the meshes of the electrode 14 in use of the tube are accelerated towards the screen 6 in the uniform electric field existing between the electrode and the aluminium film 8. Not all the electrons will, however pass through the meshes of the electrode, an appreciable proportion striking the dielectric film 16. This results in the emission of secondary electrons from the film causing it to be charged positively until sufficient of the secondary electrons are recollected to reduce the effective secondary electron emission coefficient to unity, the dielectric film thereafter being maintained at a positive potential with respect to the electrode itself and approximately at the potential of the layer 10.

Under these conditions secondary electrons emitted by the film 16 are prevented from passing through the meshes of the electrode owing to the presence of the electric fields within the meshes produced by the difference in potential between the surface of the film and the surface of the electrode, so that undesired bombardment of the screen by secondary electrons is substantially avoided.

The mesh electrode 14, together with the shield 18, ensure that the electrons travel on a substantially free field space between the deflecting plates 7 and the mesh electrode, thereby preventing any significant degree of deflection loss; in addition the effect of stray electric fields on the electron beam at appreciable angles of deflection, which could lead to distortion of the luminous image produced on the screen, is substantially prevented by the shield 18 and the surrounding part of the frame 15.

In a modification of the tube described, the metal shield 18 if of frusto-conical shape with its wider end directed towards the electrode 14, the shield being held in position by support members 19 projecting outwards from the opposite end and sealed into the envelope wall as is the case with the shield of the tube illustrated.

In a further modification of the tube described, designed for colour television reception, the phosphor layer is replaced by three superposed transparent phosphor layers arranged to emit red, blue and green light when excited by the electron beam. In use of the tube voltage colour signals from a colour synchroniser circuit are applied to the aluminium film, the values of the colour signals being such as to cause the electron beam to penetrate to each of the layers in an appropriate sequence.

Where the electron beam is required to be deflected electromagnetically the electrostatic deflecting electrodes in the arrangement illustrated or in the modification thereof can, of course, be replaced by electromagnetic deflecting coils of any convenient construction.

I claim:

1. A post-deflection accelerator cathode ray tube incorporating an electrically-conducting target screen with a single electrically conducting mesh electrode extending across the path of the electron beam in the vicinity of and substantially parallel to the target screen, wherein the surface of the mesh electrode remote from the screen is coated with a layer of dielectric material having high secondary electron emission properties for causing the layer to be charged positively with respect to the mesh electrode in normal use of the tube, and the tube includes an open-ended hollow conducting shield member located on the side of the mesh electrode remote from the screen and through which the electron beam is arranged to pass subsequent to its passage past the deflecting means, the shield member being of appreciable axial length and being disposed with one end adjacent to but insulated from the mesh electrode, and the mesh electrode extending radially outwards beyond the adjacent end of the shield member around the whole of its periphery.

2. A cathode ray tube according to claim 1 wherein the dielectric layer on the mesh electrode consists of

one member of the group consisting of silica, alumina and magnesia.

3. A cathode ray tube according to claim 1 wherein the target screen consists of at least one layer of cathodoluminescent phosphor material together with a conducting layer.

4. A cathode ray tube according to claim 1 wherein the target screen consists of a plurality of superposed layers of cathodoluminescent material together with a conducting layer.

5. A cathode ray tube according to claim 1 wherein the rim of the mesh electrode has an axially directed flange which extends away from the screen and surrounds the gap formed between the electrode and the adjacent end of the shield member.

6. A cathode ray tube according to claim 5 wherein the mesh electrode comprises a metallic wire mesh carried by an annular metal frame and which frame incorporates said axially directed flange surrounding the gap between the annular metal frame and which frame incorporates said axially directed flange surrounding the gap between the electrode and the adjacent end of the shield member.

7. A cathode ray tube according to claim 1 wherein the end of the shield member further from the mesh electrode extends into contact with the wall of the envelope.

8. A cathode ray tube according to claim 7 wherein the cathode ray tube envelope includes a frusto-conical bulb portion housing the shield member and the mesh electrode, and the shield member is in the form of a hollow cylinder with the end remote from the mesh electrode in contact with the inner surface of the bulb portion.

9. A cathode ray tube according to claim 1 wherein the inner surface of the cathode ray tube envelope is coated from the final accelerating electrode of the electron gun to at least the adjacent end of the shield member with a conducting layer, which layer is in electrical contact with the final accelerating electrode of the electron gun and the shield member for maintaining the latter at the same potential as the accelerating electrode in use of the tube.

10. A cathode ray tube according to claim 9 wherein the conducting layer is connected to a further conducting layer, which forms part of the target screen, by an annular resistive coating on the inner surface of the cathode ray tube envelope.

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