

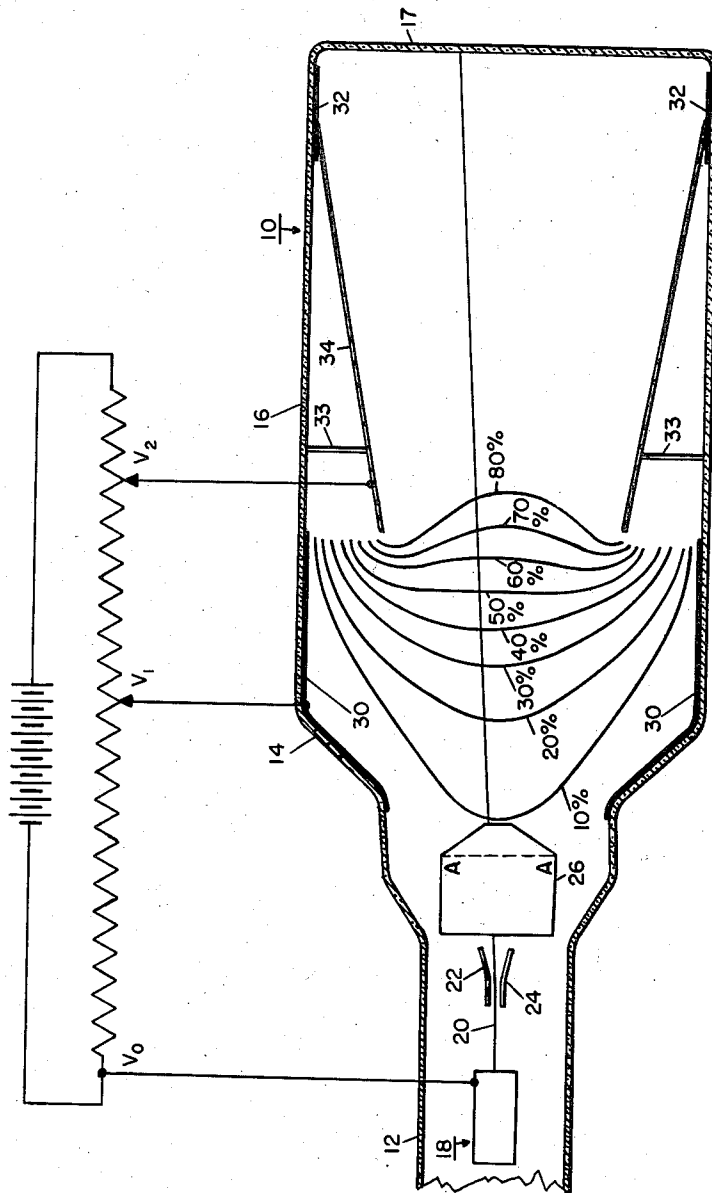
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POST-ACCELERATION CATHODE RAY TUBE

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POST-ACCELERATION CATHODE RAY TUBE

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This invention relates to post-acceleration cathode ray tubes, and more particularly to the production of a strong thin electron lens for use therein.

The function of a cathode ray tube is to form a bright presentation on a fluorescent screen deposited on the inner surface of the tube's faceplate. In order to form a picture of satisfactory brightness, or intensity, the impinging velocity of the electrons must be high, and one way in which this velocity may be imparted to the electrons is known as "post-acceleration." In post-acceleration tubes the electrons pass relatively slowly through the deflecting field, and are subsequently accelerated to produce the desired impingement velocity. Unfortunately, however, the nature of post-acceleration is such that the paths of the moving electrons become curved, causing a form of distortion in which vertical or horizontal lines of the presentation become concave (pincushion distortion), or convex (barrel distortion), this distortion being at a maximum near the edges, and decreasing toward the center. Since the curved electron paths converge in a manner similar to the effect produced on light rays by a positive optical lens, an electrostatic field which accelerates the electrons, and coincidentally bends the electron paths, is known as an "electron lens." When, for simplicity of construction, the desired picture intensity is achieved by increasing the electron velocity in one step (single step intensification), the electrostatic field produces a relatively strong electron lens, which coincidentally distorts the picture presentation.

It is the principal object of my invention to provide an improved post-acceleration cathode ray tube.

It is another object of my invention to provide an improved post-acceleration cathode ray tube utilizing a single step intensifier.

It is still another object to provide an electrode structure which produces a strong thin electron lens.

These objects and others will be apparent when the specification is considered in conjunction with the drawing, which is a diagrammatical cross-sectional view of a cathode ray tube illustrating the basic principles of the invention.

My invention contemplates the use of a single two-cone electron lens positioned between the electron gun and the fluorescent screen of a post-acceleration cathode ray tube to minimize distortion.

The tube illustrated in the drawing comprises an evacuated envelope 10 which has a tubular neck portion 12, a funnel shaped portion 14, a cylindrical portion 16, and a faceplate 17. Within the neck portion is an electron gun structure 18 which emits a stream of electrons 20. The electrons which form the stream pass between a first pair of deflection plates 22 and 24 which cause beam 20 to move from the top to the bottom of the illustration. A second pair of deflection plates 26 and 28 (of which 26 only is visible) straddles electron beam 20 and causes it to move into and out of the plane of the paper.

Deflection circuits and connections well known in the art cause beam deflection, but since the operation of these elements is well known, it will not be further described.

The inner surface of envelope 10 has deposited thereon two separate conductive coatings 30 and 32.

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The first coating—known as the second anode—is on the inner surface of funnel-shaped portion 14 of envelope 10, and is formed by the conductive lining 30; taking the shape of a funnel which has its orifice toward the electron gun 18 and its base toward the faceplate. The cylindrical portion 16 of envelope 10 has a conductive coating 32 deposited on its inner surface, and this conductive coating takes the form of a cylinder. A second funnel, 34, preferably of metal so as to be conductive and more or less self-supporting, has the larger end thereof in electrical contact with conductive cylinder 32. Cone 34 is positioned by a plurality of support members 33. The plane of the cone-mouth is designated as the "transverse plane" whose significance will be hereinafter discussed. Actually, the second funnel 34, and cylindrical conductive layer 32 coact to form the third anode, but for convenience the terms "cone 34" and "third anode" will be used inter-changeably. Alternately, envelope 10 may be shaped so that conductive films on the inner surface thereof will form two anodes similar to 30 and 34. A source of potential and a voltage divider are utilized to establish various potentials, such as V_0 at gun structure 18, V_1 at second anode 30, and V_2 for the third anode.

Electrons emitted by gun structure 18 traverse the deflection fields produced by plates 22—28, and are shown as having their paths bent upward thereby. Alternately magnetic deflection may be used. The electrons follow this upwardly bent path until they encounter the electron lens which is established between the base of funnel 30 and the mouth of cone 34. The electron lens acts to accelerate the electrons, and simultaneously to cause the path of the electron beams to be curved back toward the axis of the tube. The overall electron path is merely indicated schematically, no attempt having been made to show the exact configuration caused by the electron lens.

In prior art post-acceleration cathode ray tubes, conductive cylinder 32—the prior-art third anode—has been of the same diameter as indicated above and of sufficient length to approach the base of funnel 30—the second anode—thus producing an electron-lens described as a coaxial cylindrical lens. In this prior art type of electron lens, the equipotential lines bulged symmetrically in both directions with progressively greater spacing, setting up a condition best known as a "thick lens" from its analogy to optics.

My invention produces an electrostatic accelerating field which acts as a strong, thin electron lens which inherently has less distortion. Fig. 1 shows a series of lines illustrating the locus of equipotential lines between cone 34 and funnel 30. These lines are designated by numbers which indicate the relative values of the particular potentials. It may be seen that the equipotential lines do not bulge symmetrically outward in both directions in the form of a thick lens, but instead are compressed and tend to be more equally spaced in the manner of a thin lens.

I have found that if cone 34 is positioned so that there is a large separation between the plane of its mouth (the transverse plane) and the reference plane A—A of the deflection system, the resultant distortion is barrel shaped. As cone 34 is either lengthened or moved bodily so that its mouth becomes progressively closer to reference plane A—A, the distortion due to deflection plates 26—28 changes from barrelled to pincushioned. At the transition point where barrel distortion changes to pincushioning, the sides of the presentation become straight. This straightening effect is in evidence only for that portion of the presentation caused by the second pair of deflection plates 26 and 28.

I have used various sizes, shapes, and positions for

cone 34. In each case the dimension of the mouth was large enough to avoid interception of the beam under conditions of maximum deflection. I have found that optimum results are obtained when the separation (distance between reference plane A—A and the transverse plane of the cone-mouth) is in the range from 50% to 100% of the tube diameter. For optimum results, the diameter of the cone-mouth should be between 65% and 85% of the tube diameter at the transverse plane. The smaller the cone-mouth, the closer it should be to A—A.

According to the foregoing, the cone may be long or short, steep-angled or shallow-angled. The optimum position of the cone in the tube will vary somewhat with its shape. For a tube 5" in diameter, I have obtained satisfactory results with a cone-mouth of 4" diameter spaced approximately 4 1/4" from the reference plane.

Starting from the optimum cone position, if the separation decreases, the 10% line bulges progressively deeper into funnel 30 and toward deflection plates 22—28, and it is apparently this effect which changes the distortion from barreling to pincushioning. For tubes having different dimensions or outlines the optimum position of the cone and funnel will vary.

For a cone having a given length, angle, and position, the "horizontal" sides of the presentation determined by the second pair of plates 26 and 28 can thus be made straight. However, the "vertical" edges, determined by the first pair of plates 22 and 24, are invariably barrel shaped. This distortion may be corrected by shortening conductive funnel 30 by the removal of conductive material from its orifice end adjacent to electron gun 18. Minimum distortion occurs when the edge of the second set of deflection plates 26—28 is approximately coplanar with the orifice of funnel 30. In the illustration, the base of conductive funnel 30 terminates at the transverse plane. It may, however, be extended slightly so that the third anode 34 penetrates into second anode 30.

It is preferable that no part of the deflection plates penetrate into funnel 30. This may be controlled by properly positioning the funnel-orifice. In this manner, both pincushioning and barrel distortion of all edges of the presentation can be eliminated to achieve a straight edged presentation.

In prior art tubes the shape of the edge of the deflection plates 26—28 was quite critical, for example, a straight edge caused pincushioning. It was therefore necessary to curve the edge, and a specific degree of convexity was used to aid in the correction of pincushioning. Too much curvature would introduce barrel distortion. In my invention the shape of the deflection plate exit edge has no effect on distortion of the type discussed. Since the shape of the deflection plate is less critical, larger tolerances are possible with resultant reduction in manufacturing costs.

Another advantage accrues from my invention. In prior art single step intensifier tubes, distortion limited the voltage ratio V_2/V_1 to a value of 2, thus limiting the impingement velocity. Due to my invention, the voltage ratio may be increased to a value of 4 or greater, thereby permitting a greater brightness of the presentation. I have obtained satisfactory results using a ratio of 5.

Another advantage accrues from my invention. It permits distortionless presentation with only one accelerator electrode, while at least three such accelerator electrodes were needed in the prior art to eliminate distortion.

While I have described the principles of my invention, and a preferred embodiment thereof, variations will occur to those skilled in this or related arts. I desire therefore to be limited not by the foregoing specification, but by the claims granted to me.

What is claimed is:

1. A post-acceleration type of cathode ray tube, comprising: a bulb having a tubular neck, a funnel shaped portion, a cylindrical portion, and a faceplate; an electron beam producing gun in said tubular neck; deflection means; and an improved post-accelerator configuration comprising a first funnel-shaped conductive electrode having a smaller end of substantially the same size as said neck and a larger end of substantially the same size as said cylindrical portion, and a second funnel-shaped electrode having a larger end of substantially the same size as said cylindrical portion and being positioned within said tube with said larger end toward said faceplate, the smaller end of said second electrode being pointed toward said gun said funnel-shaped electrodes being electrically insulated from each other whereby an electron lens may be formed between adjacent ends thereof.

2. The device of claim 1 wherein the smaller end of said first funnel-shaped electrode is substantially coplanar with the edge of the deflection plates nearer said faceplate.

3. The device of claim 1 in which said second funnel-shaped electrode is frusto-conical, and said first funnel-shaped electrode comprises a conductive coating on the inner surface of the funnel shaped portion of said bulb.

4. The device of claim 1 comprising in addition a plurality of support studs sealed into said cylindrical portion of the bulb and extending therefrom and being attached to said second funnel-shaped electrode to support and position said second electrode.

5. The device of claim 1 including a source having a plurality of direct potentials; a first connection between said gun and a point of potential; a second connection between said first funnel-shaped electrode and a point of higher potential; a third connection between said second funnel-shaped electrode and a point of still higher potential.

6. The device of claim 5 wherein the voltage ratio of said second electrode and said first electrode funnel is greater than 4.

7. In a post-acceleration type of cathode ray tube having a tubular neck, a funnel-shaped portion, a body portion, a faceplate, an electron-beam-producing gun, and deflection plates, an improved post-accelerator configuration comprising: a first funnel-shaped electrode having an orifice of substantially the same size as said neck, and a base having substantially the same size as said body portion; a second funnel-shaped electrode having a larger end of substantially the same size as said body portion, and a mouth defining a transverse plane, said second electrode being positioned within said tube with said larger end toward said faceplate and the mouth toward said gun said funnel-shaped electrodes being electrically insulated from each other whereby an electron lens may be formed between adjacent ends thereof.

8. The device of claim 7 wherein the diameter of said mouth is between 65% and 85% of the diameter of said body portion at said transverse plane.

9. The device of claim 7 wherein the separation between said transverse plane and the reference plane of said deflection system is within the range of 50% to 100% of the diameter of said tube at said transverse plane.

10. The device of claim 7 wherein said deflection plates do not penetrate into the orifice of said second anode.

11. The device of claim 7 wherein the base of said first electrode extends at least to the transverse plane.

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