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2,951,179

ELECTRON SHIELD FOR POST ACCELERATION CATHODE RAY TUBE

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2 Sheets-Sheet 1

FIG. 1.

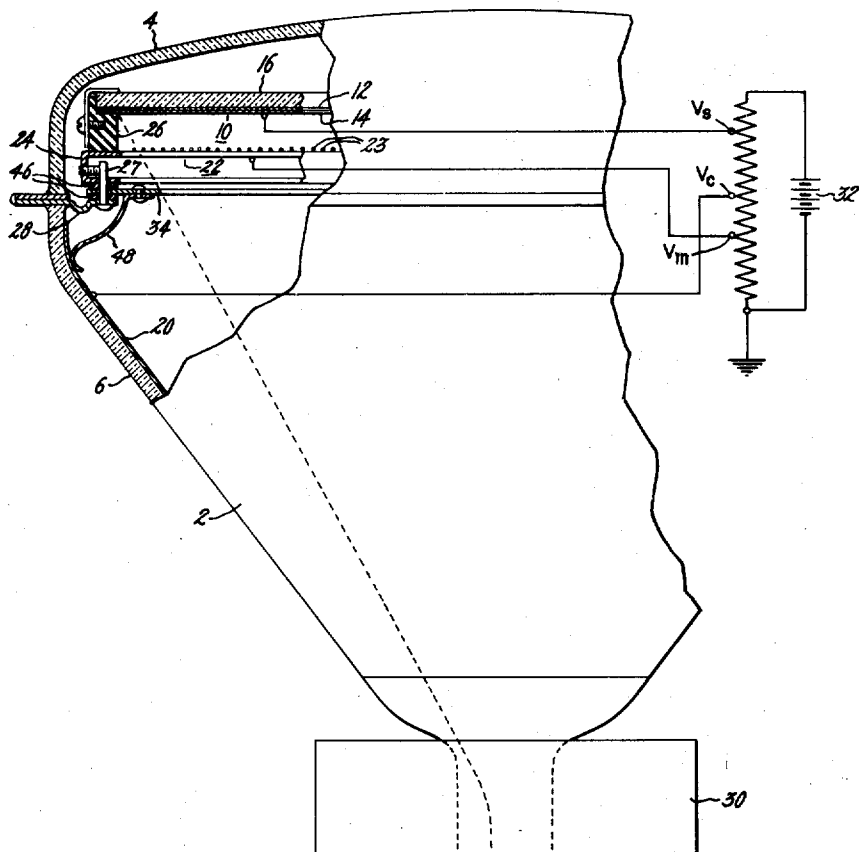


FIG. 2.

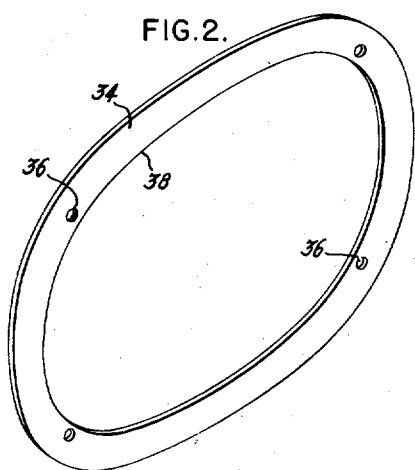
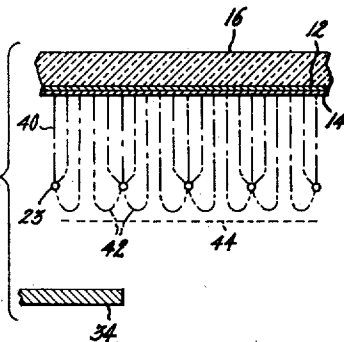


FIG. 3.



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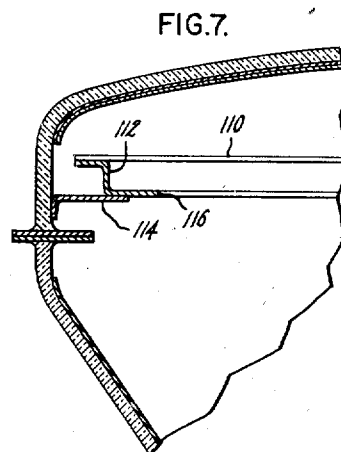
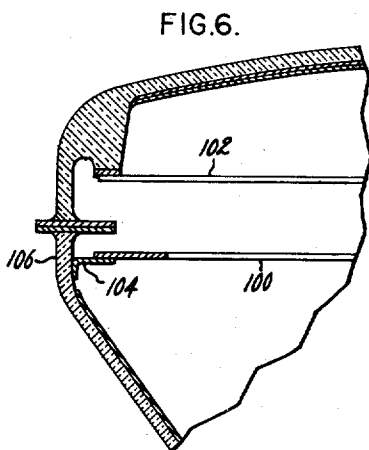
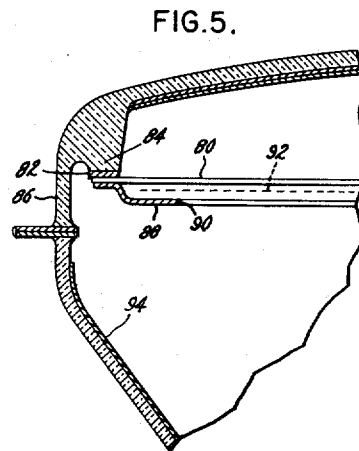
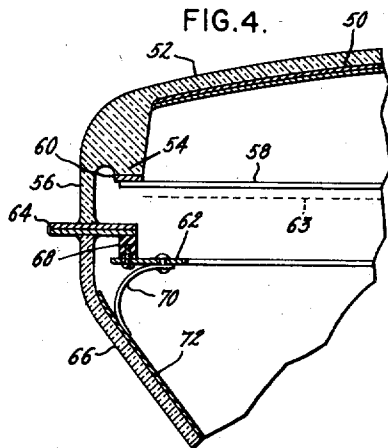
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ELECTRON SHIELD FOR POST ACCELERATION CATHODE RAY TUBE

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2 Sheets-Sheet 2



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ELECTRON SHIELD FOR POST ACCELERATION CATHODE RAY TUBE

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3 Claims. (Cl. 315—15)

This invention relates to cathode ray tubes of the post acceleration type and more particularly to improved means for eliminating spurious electron bombardment of the screens of such tubes.

In a cathode ray tube of the post acceleration type, electrons are accelerated toward the screen after deflection, the additional acceleration being provided by an accelerating electrostatic field formed between the screen and an electron permeable mask of lower potential disposed in the path of the electrons to the screen. Commonly the mask is positioned relatively near and substantially parallel to the screen and is substantially co-extensive in area with the screen. To prevent the screen-illuminating electrons from striking the envelope or other parts of the tube and building up charges at undesired points thereon, or where a precise definition of the boundary for the illuminated area of the screen is desired, as in television picture tubes for example, there is also provided in the tube an electron impervious shield or baffle. The shield is spaced from the mask on the side thereof away from the screen, i.e. facing the electron gun or guns of the tube. The shield extends along the peripheral portion of the mask, and is so positioned relative to the mask that it serves as a frame for an aperture, the electron shadow of which on the screen defines the boundary of the screen area desired to be illuminated. Thus electrons whose paths are such that they would strike the screen outside this desired area are intercepted by the shield and thereby prevented from reaching the screen.

One of the disadvantages of such a shield heretofore, however, is that it gives off secondary electrons when impinged by primary electrons emanating from the gun or guns of the tube. Many of such secondary electrons are drawn into the accelerating field between the mask and screen and are then accelerated to the screen. These secondary electrons strike the screen at random locations and cause spurious light output which has a deleterious effect on the quality of fidelity of the displayed image. In multiple-phosphor color television picture tubes, for example, such secondary electrons produce white light which undesirably dilutes the picture colors.

Attempts have been made to recover these secondary electrons before they are drawn into the accelerating field, by providing a suitable scavenging potential for the collector electrode conventionally coated on the interior surface of the envelope funnel section. This collector electrode is normally operated at a potential at or near the mask potential so as to attract stray electrons and provide a substantially field-free region in the funnel of the tube on the side of the mask away from the screen. Raising the potential of the collector electrode to a level sufficient to make it an effective scavenger for the secondary electrons from the shield, however, destroys the field-freeness of the funnel region. This in turn creates non-homogeneous distortions of the paths of electrons emanating from the gun or guns of the tube, which distortions are suffi-

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cient in color picture tubes, for example, to cause significant color impurity, and hence cannot be tolerated.

Accordingly, a principal object of the present invention is to provide novel means of improved effectiveness for preventing impingement of the screen of a post-acceleration cathode ray tube by spurious secondary electrons emanating from the electron shield thereof.

Another object is to provide improved means for scavenging spurious secondary electrons in a post acceleration cathode ray tube, which scavenging means is practical, inexpensive, and easy to incorporate in a tube.

These and other objects of the invention will be better understood from the following description, and the scope of the invention will be defined in the appended claims.

Briefly, in accordance with the invention, I have found that the number of secondary electrons from the shield which are drawn into the accelerating field can be substantially reduced by suitably positioning the shield, and particularly the inside edge thereof, with respect to the plane of the mask, and by selecting a suitable potential for the shield. In a preferred aspect of the invention, I space the shield from the mask in a direction away from the screen a sufficient distance to minimize attraction of secondary electrons into the accelerating field, and I further select a potential for the shield such as to create a potential gradient between the shield and mask, or field in the vicinity of the mask, which repels secondary electrons emanating from the shield and thereby effectively prevents them from being drawn into the accelerating field. I also select a potential for the collector electrode which is at least equal to the potential of the shield and thereby facilitates effective scavenging by the collector electrode of secondary electrons emanating from the shield. With this arrangement, secondary electrons emitted from the electron shield are effectively prevented from being drawn into the accelerating field of the tube, and return either to the shield or to the collector electrode, thus being completely eliminated as a source of spurious illumination of the screen.

In the drawings:

Figure 1 is a partially schematic, partially broken-away plan view of one form of a post-acceleration cathode ray tube constructed in accordance with the invention;

Figure 2 is a diminished perspective view of one part of the tube of Figure 1;

Figure 3 is an enlarged fragmentary view of a portion of the structure of Figure 1;

Figure 4 is a fragmentary sectional view of another post acceleration tube illustrating another embodiment of the invention;

Figure 5 is a view similar to Figure 4 showing another embodiment of the invention;

Figure 6 is a view similar to Figure 4 showing still another embodiment of the invention; and

Figure 7 is a view similar to Figure 4 showing a further embodiment of the invention.

Referring to the drawing, the tube of Figure 1 includes an envelope 2 having a faceplate 4, a generally conical funnel section 6, and a neck section 8. The tube has a screen 10 consisting of a layer of one or more light emitting phosphors 12 backed by an electrically conductive layer 14. The screen may be supported directly on the inside surface of the faceplate of the tube, or, as in the tube shown, may be supported by a separate foundation plate 16 mounted within the tube near the faceplate 4. The screen is illuminated by electrons from one or more electron guns 18, here shown as three in number, situated in the neck 8. A collector electrode 20, in the form of a conductive coating of colloidal graphite or the like, is deposited on the interior surface of the funnel section 6. Spaced from the screen 10 on the side thereof facing the

electron guns 18 is an electron-permeable electron optical lens mask 22 here shown as a grille of fine closely spaced parallel wires 23 supported by a frame 24. The screen foundation plate 16 is mounted on spacers 26 carried by the frame 24, and the frame is in turn supported by fasteners 27 from an inwardly extending metal flange 28 sealed to the envelope 2 at the junction of its funnel and faceplate portions. Alternatively, of course, the frame 24 may be supported directly by the wall of the tube envelope. A deflection yoke 30 is provided for scanning the electron beams across the screen. The mask 22 is maintained at a suitable electron beam accelerating potential V_m with respect to the cathode of the tube by a suitable power supply shown schematically at 32. The screen is maintained by the power supply 32 at a potential V_s substantially higher than the mask potential V_m so as to produce a strong accelerating field in the space between the mask and screen which will increase the velocity of the electron beams as well as focus the beams and thereby provide the desired sharpness and brightness of the image produced on the screen.

The electron shield 34 consists of a generally hoop or ring-shaped planar member of electron-impermeable electrically conductive material, and is shown in perspective in Figure 2. The shield is connected to the flange 28 by fasteners 27 extending through holes 36 in the shield. The shield conforms generally in shape to the marginal or peripheral portion of the mask 22, and is so dimensioned that its inner peripheral edge 38 defines an aperture through which electrons from the guns 18 may pass to the screen. The electron shadow of the shield on the screen 10 defines the boundary of the area desired to be illuminated thereon, and the shield intercepts or blocks off the electron beams from guns 18 whenever they are so directed as to strike a portion of the screen outside of the desired area.

Turning now to Figure 3, there is shown diagrammatically the distribution of certain of the lines of flux of the electric field between the mask and screen. As shown, the nature of the distribution of the field in the vicinity of the wires of the mask 22 is such that some of the flux lines 40 between screen and mask extend directly to the mask wires 23 while other flux lines 42 pass through the spaces between the wires, extend slightly to the rear or side thereof away from the screen, and then curve around in a forward direction before terminating on the wires 23. This phenomenon is well known to those skilled in the art and is responsible for the desirable lensing or focusing effect of the mask on electron beams passing therethrough. Since the voltage along a flux line changes progressively from one end of the line to the other, it will be recognized that the extension of some of the flux lines 42 behind the mask creates a region or potential plane, generally coextensive with the mask and slightly spaced therefrom in a direction away from the screen, where the field potential is higher than the mask potential and the field intensity is such as to have a not insignificant effect on electrons in the vicinity. The effective location of the rearward most portion of this region is designated generally in Figure 3 by the plane 44, and corresponds to the vicinity in which the flux lines 42 reverse direction. Since this region is both behind the mask, i.e. in a direction away from the screen, and has a potential higher than the mask, it has a high attraction for secondary electrons adjacent the rearward side of the mask. Moreover, it will be apparent that once electrons approach this attraction region 44, they will be drawn by the strong voltage gradient of the accelerating field through the spaces between the wires 23 and into the space between the mask and screen. Once this happens, of course, such electrons will be strongly accelerated toward the screen, and will strike it with high energy at random locations thereby causing undesirable spurious illumination of the phosphors.

In accordance with a preferred aspect of the present invention, such attraction of secondary electrons from the shield 34 into the accelerating field is prevented by spacing the electron shield 34 further from the mask 22 in the direction of the electron guns 18 than the electron attraction region 44, and by electrically isolating the shield 34 from the mask, as by insulators 46, and selecting a potential for the shield and collector electrode which is not less than, and preferably somewhat in excess of, the potential of region 44. Thus, a potential gradient is created between the shield 34 and the region 44 which repels secondary electrons emanating from the shield and tends to direct such electrons either back to the shield or around to the collector electrode 20 where they are recaptured. Conveniently, the shield may be maintained at the desired potential by merely electrically connecting the shield to the collector electrode 20 through a metal finger 48, and selecting a potential V_c for the collector which is somewhat greater than the potential of region 44.

Thus, in accordance with the present invention, the field potential of the region 44, being lower than potential V_c , is made to serve as a barrier or fence which in effect repels secondary electrons approaching from the vicinity of the shield and prevents their flow toward the accelerating field.

Figure 4 shows the application of the present invention to a somewhat different type of tube construction. In the tube of Figure 4 the screen 50 is deposited directly on the faceplate 52 of the tube and an integral rearwardly facing ledge 54 in the tube envelope 56 provides the support for the mask 58. In the construction shown a metal strip 60 is cemented to the ledge 54 and the wires of the mask are secured to the metal strip 60. The metal of strip 60 should preferably match the coefficient of the glass, and may be, for example, one of the chrome-irons. The electron shield 62 is located rearward of the electron attraction region 63 corresponding to region 44 in the tube of Figure 1, and is supported mechanically by the flange 64 between the faceplate section and funnel section 66 of the tube. The shield is electrically insulated from the flange 64 by suitable insulators 68. A conductive tab or extension 70 makes electrical contact between the shield and the collector electrode 72.

Alternatively, if it should be desired to preserve the electron shield at the potential of the mask the shield is nevertheless shaped in such a way that the plane of its inner edge is spaced to the rear of the electron attraction region of the tube. Such a construction is shown in Figure 5 wherein the mask 80 is attached to a metal strip 82 cemented to the integral rearwardly facing ledge 84 in the tube envelope 86, and the electron shield 88 is mechanically supported from and electrically connected to the metal strip 82. As shown, the shield 88 is contoured in accordance with the invention so as to minimize the flow of secondary electrons around the inner edge 90 of the shield to the electron attraction region, designated generally at 92, by displacing the inner edge 90 rearwardly sufficiently to space it well behind the region 92. This arrangement has the advantage of simplified construction resulting from the attachment of the shield directly to the metal strip 82, yet the position of the inner edge 90 of the shield relative to region 92 minimizes flow of secondary electrons into the accelerating field and facilitates recovery of the secondary electrons by collector electrode 94.

Figure 6 shows another embodiment of the invention in which the electron shield 100 is not only electrically isolated from the mask 102 but is mechanically supported by tabs or brackets 104 attached directly to the wall 106 of the tube envelope. This arrangement has the advantage that the tabs or brackets 104 may be cut loose from the tube wall and the electron shield thereby easily removed, for example, to facilitate convenient replacement or salvage of the mask 102.

Figure 7 shows still another embodiment in which the mask 110 is attached to the shield 112, and the shield is in turn secured to a mounting ring 114 attached directly to the interior wall of the tube envelope. This has the advantage of eliminating a support such as the ledge 84 shown in Figure 5 and thereby providing a substantial increase in picture size for a given tube envelope size. As with the embodiment shown in Figure 5, the inner edge 116 of the shield is spaced to the rear of the mask sufficiently to minimize flow of secondary electrons into the accelerating field and facilitate recovery of the secondary electrons by the collector electrode of the tube.

Thus it may be seen that the present invention provides an improved electron shield arrangement which is practical, inexpensive, and easy to incorporate in the tube both from a mechanical and electrical standpoint, and which effectively minimizes flow of secondary electrons from the shield to the target and thereby eliminated the spurious light output at the target caused by such secondary electrons.

It will be appreciated by those skilled in the art that the invention may be carried out in various ways and may take various forms and embodiments other than those illustrative embodiments heretofore described. It is to be understood therefore, that the scope of the invention is not limited by the details of the foregoing description, but will be defined in the following claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a cathode ray tube including an envelope containing at least one electron gun and a screen adapted to be illuminated by electrons from the gun, an electron permeable mask in the path of electrons from the gun to the screen between which and the screen is adapted to be formed an electron accelerating electrostatic field, said mask having apertures through which pass electric flux lines extending said screen to said mask, whereby an electron attraction region having a field potential slightly higher than the potential of said mask is formed at a location spaced from said mask on the side thereof away from said screen, an electron impermeable shield disposed between said electron gun and said mask and framing an aperture through which electrons pass from said gun to said screen, at least the inside edge of said shield being located in a plane spaced from said electron attraction region in the direction of said gun, an electron collector electrode adjacent to the shield adapted to be maintained at a potential not less than the potential of said attraction region, and a conductive strap forming a direct electrical connection between said shield and said collector electrode to maintain said shield and collector electrode at the same potential.

2. In a post acceleration cathode ray tube including an envelope containing at least one electron gun and a screen adapted to be illuminated by electrons from the gun, an electron permeable mask disposed in the path of electrons from the gun to the screen, means for main-

taining a potential difference between the screen and the mask such as to form an electron accelerating electrostatic field therebetween, said mask having apertures through which pass electric flux lines extending between said screen and said mask, whereby an electron attraction region having a field potential slightly higher than said mask is produced on the side of said mask away from said screen as a result of the extension of some of the electric flux lines from said screen through said apertures before termination on said mask, an electron impermeable shield on the side of said mask facing said gun, said shield extending about the periphery of said mask and framing an aperture the projection of which on said screen defines the area of said screen illuminated by electrons from said gun, said shield lying generally in a plane spaced from said electron attraction region in the direction of said gun, means for maintaining said shield at a potential higher than the potential of said electron attraction region whereby to inhibit flow of secondary electrons emanating from said shield to said attraction region, an electron collector electrode on the wall of the envelope adjacent the shield, said collector electrode being adapted to be maintained at a potential not less than the potential of said shield.

3. In a cathode ray tube including an envelope containing at least one electron gun and a screen adapted to be illuminated by electrons from the gun, a mounting ring sealed to the interior wall of the tube envelope, a generally hoop-shaped electron impermeable shield carried by the mounting ring and forming a frame the projection of which on said screen delimits the area of said screen illuminated by electrons from said gun, an electron permeable mask carried by the shield and disposed in the path of electrons from the gun to the screen, said mask and screen being adapted to be maintained at different potentials such as to form an electron accelerating electrostatic field therebetween, said mask having apertures through which pass some of the electric flux lines extending between said screen and said mask, whereby an electron attraction region having a field potential slightly higher than said mask is formed on the side of said mask facing said gun, at least the inside edge of the frame formed by said shield being located in a plane spaced from said electron attraction region in the direction of said electron gun, and means for maintaining said shield at a potential greater than that of said attraction region.

References Cited in the file of this patent

UNITED STATES PATENTS

2,263,733	Knoll	Nov. 25, 1941
2,497,660	Devine	Feb. 14, 1950
2,611,100	Faulkner	Sept. 16, 1952
2,661,437	Beckers	Dec. 1, 1953
2,683,833	Zaphiropoulos	July 13, 1954
2,721,288	Vale	Oct. 18, 1955
2,722,623	Law	Nov. 1, 1955
2,728,872	Smith	Dec. 27, 1955