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CATHODE RAY TUBE

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Fig. 1

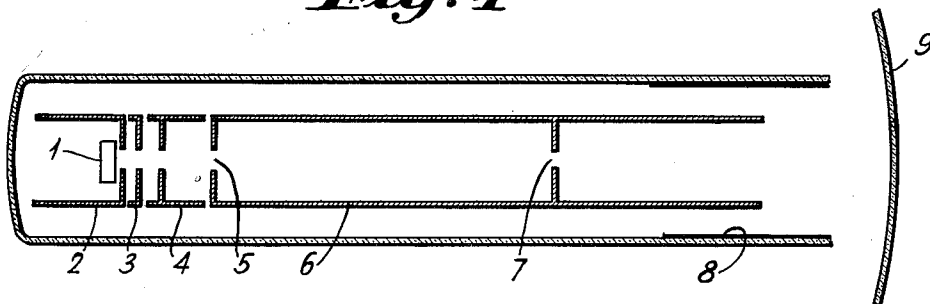


Fig. 2

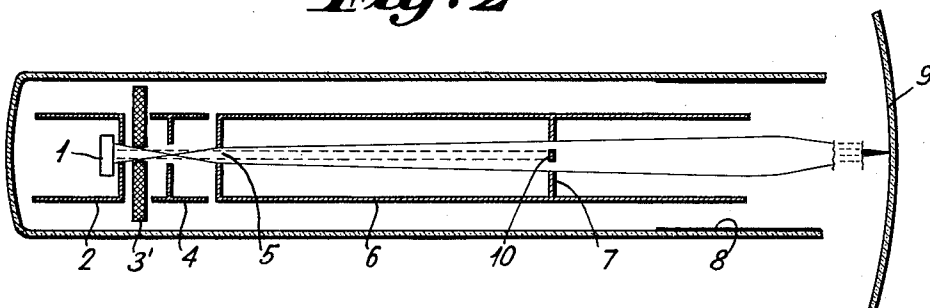


Fig. 3

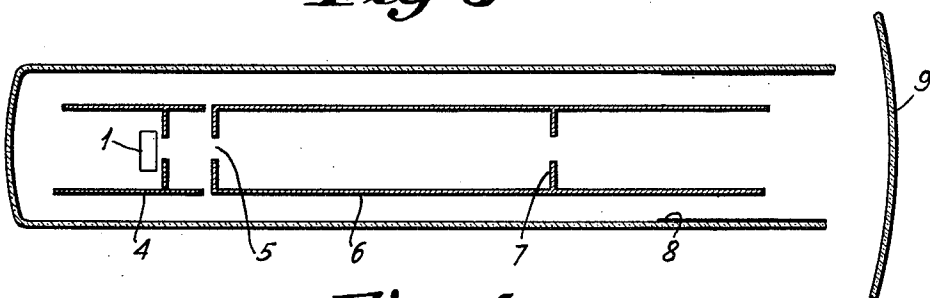
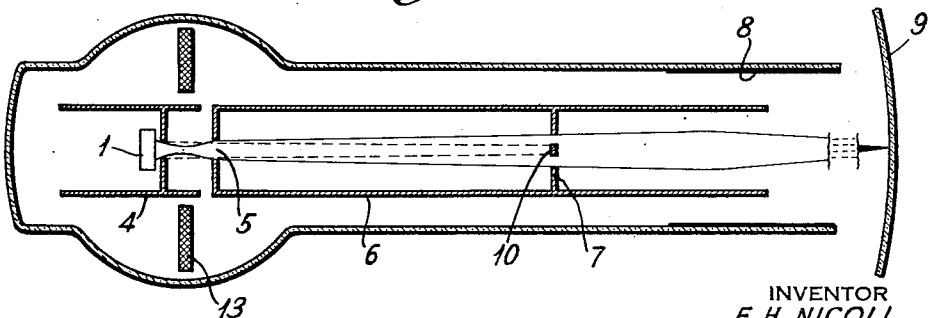


Fig. 4



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CATHODE RAY TUBE

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4 Claims. (Cl. 250-162)

This invention relates to cathode ray tubes of the hard type such as are employed for the reconstitution of an image in television and like receiving systems. Cathode ray tubes of this kind usually comprise a cathode, a grid or modulating electrode, one or more focusing electrodes, an anode and a fluorescent screen provided on the end of an evacuated envelope in which the elements of the tube are mounted, the beam of electrons emanating from the cathode being focused to a small spot on the screen, received picture signals being applied between the cathode and modulating electrode so as to vary the intensity of the ray reaching the screen, thus producing a corresponding variation in intensity of the fluorescent light emanating from the screen.

With the cathode ray tubes having oxide cathodes there is inevitably a small proportion of oxygen present which eventually appears in the form of negatively charged ions during the operation of the tube. In tubes without oxide cathodes the degree of vacuum which can be obtained is rarely sufficient to exclude a perceptible production of oxygen ions during discharge. In addition, ions may be derived from other sources and in all cases their effect is similar to that of the oxygen ions which results in a rapid and irreversible deterioration of the fluorescent screen in the region where they impinge. During the reconstitution of the image the cathode ray beam is deflected over the surface of the screen and where deflection is produced by electrostatic fields, the effect of the bombardment of the screen with ions is to cause decay of the fluorescent emission over the whole scanned patch, and where deflection of the beam is produced by electromagnetic fields which only have a slight deflecting action on the ions travelling along the axis of the tube the effect of the ions is to cause a deterioration of the fluorescent emission at a substantially central spot on the screen.

Attempts have been made with a view to preventing deterioration of the fluorescent screen by producing a material for the screen which is less susceptible to ionic bombardment. These screens, while serving to some extent in overcoming the deleterious effect of ionic bombardment, are not entirely satisfactory in overcoming the difficulty mentioned and, accordingly, it is the chief object of the present invention to provide an improved cathode ray tube in which the deterioration of the fluorescent screen is eliminated or substantially reduced.

In other cathode ray tubes, screens other than fluorescent screens are sometimes employed. For

example, in a television transmitting tube a beam of electrons is caused to scan a photo-electric mosaic screen on which an image of an object for transmission is projected. It is possible that, according to the materials employed in the screen, such screen may be liable to deterioration due to ionic bombardment, and hence the present invention may also be applied, if required, to cathode ray tubes of this kind.

According to the invention, a cathode ray tube of the hard type comprises a cathode for producing an electron beam and a fluorescent screen or other surface upon which the beam is focussed and in which means are provided whereby negative ions emanating from the cathode or from the region of the cathode are intercepted prior to the screen whereby the electron beam when impinging on the screen or surface is substantially free from negative ions.

The present invention, therefore, seeks to reduce the disadvantages mentioned above the principle of intercepting the ions prior to the screen rather than by allowing the ions to impinge on the screen and making the screen less liable to deterioration.

More particularly, means are provided which are so constructed as to cause the greater portion of the ions and the greater portion of the electrons emanating from the cathode to follow defined by different paths, and a suitable stop or obturating surface is disposed in the path of the negative ions whereby the electrons are permitted to pass the final focusing means while the ions are intercepted prior to the final focusing means so that the focused beam which impinges on the screen or other surface is substantially free from ions.

It is known that in an electrostatic field of either a deflection or focusing type, the bending produced by the field is independent of the ratio of the charge of the particle to the mass of the particle, providing that this ratio is constant during the passage of the particle through the field. Consequently, electron and negative ions will follow the same paths, that is to say, the provision of electrostatic deflecting means will cause both ions and electrons to be deflected while electrostatic focusing means will focus both electrons and ions. Thus where, as is sometimes the case, electrostatic deflecting means are employed, the presence of ions in the deflected beam causes deterioration of the screen over the whole of the surface thereof on which the beam impinges. In a magnetic or electromagnetic field it is known that the bending produced by the field is de-

pendent upon the ratio of the charge of the particle to the mass of the particle, and hence with electromagnetic deflecting means substantially only the electron beam is deflected which results in the deterioration of the screen at a substantially central spot as above-mentioned since the ions are substantially unaffected by the magnetic field. It can be shown that for a given magnetic lens, the focal length for ions is considerably greater than for electrons and the angle of deflection for ions in a uniform magnetic field is only a small fraction of that for electrons.

The means employed in the specific form of the invention for the purpose of causing the ions and electrons to follow defined but different paths depend upon the combination of electro-magnetic and electro-static fields which are so adjusted as to control the passage of electrons and ions whereby the electrons and ions follow defined but different paths as aforesaid. With such a control of the paths of the ions and electrons it will be appreciated that by inserting in the path of the ions a suitably shaped and disposed stop or obturating surface, ions can be prevented from passing a predetermined zone in the tube while the electron beam is permitted to pass to final focusing means whereby the finally focused beam is substantially free from ions.

In order that the said invention may be clearly understood and readily carried into effect the same will now be more fully described with reference to the drawing in which:

Fig. 1 illustrates diagrammatically a known form of cathode ray tube,

Fig. 2 illustrates diagrammatically a tube similar to that shown in Fig. 1 but embodying one form of the present invention,

Fig. 3 illustrates a further known type of tube, and Fig. 4 illustrates a tube similar to that shown in Fig. 3, but embodying a further form of the invention.

Referring now more particularly to Fig. 1 of the aforesaid drawing, which illustrates diagrammatically the elements of a cathode ray tube similar to that described in the specification of English Patent No. 431,327. The reference numeral 1 indicates the cathode adjacent to which is disposed a cathode screen 2 having an apertured diaphragm through which electrons emanating from the cathode are accelerated by an accelerator 3, which is maintained usually at about 300 volts positive with respect to the cathode, the electron beam being brought to a focus in the modulator electrode 4 which is maintained usually at or near the cathode potential. The electrons then pass through an aperture 5 in the anode 6 which is maintained at a positive potential of about 1000 volts and through the aperture 7 at the opposite end of the anode 6 and are finally focused on to the screen 9 by an electrostatic lens developed between the electrode 8 and the anode 6, which electrode is usually maintained at a positive potential of about 5000 volts. With the construction shown in Fig. 1 both electrons and ions are focussed on to the screen 9 and hence the screen is subjected to deterioration as aforesaid.

Fig. 2 of the drawing illustrates a tube having an electrode structure similar to that shown in Fig. 1 but modified in accordance with the invention for the purpose of intercepting the ions prior to the final focusing which occurs between the electrode 8 and the anode 6. In this figure the arrangement is such that the electron beam is brought to a focus at the modulator electrode

4 while the ion beam suffers little convergence and is arranged to pass in a substantially parallel beam along the axis of the tube. In Fig. 2 the ion beam is indicated in dotted lines while the electron beam is shown in full lines. The electron and ion beams are caused to follow the paths indicated by a combination of an electro-static and an electro-magnetic lens disposed adjacent the cathode 1. A coil is combined with the accelerator electrode 3' as shown in Fig. 2 for producing an electromagnetic field, and the cathode screen 2 is adjusted in relation to the cathode 1 in the manner hereinafter referred to whereby ions and electrons are caused to move in the required paths. The coil may be combined with the accelerator electrode by surrounding the coil on each side and at the aperture in the centre of the coil with a shield of magnetic material which not only serves to confine the magnetic field to a relatively short distance along the axis of the electrode structure, but also serves as the accelerator electrode, a lead from the shield being brought to the exterior of the tube in the usual manner so that the required operating potential can be applied thereto to cause the shield to function as the accelerator electrode.

In some cases, however, the coil may be arranged externally of the tube and the accelerator electrode may be formed of magnetic material and may comprise a pair of adjacent plates in which is induced the magnetic field produced by the coil surrounding the tube, the plates having connections to the exterior to enable the required operating potential to be applied thereto to cause the plates to function as the accelerator electrode.

Associated with the aperture 7 of the anode 6 is a stop 10 which may be in the form of a circular disc and suitably suspended, or mounted in position so that the ion beam indicated in dotted lines strikes the stop and is thereafter prevented from passing with the electrons to the final focusing means. The stop 10 will of course obturate part of the electron beam, but the diameter of the ion beam can be made sufficiently small so that only a relatively small proportion of the electrons are intercepted by the stop 10. The arrangement of the combined electrostatic and electromagnet lens is such that the convergence of the electron beam is the same as that produced by the electrostatic field between the cathode 1 and the aperture in the modulator 4 of the arrangement shown in Fig. 1. Thus, since the magnetic field adjacent the cathode produces a convergence of the beam, the convergence produced by the electrostatic field should be reduced. This may be effected in several ways. For example, the spacing between the cathode 1 and the cathode screen 2 may be reduced, thus decreasing the convergent action of the field, or a concave cathode may be employed, the radius of curvature of which is such that the convergence produced is less than that produced by the cathode and cathode screen arrangement shown in Fig. 1. Alternatively it may be possible to employ a flat cathode and to omit the apertured diaphragm in the cathode screen 2, or a convex cathode may be employed affording a divergent beam of ions and electrons, the arrangement being such that the electrons are brought to a focus in the modulator 4 by the magnetic field while the ions pass in a substantially parallel path to be intercepted by the stop 10. The arrangement shown in Fig. 3 illustrates a further known form of cathode ray tube

in which a beam of electrons from the cathode 1 are drawn through an apertured disc in the modulating control electrode 4 by an electrostatic field produced by the anode 6 which is usually maintained at a positive potential of about 1000 volts with respect to the cathode 1. The beam of electrons so formed passes through the apertures 5 and 7 in the anode 6 and is finally focused by the field between the anode 6 and an electrode 8 and projected on to the screen 9. Both the ions and electrons are focused on to the screen as with the arrangement shown in Fig. 1. In the arrangement according to a further form of the invention shown in Fig. 4 a magnetic focusing coil 13 is disposed adjacent the cathode 1 of such a construction that the electrons are caused to follow a path substantially similar to that indicated in full lines, while the ion beam is caused to follow substantially the path indicated in dotted lines, the ion beam being intercepted by a stop 10 disposed in the path of the ion beam and contiguous to the aperture 7. In the arrangement shown in Fig. 4 it is necessary to decrease the convergence produced by the electrostatic field for the reasons stated above in connection with the arrangement shown in Fig. 2 in order that the combined electrostatic and magnetic fields will produce the same effect as that produced by the electrostatic field of Fig. 3. This may be effected as described above by alteration of the convergence produced at the cathode, or alternatively, the length of tubing between the cathode 1 and the anode aperture 5 on the modulating electrode 4, may be shortened thus reducing the curvature of the equipotentials in the modulator, and hence their converging effect on the electron and ion beam.

The magnetic fields necessary in connection with the arrangements shown in Figs. 2 and 4 may be produced by the use of a relatively small coil which may be of annular form, or by the use of a permanent magnet which is preferably shielded at both sides by a material having a high permeability so that the field is confined to a short distance along the axis of the tube. In both Figures 2 and 4, when employing a coil for producing the magnetic field, focusing occurs with the beam at a relatively low velocity, and hence the power consumed by the coil is relatively small. In each embodiment of Figs. 2 and 4 the coil may be disposed inside or outside the evacuated envelope, and when disposed inside or outside the envelope it may be associated with the accelerator electrode 1 as described in connection with Fig. 2 or located around the modulator tube 4 as in the arrangement shown in Fig. 4.

The invention is not to be limited to the specific embodiments described above since modifications may be made thereto. For example, instead of causing the ion beam to travel in a substantially parallel path as shown in Figs. 2 and 4, the arrangement may be such that the ion beam is intercepted, for example, by the material bounding the aperture 7 in Fig. 2 or in Fig. 4, thus obviating the necessity of employing the central stop 10.

Alternatively, the coil of Fig. 2 or Fig. 4 may be arranged to cause a divergence of the ion beam at the point where the electron beam of Fig. 2 is focused at the electrode 4 or where the electron beam of Fig. 4 converges and the aperture in the electrode 6 of Fig. 2 or the aperture in the

cathode shield 4 of Fig. 4 made small so that due to the divergence of the ion beam at this point the ion beam impinges on the diaphragm on which the aperture is formed and so the major portion of the ion beam is prevented from passing to the final focusing means.

Thus, with the arrangement in accordance with the invention it is possible by intercepting the ion beam prior to the final focusing means to ensure that the beam which is deflected over the surface of the fluorescent screen is substantially free from ions thus increasing the life of the fluorescent screen.

Although in the specific description the invention has been described as applied to cathode ray tubes having fluorescent screens, it will be understood that the invention can be applied to cathode ray tubes having other types of screens or surfaces on which cathode ray beams impinge.

I declare that what I claim is:

1. A cathode ray tube of the hard type including an electron gun structure for producing a beam of electrons and wherein negatively charged ions may be present comprising means for accelerating the electrons and ions along the axis of the tube, means for applying a radial deflecting force to said electrons and ions whereby the electrons may be deflected in excess of the ions because of the greater mass of the latter, and means positioned centrally with respect to the radially deflected electrons for obstructing the passage of the ions.

2. A cathode ray tube of the hard type comprising a cathode adapted to emit electrons and wherein negatively charged ions may be present in the region of the cathode, means for accelerating the electrons and ions along the axis of the tube, electromagnetic means for applying a radial deflecting force to said electrons and ions, the electrons being deflected to a greater degree than the ions because of the greater mass of the latter, means positioned centrally with respect to the radially deflected electrons for obstructing the passage of the ions and means for focusing the unobstructed electrons into a beam of electrons.

3. A cathode ray tube comprising means including a cathode for producing an electron beam wherein negatively charged ions may be present, a fluorescent screen or other surface upon which the beam may be focused, means including means for developing a magnetic field for causing deflection of the electrons to a greater extent than the deflection of the ions, means for intercepting the ions, and means for subsequently focusing the electrons upon the fluorescent screen whereby the electron beam, when impinging upon the screen or other surface, is substantially free from negative ions.

4. A cathode ray tube comprising means for producing an electron beam wherein negatively charged ions may be present, an electron responsive screen upon which a beam may be focused, means including means for developing a magnetic field for causing the electrons and the negatively charged ions which constitute the beam to follow defined but different paths, electron and ion impervious means positioned in the path of the ions whereby the ions are intercepted, and means for subsequently focusing the electrons upon the electron responsive screen whereby substantially no negative ions will be present in the final electron beam.