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L. F. BROADWAY ET AL

2,213,688

CATHODE RAY TUBE

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Fig. 1

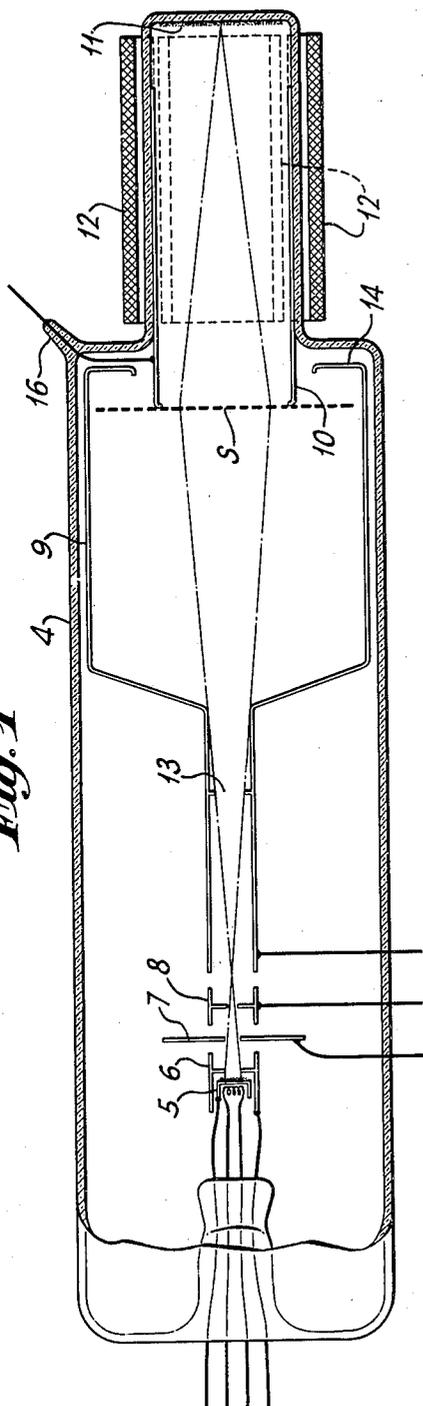


Fig. 3

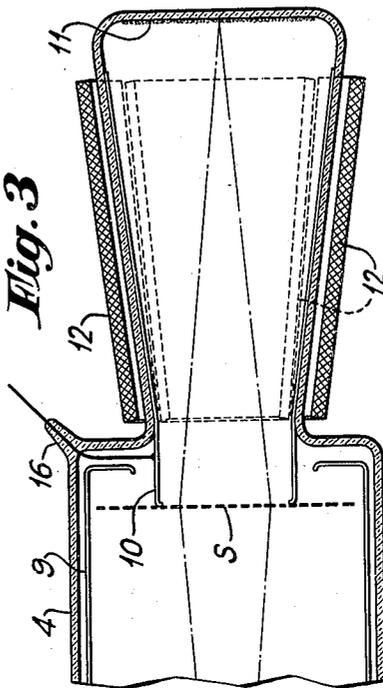
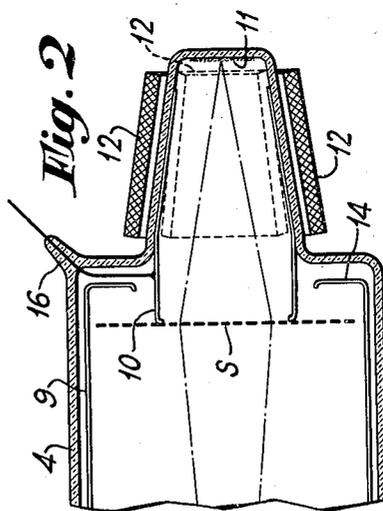


Fig. 2



INVENTORS
LEONARD FRANCIS BROADWAY
AND OTTO KLEMPERER

BY

Charles M. Clair
ATTORNEY.

UNITED STATES PATENT OFFICE

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CATHODE RAY TUBE

Leonard Francis Broadway, Hillingdon, and Otto Klemperer, Iver, Buckinghamshire, England, assignors to Electric and Musical Industries Limited, Middlesex, England

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7 Claims. (Cl. 250—160)

This invention relates to improvements in cathode ray tubes such as are employed for the reconstitution of television signals and particularly to tubes for projecting a luminous image on a distant viewing screen.

In cathode ray tubes employed for the reconstitution of television signals in which the image produced on the luminous screen is projected by an optical system on to a viewing screen it is desirable to utilize a cathode ray beam having a very high current intensity. In order to focus high intensity beams without undue mutual repulsion of the electrons of the beam it is desirable therefore to increase the final angle of convergence of the electron beam as much as possible. In cathode ray tubes for use as above described, which are commonly referred to as "projection tubes," the cathode ray beam is focused by an electron lens comprising the usual first and second anodes which are coaxially arranged within a cylindrical tube and are of substantially the same diameter, the end wall of the tube having a fluorescent screen formed thereon. In order to increase the final angle of convergence of the beam the width of the beam should be as large as possible at the lens and the distance from the lens to the fluorescent screen should be as small as possible. The scanning coils which are provided for deflecting the cathode ray beam over the screen are mounted externally around the cylindrical envelope and have a diameter slightly larger than the diameter of the electrodes of the lens. The diameter of the scanning coils is two-and-a-half to three times the maximum diameter of the electron beam and such an arrangement has the disadvantage that considerable power output is required from the scanning circuits energizing the coils since the magnetic field required for scanning has to be established over a large volume.

It is an object of our invention to provide an improved cathode ray tube in which a cathode ray beam of large diameter may be focused on and deflected over a target with the minimum distortion and minimum deflection power. It is another object of our invention to provide an improved cathode ray tube in which the diameter of the scanning coils can be reduced whereby less power is required to energize the coils than heretofore.

According to the present invention a cathode ray tube is provided comprising an electron gun for generating a scanning beam of electrons and an electrostatic electron lens adapted to focus the electrons on to a luminescent screen or tar-

get, said lens comprising a pair of coaxially-arranged electrodes, the electrode nearer the screen being of smaller diameter than the electrode nearer the cathode or having a portion of smaller diameter and the envelope of the tube in the vicinity of said smaller diameter is also of smaller diameter so that scanning coils can encircle the portion of the envelope of reduced diameter whereby the coils can be made of a diameter less than the diameter of the electrode of the lens nearer the cathode. Where the invention is applied to a cathode ray tube of the projection type the fluorescent screen may be formed on the end wall of that portion of the tube of reduced diameter, the internal diameter of which corresponds substantially to the external diameter of the smaller electrode, or alternatively, the portion of reduced diameter may be tapered towards its end to a diameter less than the diameter of the smaller electrode or may taper outwardly to a diameter larger than the diameter of the smaller electrode in cases where it may be desirable to provide the screen on a wall of a diameter approximating to the diameter of the larger electrode. The ratio of the diameters of the two electrodes may be between 1.5:1 and 2.5:1 but they are preferably in a ratio of 2:1 since this ratio is found to give optimum results so far as freedom from longitudinal spherical aberration is concerned.

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

Figure 1 is a longitudinal cross-sectional view of a cathode ray tube constructed in accordance with one form of the invention;

Figure 2 is a similar view of a portion of a tube constructed according to a modification of the invention; and,

Figure 3 is a similar view of a portion of a tube constructed in accordance with a further modification of the invention.

As shown in Figure 1, the cathode ray tube comprises an evacuated envelope 4 provided with a cathode 5, a control electrode 6, an accelerating electrode 7, and a constricting electrode 8. The stream of electrons originating at the cathode is controlled in intensity, accelerated and focused into a beam of electrons by a first anode 9 and a second anode 10, the anodes 9 and 10 constituting the electrodes of an electron lens. The electron gun structure comprising the electrodes 5, 6, 7 and 8, and the lens anodes 9 and 10 are substantially similar to the structure disclosed by F. H.

Nicoll et al. in their copending application Serial No. 229,724, filed September 13, 1938, but other constructions of the electron gun may be employed if desired. The cathode ray tube shown in Figure 1 is of the projection type and the electron gun provided near one end of the envelope is opposite and exposed to the fluorescent screen 11 which is formed on the end wall of the tube opposite the electron gun. The diameter of the second anode 10 is made smaller than the diameter of the first anode 9 and the envelope 4 of the tube is reduced in diameter so that it approximates the diameter of the second anode 10. Preferably, the diameter of the second anode 10 is half the diameter of the anode 9. The scanning coils 12, only two of which are indicated in cross-section, are mounted on and partially encircle the cylindrical portion of the envelope 4 of reduced diameter.

More particularly, the first anode 9 comprises a cylindrical portion of small diameter having a diaphragm with an aperture 13 therein and a much larger diameter portion which is the portion which co-operates with the second anode 10 to constitute the electron lens. The length of the larger diameter portion of the first anode may be between one and two times its diameter. The diameter of the aperture 13 is so chosen that it limits the apparent diameter of the electron beam in the plane of the lens to substantially one-half the diameter of the larger diameter portion of the first anode. This latter portion terminates in an annulus 14 which serves the double function of strengthening the metal structure of the first anode and for screening the effect of charges which may accumulate on the envelope 4 from the electron beam. The inner edge of the annulus 14 is, as shown, bent or rolled over in order to prevent a breakdown when high voltages are applied to the anodes 9 and 10 for causing them to function as an electrostatic lens, the higher potential being applied to the anode 10. The end of the second anode 10 adjacent the first anode 9 is likewise rolled or bent over to prevent breakdown when high voltages are employed. The leads to the various electrodes of the gun structure may be brought out externally of the envelope 4 through the usual pinch 15, the lead to the second anode being brought out through a seal 16 as shown. The second anode 10 may project into the first anode 9 a distance which may vary up to one-half the radius of the electrode 10; the precise distance for any particular lens depending on the best compromise between the aberration of the lens and the position of the principal planes for the particular focussing ratio which the geometry of the tube requires. The distance from the mid-plane S of the electron lens to the fluorescent screen may be, for example, from two to four times the diameter of the second anode and the focussing ratio, which is dependent upon the potentials applied to the first and second anodes, may be between ten and twenty. However, the invention is not limited to these definite ratios.

It will be observed that the scanning coils 12, two of which are shown, are on opposite sides of the path between the electron gun and the target and are spaced apart by a distance which is considerably less than the diameter of the large portion of the first anode. The second pair of coils are similarly positioned at right angles to those shown. With this arrangement less power is required for deflecting the cathode ray beam

compared with the case in which the coils are approximately the same diameter as the diameter of the first anode. Although the fluorescent screen is reduced in area this is substantially immaterial since substantially no loss of resolution occurs owing to the fact that the lens described is substantially free from aberration and the fluorescent screen is arranged proportionally nearer the lens.

Figure 2 shows a modification of the invention in which the portion of the envelope 4 of reduced diameter is tapered inwardly from the second anode 10 so that the fluorescent screen is of smaller diameter compared with the arrangement shown in Figure 1. The fluorescent screen in this case is disposed closer to the plane 5, the scanning coils being seated upon the tapered portion of the envelope, as shown.

Figure 3 illustrates a further example of the invention in which the portion of the envelope 4 of reduced diameter is tapered outwardly so that the fluorescent screen may be formed upon a surface which is larger than the surfaces available in Figures 1 and 2. The surface upon which the fluorescent screen is formed is, in this case, of approximately the same diameter as the diameter of the larger portion of the first anode, the scanning coils are seated upon the conical wall of the reduced portion.

Cathode ray tubes made in accordance with our invention permit the use of an electron beam having high current density and it will be observed that the prefocused diameter of the beam in the region of the plane S substantially fills the second anode 10, and since the distance between opposite scanning coils closely approximates the diameter of the second anode, the diameter of the beam during deflection by the coils 12 is relatively large which increases the efficiency while at the same time requiring less power for energizing the scanning coils.

Our invention is not limited in its application to cathode ray tubes designed for the reconstitution of television signals but may also be applied to cathode ray tubes for the generation of signals suitable for transmission. In this case instead of the end wall of the tube having a fluorescent screen formed thereon a target such as a mosaic electrode may be provided and an image of the object for transmission may be projected on to the mosaic screen on the opposite side to that scanned by the beam. In this case the usual signal plate may be transparent or, alternatively, a double-sided mosaic electrode may be employed and an electron image projected on to the side of the electrode opposite the side which is scanned by the electron beam.

From the foregoing description it will be apparent that various other modifications may be made in our invention without departing from the spirit and scope thereof, and we desire, therefore, that only such limitations shall be placed thereon as are necessitated by the prior art and set forth in the appended claims.

We claim:

1. A cathode ray tube comprising an evacuated envelope, an electron gun at one end of said envelope to generate a stream of electrons, a fluorescent screen at the opposite end of said envelope to receive electrons from said electron gun, a pair of cylindrical electron beam focusing electrodes of unequal diameter arranged axially of said envelope and extending along different portions of the path between said gun and said screen, the electrode of smaller diameter tele-

scoped at one end within said electrode of larger diameter and extending at the opposite end to a point closely adjacent said screen, said point closely adjacent the screen being the nearest point of approach to said screen of any of the electrodes in said tube and cylindrical oppositely disposed electron beam deflection members arranged axially of said envelope and spaced from each other on opposite sides of the path between said gun and said screen by a distance less than the diameter of the electrode of larger diameter and partially surrounding the electrode of smaller diameter to scan the electrons from said gun over said screen.

target, the electrode of smaller diameter being telescoped at one end within said electrode of larger diameter and extending at the opposite end to a point closely adjacent said screen, said electrode of smaller diameter being the closest electrode of the electrodes in said tube to said screen, and two pairs of cylindrical oppositely disposed coils arranged axially, partially surrounding and closely adjoining the electrode of smaller diameter, the distance between opposite coils being less than the diameter of said larger electrode.

2. A cathode ray tube comprising an envelope having two coaxial cylindrical sections one of which is of larger diameter than the other, an electron gun at one end of said larger section of the envelope to generate a stream of electrons, a target in the smaller of said sections oppositely disposed from said gun to receive electrons from said gun, a pair of coaxial cylindrical focusing electrodes intermediate said gun and said target of unequal diameters, that electrode nearer the target being of smaller diameter and telescoped within the electrode of larger diameter and closely adjacent the envelope section of smaller diameter, that nearer the said gun being closely adjacent the envelope section of larger diameter to focus said stream of electrons as an electron beam on said target, the electrode of smaller diameter likewise extending to a point closely adjacent said screen, which point is the nearest point of approach to said screen of any of the electrodes in said tube, and means partially surrounding and closely adjoining the envelope section of smaller diameter and between one of said focusing electrodes and said target for deflecting the electron beam over said target.

4. A cathode ray tube comprising an envelope having a cylindrical section and a frusto-conical section, the two sections being joined to form a single closed container of extended length, the diameter of said envelope where said sections are joined being considerably less than the diameter of said cylindrical section, an electron gun in said envelope near the end thereof opposite said frusto-conical section to generate a stream of electrons, an electron receiving target at the opposite end of said frusto-conical section from the end joined to said cylindrical section to receive electrons from said gun, a first anode in said cylindrical section, a second anode in said frusto-conical section of smaller diameter than said first anode and extending for a short distance within said first anode to generate with said first anode an electron focusing field, and scanning means comprising at least one pair of coils, the coils of the pair being on opposite sides of said frusto-conical section, separated by a distance less than the diameter of said first anode and lying between the point where said sections are joined and the said target for scanning the electrons from said gun over said target.

3. A cathode ray tube comprising an evacuated envelope, an electron gun at one end of said envelope to generate a stream of electrons, a target at the opposite end of said envelope to receive electrons from said gun, a pair of elongated coaxial cylindrical electrodes surrounding different portions of the path between said gun and said target and lying closely adjacent the walls of said envelope to focus the electrons from said gun as an electron beam on said target, the electrode nearer the gun being of larger diameter than the electrode nearer the

5. A cathode ray tube as claimed in claim 4 wherein the frusto-conical portion of the envelope slopes to a smaller diameter toward the said target.

6. A cathode ray tube as claimed in claim 4 wherein the frusto-conical portion of the envelope slopes to a larger diameter toward the said target.

7. A cathode ray tube as claimed in claim 3 wherein the end of the first anode adjacent the second anode has a diameter twice that of the second anode.

LEONARD FRANCIS BROADWAY.
OTTO KLEMPERER.