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## CATHODE RAY TUBE

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My invention relates to cathode ray tubes and particularly to the type wherein electrostatic deflection plates are used to deflect the cathode ray beam over a target or screen structure.

5 Cathode ray tubes having two sets or pairs of electrostatic deflection plates are known, but particular difficulty has been encountered in making such tubes where it is desired to have linear deflection characteristics. One type of distortion known as "keystoning" is particularly hard to eliminate in tubes of the electrostatic deflection type, especially where one deflection plate of each of the two sets of deflection plates are tied together electrically and to the second anode potential in order to minimize the number of necessary leads through the envelope. Keystoning is the effect which results when the electron beam developed within the tube is deflected and the maximum length of the traverse of the beam under a given deflection voltage at one edge of the target or screen is greater or less than the extent of traverse for the same deflection voltage across that portion of the target or screen which is diametrically opposite the first path of traverse. This keystoning effect becomes very apparent where it is desired to form a square or rectangular raster on the scanned target. Instead of the desired square or rectangular shape, the raster becomes substantially trapezoidal in shape. Tubes of this general type also exhibit some slight defocusing of the electron beam while passing through the deflection plate structure, this defocusing effect being attributed to the non-uniformity of the electrostatic deflecting field developed between the plates. Tubes of this general type also show a third form of distortion due to interaction between the two electrostatic deflection fields. It has been found that a deflection voltage impressed across one set of deflection plates may produce deflection of the electron beam normal to the deflection produced by the said potential across this pair of plates. Such interaction between the deflecting fields is undesirable, especially in the application of such tubes to television reception where it is desired to separate the effects of line and frame scanning from each other as much as possible.

It is an object of my invention to provide a cathode ray tube of the electrostatic deflection type wherein keystone distortion may be reduced to a minimum. It is another object of my invention to provide a tube of the type described wherein keystone distortion may be reduced while at the same time the distortion due to defocusing of the electron beam while passing through the

deflection structure is reduced to a minimum. It is a further object of my invention to provide a tube wherein the electrostatic deflection fields may be separated to eliminate mutual interference or reaction one with the other and it is a still further object to provide a cathode ray tube structure of the electrostatic deflection type which may be manufactured with the least possible difficulty while at the same time incorporating the operating advantages of my improved cathode ray tube.

In accordance with my invention, I provide a cathode ray tube having an electron gun to generate an electron beam and direct the beam on an oppositely disposed target such as a fluorescent screen. Intermediate the electron gun and target I provide two pairs of mutually perpendicular deflection plates, one plate of each pair being connected together and to the anode structure of the electron gun, the remaining plate of each pair being connected to apertured electrodes or flanges on the plates surrounding a portion of the path of the beam and arranged with respect to the deflection plates in such a manner that the objects of my invention are obtained.

These and other objects, features and advantages of my invention will appear from the following description taken in connection with the accompanying drawing in which:

Figure 1 is a longitudinal perspective view showing a cathode ray tube embodying my invention,

Figure 2 is a longitudinal perspective view of a portion of a cathode ray tube incorporating a modification of the structure shown in Figure 1, and

Figure 3 is a cross-sectional view showing a further modification of my invention.

In the illustrative embodiment of my invention as shown in Figure 1, the cathode ray tube comprises a highly evacuated glass envelope or bulb 1 of frusto-conical shape with a tubular arm or neck section enclosing a conventional type electron gun 2. The conical portion of the envelope is terminated with a transparent end wall which may be coated with fluorescent material to form a screen or target 3 which receives electrons from the electron gun 2. The electron gun comprises a cathode 4 from which an electron stream may be drawn, a control electrode 5 connected to the normal biasing battery and a first anode 6 maintained positive with respect to the cathode 4. The electron stream leaving the first anode 6 is accelerated and concentrated into an electron scanning beam focused on the surface of the

target 3 by a second anode 7 which is preferably a cylindrical electrode but may comprise a conductive coating on a portion of the inner surface of the neck section of the bulb 1. The first anode 6 and the second anode 7 are maintained at the desired positive potentials with respect to the cathode by a potential source such as the battery 8.

I provide the two pairs of electrostatic deflection plates between the electron gun 2 and the target 3, these deflection plates preferably being in the neck section of the bulb 1. In accordance with the modification of my invention shown in Figure 1 and intermediate the two pairs of deflection plates and between the deflection plates and the electron gun and likewise between the deflection plates and the target I provide apertured or slotted electrodes to control the shape of the electrostatic fields adjacent the deflection plates. Referring to Figure 1, I provide two oppositely disposed deflection plates 10 and 11 on opposite sides of a portion of the beam path between the electron gun 2 and target 3. Separated from these plates in the direction from the electron gun to the target I provide two additional deflecting plates 12—13 mutually perpendicular to the plates 10—11 to deflect the beam along paths substantially perpendicular to the deflection produced between the plates 10 and 11. Between the deflection system and the electron gun I provide an apertured disk or shielding electrode 14 and likewise a second apertured disk or shielding electrode 15 between the deflection system and the target 3. The electrodes 14 and 15 are connected to one plate of each pair of plates such as the plates 10 and 12 and to the second anode 7 so that the plates 10 and 12 and the shielding electrodes 14 and 15 are maintained at second anode potential. In this arrangement, deflection potentials to deflect the beam in mutually perpendicular directions are applied between the second anode and the plates 11 and 13, the plates 11 and 13 being termed the "unconnected" plates. Further in accordance with my invention, I provide additional electrodes such as the slotted electrodes 16 and 17 axially aligned with the electron gun and between the deflection plates 10—11 and the deflection plates 12—13. The slotted electrode 16 is connected to the plate 11 and the slotted electrode 17 to the plate 13. I have found that when the slotted electrodes 16 and 17 are used with the respective connections to the plates 11 and 13, the keystone distortion is reduced to substantially zero and that when deflection potentials, such as two sawtooth potentials of different frequency as customarily used in television reception, are applied between the anode and the plates 11 and 13, the resulting raster formed by the cathode ray beam scanning the screen 3 is substantially rectangular and the beam is well focused on the target for all degrees of deflection.

The electrode structure shown in Figure 1 is somewhat difficult to mount in the neck section of the bulb 1 and I therefore prefer to form the deflection plates and slotted electrodes integrally, which arrangement considerably simplifies the tube construction. Referring to Figure 2, the apertured electrodes 14 and 15 are formed as flanges integrally with the deflection plates 10 and 12, and the slotted electrodes 16 and 17 are formed as flanges integrally with deflection plates 11 and 13 to form two pairs of L-shaped electrodes, the base portions being slotted and the side portions being on opposite sides of the nor-

mal path of the beam which passes through the slotted base portions. With the construction shown, the number of parts comprising the deflection and shielding structure to be mounted in the neck section of the tube is reduced from eight electrodes to four and I have found that these can be easily mounted axially of the neck section and axially aligned with the electron gun with the use of simple mounting jig structures.

The arrangements described in connection with Figures 1 and 2 are very effective in reducing keystone and defocusing distortion, but I have found that the structure shown in Figure 1 can be modified in accordance with the arrangement shown in Figure 3 to further eliminate interaction between the two sets of deflection plates. Referring to Figure 3 wherein parts corresponding to those in Figure 1 are similarly referenced, I provide between the deflection plates 10—11 and 12—13 a pair of slotted electrodes 18—19 which are connected to the deflection plates 10 and 12 and to the second anode 7. The electrodes corresponding to 16 and 17 of Figure 1 are located at the opposite ends of the deflection structure in the directions of the electron gun and target 3.

Referring again to Figure 3, I provide an apertured electrode 20 between the deflection plates 10—11 and the apertured electrode 14 and a slotted electrode 21 between the deflection plates 12—13 and the slotted electrode 15. These electrodes are similarly connected as electrodes 16—17 of Figure 1 to the corresponding plates 11 and 13 to which the deflection potentials are applied with respect to the second anode. While I have shown two plates 18 and 19, it will be understood that a single plate may be used if so desired with substantially the same results.

It will be obvious from the above description of the structure shown in Figure 3 that I have isolated the electrostatic fields developed between the deflection plates by providing an equipotential space between the two sets of deflection plates, while at the same time, I have retained the advantages described in connection with Figures 1 and 2 by providing shielding electrodes tied directly to the plates to which the deflection potentials are applied.

While I do not wish to be limited to any particular theory which might explain the improved operation of my cathode ray tube, it appears that the electrostatic fields generated between the plates of any single pair of plates are of a fringing character, whereas by the use of shielding plates or flanges electrically connected to the deflection plates, either within or without the envelope or bulb 1, reduces this fringing effect to a minimum, thereby resulting in a substantially distortionless deflection and freedom from keystone effects.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

I claim:

1. A cathode ray tube having an electron gun including an anode and a cathode to develop an electron beam, a luminescent target in the path

of the beam, a first pair of L-shaped beam deflection electrodes each having a slot in the base portion arranged with the side portions on opposite sides of the beam path, the normal path of the beam being through the slotted base portions, and a second pair of L-shaped beam deflection electrodes between said first pair and said target, said second pair of electrodes each having a slot in the base portion and arranged with the side portions on opposite sides of the beam path and perpendicular to the side portions of said first pair of electrodes, the normal path of the beam being through the slotted base portions.

2. In an electron tube, means to develop an electron beam, a pair of electrodes one on either side of the path of the electron beam to deflect said electron beam, an apertured flange at the opposite ends of the beam path between said electrodes extending from one electrode at one end thereof and from the other electrode at the opposite end thereof and in a direction transverse to the direction of beam motion between the plates and aligned to permit the electron beam to pass through the aperture in each of the apertured flanges.

3. In an electron tube, an electron source, an electron accelerating electrode and a luminescent screen, a pair of electrostatic deflecting electrodes positioned intermediate the accelerating electrode and the luminescent screen, the said electrodes being on opposite sides of the path between said electron source and said screen, each of said deflecting electrodes having an apertured flange member electrically and physically connected therewith extending toward the opposite deflecting electrode the said flange members being at

opposite ends of the space between said deflecting electrodes in the direction between said accelerating electrode and said screen.

4. The electron tube structure claimed in claim 3 comprising in addition a second pair of similar deflecting electrodes and flange members for deflecting the electrons from said source perpendicular to the path of deflection of said first named deflecting electrodes, said last named electrodes being positioned intermediate the first named set of deflecting electrodes and the said source.

5. A cathode ray tube having an electron gun including an anode to develop an electron beam, a target oppositely disposed from said electron gun in the path of said electron beam, a pair of flanged deflecting electrodes, each having an apertured flanged portion and a side portion, said side portions being on opposite sides of the path of said beam, said flanged portions extending transversely across the path of said beam at opposite ends of the beam path between said side portions with their apertures aligned for the passage of the beam therethrough, a second pair of flanged deflecting electrodes, each having a side portion and an apertured flanged portion similarly positioned as said first-mentioned pair between said first pair and said target, the planes of said side portions being substantially perpendicular to the planes of the side portions of said first pair, means to apply electron beam deflection potentials to the electrode of each pair whose flanged portions are adjacent along the path of said beam and an electrical connection between the remaining electrodes of each pair of electrodes and said anode.

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