Feb. 7, 1956 A. E. BECKERS 2,734,147

CATHODE RAY TUBE

Filed Jan. 26, 1953 2 Sheets-Sheet 1

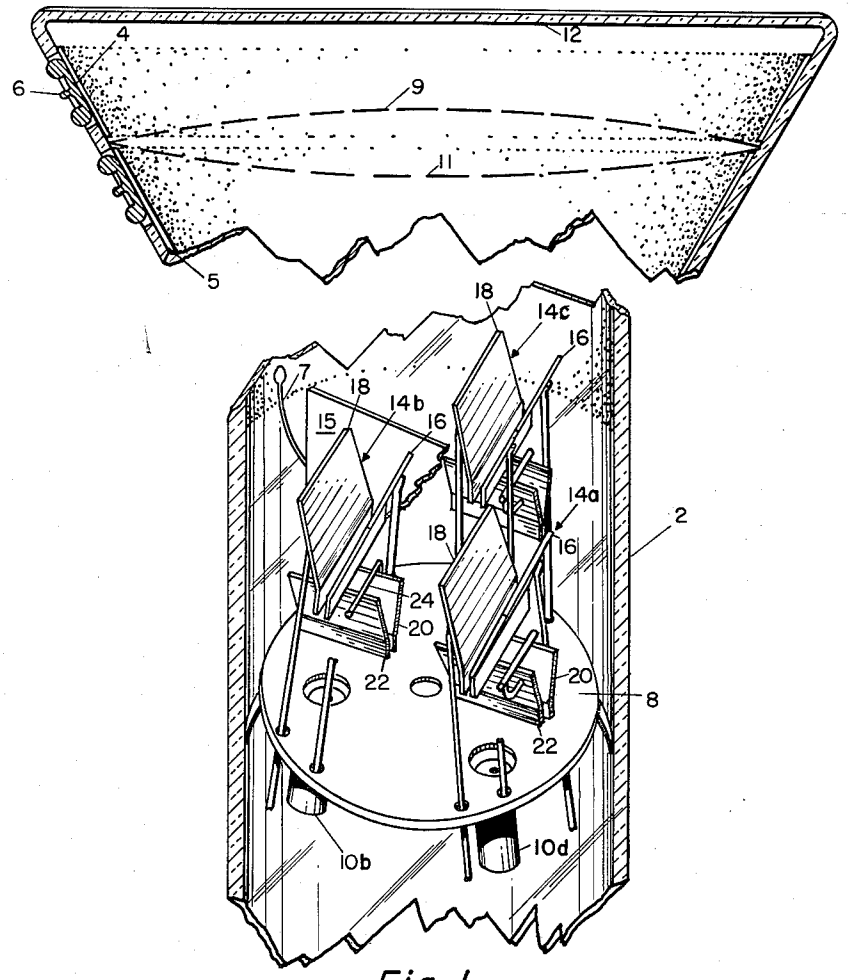


Fig. 1

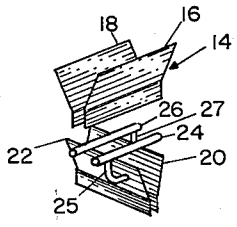


Fig. 2

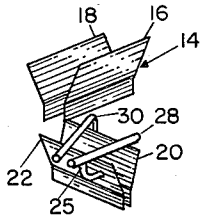


Fig. 3

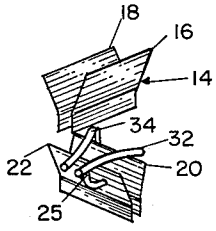


Fig. 4

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CATHODE RAY TUBE

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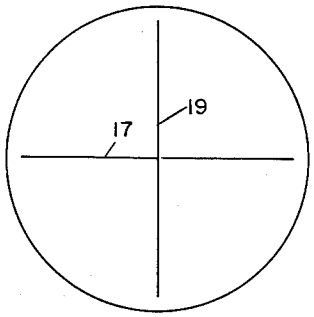


Fig. 5

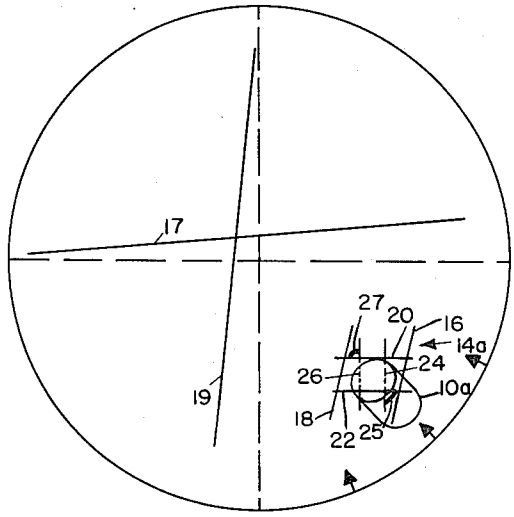


Fig. 6

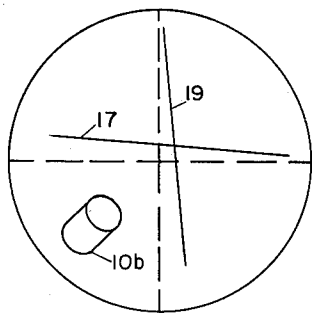


Fig. 7

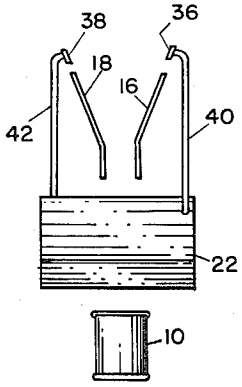


Fig. 8

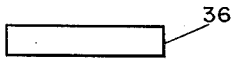


Fig. 9

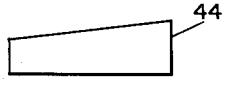


Fig. 10

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CATHODE RAY TUBE

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Application January 26, 1953, Serial No. 333,026

16 Claims. (Cl. 315—23)

The present invention relates to cathode ray tubes and particularly to cathode ray tubes employing electron guns which are aligned generally along the central axis of the tube but offset therefrom.

In single or multiple gun cathode ray tubes employing post deflection acceleration means and in which the electron guns are offset with respect to the central axis of the tube, the electron beam is subjected to distorting forces after leaving the deflection system and while passing through the post deflection acceleration field. Such distorting forces so effect the electron beam as to cause an unsymmetrical pair of ordinates in a cathode ray tube as, for example, an oscillograph tube. Such a condition in undesirable where the traces of the electron beam are visually observed to determine measurement conditions.

Accordingly, it is an object of the present invention to provide a cathode ray tube with means for overcoming such a condition and having symmetrical traces for visual inspection.

In accordance with my invention, I provide one or more skew correcting electrodes in the deflection system of cathode ray tubes in which the electron guns are offset from the central axis of the tube.

For a better understanding of my invention, reference may be had to the drawings in which Figure 1 is an enlarged fragmentary perspective view of a cathode ray tube embodying my invention; Figure 2 is a perspective view illustrating the deflection system of the tube of Figure 1 with one modification of the compensating electrodes of my invention; Figures 3 and 4 illustrate further modifications of the device illustrated in Figure 2; Figure 5 illustrates the trace of a cathode ray tube embodying my invention; Figures 6 and 7 illustrate the skewed traces of a cathode ray tube in which the electron guns are offset from the central axis of the tube; Figures 8 and 9 illustrate a further modification of my invention and Figure 10 illustrates still a further modification.

Referring now to the drawing and particuflarly to Figure 1 thereof, there is illustrated a multiple gun cathode ray tube comprising a glass envelope **2** having a post deflection acceleration conductive ring **4** encircling the inner wall of the tube with a connector **6** adapted to connect the ring with a source of voltage. Supported within the tube is a multiple electron gun assembly **8**. The assembly includes a plurality of electron guns **10** adapted to provide a beam of electrons for impingement upon a fluorescent coating, or target, **12** on the face of the tube. A second conductive ring electrode **5**, which encircles the inner wall of the tube in the region between the guns **10** and the accelerating ring electrode **4**, is electrically connected to the assembly **8** by one or more spring contacts **7**. Electrodes **5** and **4** form an electron lens, as indicated by the dashed equipotential lines **9** and **11**, which, in the normal case when electrode **4** is positive with respect to electrode **5**, exerts a radially inward force on the electron beams passing therethrough. The term "radially" is intended to apply not only to cylindrical tubes but also to rectangular tubes and tubes of any cross-

sectional shape. Positioned between the post deflection accelerating ring **4** and the electron guns **10** are a plurality of deflection systems **14**. In this connection, it will be seen that each of the deflection systems is aligned with one of the electron guns and that each of the electron guns and cooperating deflection systems are aligned generally along the central axis of the tube but offset therefrom. A shield **15**, shown broken away for greater clarity, normally separates each of the deflection systems **14** from the other two.

With such an alignment, the normal movement of the electron beam through the field caused by the accelerating ring **4** is affected by uneven field forces which causes a skewing of the beam. Where such a beam is projected along the axis of the tube, the beam passes through a symmetrical field caused by electrodes **4** and **5** and will define a trace in which the vertical and horizontal components are substantially perpendicular as illustrated in Figure 5. Where, however, the electron beam is projected from guns located as in Figure 1, the beam is subjected to uneven field forces caused by ring **4** and will produce a trace pattern of vertical and horizontal components which are not perpendicular to each other such as illustrated in Figure 6, in which the dashed lines indicate the desired coordinates and the solid lines **17** and **19** show the traces actually achieved.

To compensate for the uneven field forces caused by the electron lens between electrodes **4** and **5**, I employ a deflection system **14** including compensating deflection electrodes. Referring to Figure 2, there is illustrated, in more detail, the deflection system **14** of my invention. The deflection system **14** of Figure 2 includes deflection plates **16** and **18** which are spaced on each side of the path of the electron beam for deflecting the beam along a substantially horizontal or vertical coordinate, depending upon the position of the deflection plates with respect to the electron gun. Spaced from plates **16** and **18** are deflection plates **20** and **22** which are aligned approximately perpendicularly with respect to plates **16** and **18** and on either side of the path of the electron beam. These latter mentioned plates provide for deflection of the electron beam along a path which preferably is perpendicular to the path of that caused by plates **16** and **18**. However, as heretofore described, the effect of the field caused by ring **4** and the off axis position of the gun **10***a* and deflection systems **14***a* causes a skewing of the trace pattern to produce a trace such as that shown in Figure 6. To compensate for that condition, intermediate deflection electrodes **24** and **26** are employed. In this connection, the electrodes **24** and **26** are connected respectively to electrodes **22** and **20** by a rigid supporting connection adapting the electrodes to be aligned substantially in the planes of deflection plates **16** and **18** respectively, and perpendicular to plates **20** and **22**.

If the cathode ray tube had only a single electron gun **10***a* mounted off the axis, perpendicularity between traces **17** and **19** could be achieved in the manner just described. Then the tube as a whole could be rotated to make trace **17** vertical and the now-perpendicular trace **19** horizontal. However, tubes making use of the invention almost invariably have more than one electron gun, thereby making it necessary to establish a system of coordinates, such as that indicated by the dashed lines, and adjust the deflection system **14***a* so that the traces **17** and **19** are not only mutually perpendicular, but are aligned along the chosen coordinates. Other deflection systems for other electron guns (not shown in this figure) will then also be adjusted to align along the same coordinates.

In order to determine the arrangement of elements necessary to correct the scanning of a multi-gun tube, reference will be made to Figure 6, which shows a simplified deflection structure **14***a* for one of the off axis guns **10***a*.

Without compensation, the supposedly vertical trace for plates 20 and 22 parallel to the horizontal axis of the figure would follow the line 19 instead of the vertical, dashed line because of the radially inward force exerted by the electron lens between electrodes 4 and 5 (Figure 1) and indicated in Figure 6 by the arrows. In order to bring the trace 19 into parallelism with the vertical axis, it is necessary to apply a deflecting force to the electrons and to make the applied force perpendicular to the deflecting force of electrodes 20 and 22. The correcting force may, therefore, be applied by electrodes 24 and 26. In addition, the deflecting force must vary in a predetermined relationship to the force of plates 20 and 22. If the relationship is linear, electrodes 24 and 26 may be connected directly to plates 22 and 20 respectively, as shown in Figure 6, by the short connecting links 25 and 27. If some other relationship is desired, the electrodes 24 and 26 may be replaced by angularly disposed electrodes 28 and 30, as shown in Figure 3, or by curved electrodes, as shown in Figure 4.

In order to correct for the angular displacement of trace 17 with respect to the horizontal axis, plates 16 and 18 are rotated to an opposite angular rotation as shown.

It will be understood that the particular connections previously described for the compensating electrodes 24 and 26 of one of the guns in the tube would be reversed in its side by side relationship with a neighboring gun in the tube. The effect of the deflection electrodes of a gun such as gun 10*b* in Figure 1 is to produce a trace such as that shown by the solid lines 17 and 19 in Figure 7 when the beam is not affected by the compensating field. With fields applied by the respective compensating electrodes to deflection structures 14*a* and 14*b* of Figure 1, the resulting trace is that of Figure 5.

Another modification of my invention, which I have found useful in compensating for uneven post accelerating forces caused by the field between electrodes 4 and 5, is shown in Figures 8, 9, and 10. In Figure 8, an electron gun assembly similar to those illustrated in Figure 1 includes the electron gun 10 and a deflection system including plates 16, 18, 20, and 22 as in Figure 2. In this modification, however, the compensating electrodes 36 and 38 are oblong metal strips such as shown in Figure 9. These strips are aligned with deflection plates 16 and 18 as shown and are rigidly supported by connecting wires 40 and 42, which connect respectively with plates 22 and 20, not shown. Deflection electrodes 36 and 38 function in substantially the same manner as the compensating deflection electrodes heretofore described, except that they affect the electron beam after it has passed both pairs of deflection plates.

Figure 10 illustrates another compensating electrode 44 similar to that shown in Figure 9, except that its width varies from one end to the other to compensate for non-linear bending. Compensating electrode 44 is connected in the deflection system in the same manner as deflection electrodes 36 and 38 described in connection with Figure 8.

The compensating electrodes 24 and 26, or their equivalents, have been shown connected to the plates 20 and 22 to receive deflecting signals therefrom. As an alternative, compensating electrodes 24 and 26 could be insulated from deflection plates 20 and 22 and could be connected to contact terminals to receive signals directly from the source supplying signals to deflection plates 20 and 22. The signal applied to compensating electrodes 24 and 26 could, if desired, be modified from the signal applied to deflection plates 20 and 22, as, for instance, by linear or non-linear increase or reduction in amplitude.

Furthermore, the compensating electrodes 24 and 26 may be biased to a different center voltage than the other electrodes in gun 10 or deflection structure 14 (Figure 1) in order to compensate, in a known manner, for astigmatism of the electron beam spot on target 12.

In order to simplify the deflecting structure 14, one of the compensating electrodes 24 or 26 might be either eliminated or connected to a fixed-potential electrode, such as electrode 5, and a so-called single-ended compensating deflection of the electron beam would take place.

Still further modifications may be utilized within the scope of the invention as determined by the following claims.

What I claim is:

1. In a cathode ray tube having a fluorescent coating and an electron gun for directing a beam of electrons onto said coating; an electrostatic deflection system disposed between said gun and said coating; said system comprising: a first pair of deflection plates located between said gun and said coating and spaced apart on diametrically opposite sides of said beam; a second pair of deflection plates located between said pair of first deflection plates and said coating and spaced apart on diametrically opposite sides of said beam, said second pair of plates being substantially perpendicular to said first pair of plates; and an astigmatic electron lens comprising a pair of compensating electrodes co-acting with said first pair of deflection plates, said compensating electrodes being located on diametrically opposite sides of said electron beam and at an angle to said first pair of plates, one of said compensating electrodes being connected to each plate respectively of said first pair of plates.

2. In a cathode ray tube having a fluorescent coating and an electron gun for directing a beam of electrons onto said coating; an electrostatic deflection system disposed between said gun and said coating; said system comprising: a first pair of deflection plates located between said gun and said coating and spaced apart on diametrically opposite sides of said beam; a second pair of deflection plates located between said pair of first deflection plates and said coating and spaced apart on diametrically opposite sides of said beam, said second pair of plates being substantially perpendicular to said first pair of plates; and an astigmatic electron lens comprising a pair of compensating electrodes co-acting with said first pair of deflection plates, said compensating electrodes being located in the space between said first and said second pair of deflection plates and on diametrically opposite sides of said electron beam and at an angle to said first pair of plates, one of said compensating electrodes being connected to each plate respectively of said first pair of plates.

3. A cathode ray tube comprising a target; an electron gun forming a source of a beam of electrons; and a plurality of electrodes arranged along the path traversed by said beam, said electrodes comprising a first pair of deflecting plates; a second pair of deflecting plates arranged at an angle to said first pair and located between said first pair and said target; means forming an electron lens between said gun and said target; and an astigmatic electron lens comprising a compensating electrode co-acting with said first pair of deflection plates and arranged at an angle to said first pair of plates and located between said gun and said electron lens to provide an asymmetrical skewing deflection for said beam thereby correcting for the deflection of said beam in said electron lens.

4. The device of claim 3 in which said compensating electrode is located between said gun and said first pair of plates.

5. The device of claim 3 in which said compensating electrode is located between said first pair of plates and said second pair of plates.

6. The device of claim 3 in which said compensating electrode is located between said second pair of plates and said electron lens.

7. The device of claim 3 in which said compensating electrode is connected directly to one plate of said first pair.

8. The device of claim 3 in which said compensating electrode is curved.

9. The device of claim 3 in which said compensating electrode is substantially perpendicular to said first pair of plates.

10. A cathode ray tube comprising a target; an electron gun forming a source of an electron beam, and a plurality of electrodes arranged along the path traversed by said beam, said electrodes comprising a first pair of deflecting plates; a second pair of deflecting plates arranged at an angle to said first pair and located between said first pair and said target; means forming an electron lens between said gun and said target; and a pair of deflecting compensating electrodes on diametrically opposite sides of said beam arranged at an angle to said first pair of plates and located between said gun and said electron lens to correct for the deflection of said beam in such electron lens, each electrode of said pair of compensating electrodes being connected to a plate respectively of said first pair of plates.

11. The device of claim 10 in which said compensating electrodes are substantially parallel to each other over their operating length.

12. The device of claim 10 in which said compensating electrodes are at an angle to each other.

13. The device of claim 10 in which said compensating electrodes are curved.

14. The device of claim 13 in which said compensating electrodes are curved in a direction substantially perpendicular to said electron beam.

15. A cathode ray tube comprising a target; an electron gun forming a source of an electron beam; and a plurality

of electrodes arranged along the path traversed by said beam, said electrodes comprising a first pair of deflecting plates; a second pair of deflecting plates arranged at an angle to said first pair and located between said first pair and said target; means forming an electron lens between said gun and said target; a pair of compensating deflecting electrodes on diametrically opposite sides of said beam arranged at an angle to said first pair of plates and located between said gun and said electron lens to correct for the deflection of said beam in said electron lens; a source of signal voltage connected to said first pair of deflecting plates; and a second source of a similar signal voltage connected to said compensating deflecting electrode.

16. The device of claim 15 in which said second source is a portion of said first source.

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