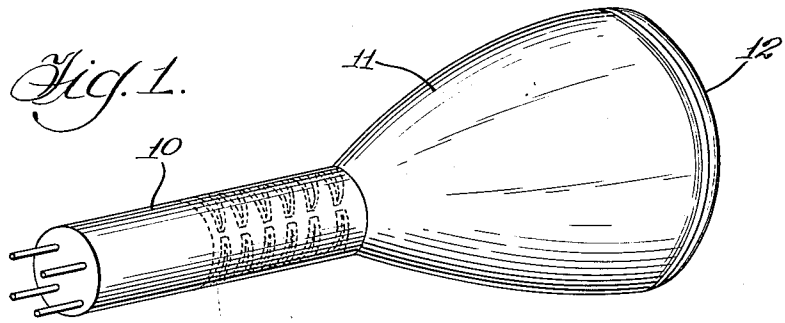
Nov. 4, 1952 K. SCHLESINGER 2,617,077

ELECTROSTATIC DEFLECTION SYSTEM FOR CATHODE-RAY TUBES

Filed Aug. 11, 1950

Fig. 1.



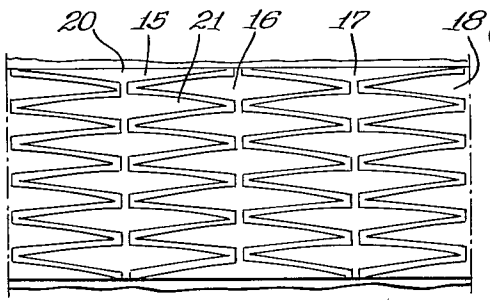


Fig. 3.

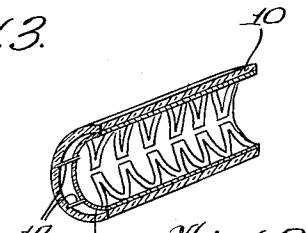


Fig. 2.

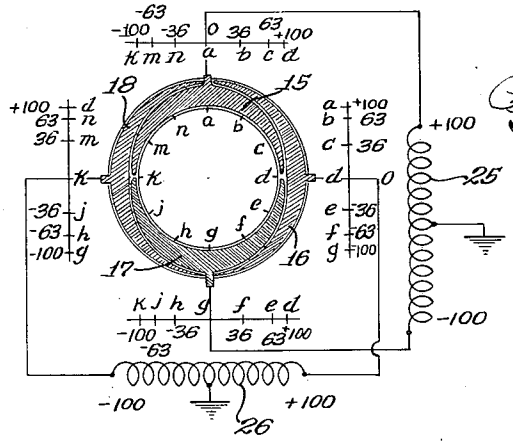


Fig. 4.

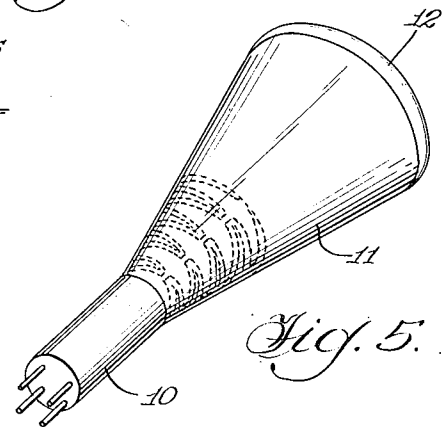


Fig. 5.

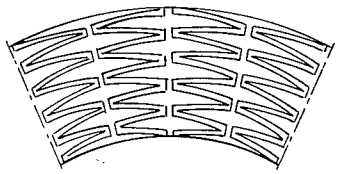


Fig. 6.

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Patented Nov. 4, 1952

2,617,077

UNITED STATES PATENT OFFICE

2,617,077

ELECTROSTATIC DEFLECTION SYSTEM FOR CATHODE-RAY TUBES

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Application August 11, 1950, Serial No. 178,943

13 Claims. (Cl. 315—23)

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This invention relates generally to electrostatic cathode ray tubes and more particularly to an electrostatic deflection system including electrodes provided on the tubular portion of the insulating enclosure of the cathode ray tube.

In cathode ray tubes such as are used in television transmitters and receivers, oscilloscopes, and other devices, provisions are required for causing deflection of the beam to scan a screen provided on the tube. Such deflection may be produced by providing either an electrostatic or an electromagnetic field in the path of the beam. Electrostatic deflection systems have several advantages over electromagnetic systems but have not been found satisfactory for large tubes. An important advantage of electrostatic deflection systems is that a comparatively small amount of energy is required so that the generator for producing the energizing voltages may be relatively inexpensive and such generator does not require a large power supply. Also ion blemish is not present in electrostatic deflection systems so that the screen of the cathode ray tube tends to have longer life.

One of the main reasons why electrostatic deflection has not been satisfactory is that horizontal and vertical deflection must be accomplished by separate electrodes along the tube neck and this requires that the tube necks be objectionably long. Deflection systems for producing horizontal and vertical deflection within the same space, without causing objectionable interference therebetween, have not been available. Further, the deflection plates or electrodes have restricted the path available for the electron beam and thereby prevented the use of high accelerating voltages for the beam.

It is therefore an object of the present invention to provide an improved inexpensive electrostatic deflection system for providing horizontal and vertical deflection of the electron beam in a cathode ray tube.

A further object of this invention is to provide a cathode ray tube having deflecting electrodes on an insulating tubular portion which provide fields positioned at right angles with respect to each other in the same space along the path traversed by the electron beam.

A feature of this invention is the provision of electrostatic deflection electrodes deposited directly on the inner surface of a glass cylinder or cone within a cathode ray tube with the electrodes having interleaved portions which provide the required potential gradient around the electron beam in the tube for producing perpendicular linear fields in the path thereof.

Another feature of this invention is the provision of an electrostatic deflection system for a cathode ray tube including four symmetrically positioned electrodes extending longitudinally

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along a tubular portion of the tube and having wedge-shaped portions of sinusoidal configuration which are interleaved with each other.

Further objects and features and attending advantages of the invention will be apparent from a consideration of the following description taken in connection with the accompanying drawings in which:

Fig. 1 illustrates an electrostatic cathode ray tube in accordance with the invention;

Fig. 2 is a fragmentary cross-sectional view of the tube of Fig. 1;

Fig. 3 shows the configuration of the electrodes provided on the inner surface of the neck of the tube of Fig. 1;

Fig. 4 is a schematic diagram illustrating the potential gradient around the neck of the tube;

Fig. 5 illustrates a second embodiment of the invention in which the electrodes are positioned on a conical or flaring portion of the tube; and

Fig. 6 is a development showing the configuration of the surfaces of the electrodes of Fig. 5.

In practicing the invention there is provided a cathode ray tube and electrostatic deflecting means for the beam thereof in the form of conducting coatings placed on the inside surface of a tubular portion of the tube. The deflection system includes four symmetrically positioned electrodes each extending longitudinally along a tubular portion of the tube and spaced at 90° with respect to each other. Each electrode includes a longitudinally extending rib or backbone from which wedge-shaped portions extend. The wedge-shaped portions of adjacent electrodes are interleaved with each other so that the four electrodes substantially completely enclose the tubular space. The wedge-shaped portions are of sinusoidal configuration to provide a potential gradient around the neck of the tube which produces a linear uniform field within the tube neck. The electrodes are supplied by sawtooth voltage waves which are symmetrical with respect to ground. The tubular portion on which the electrodes are positioned may be cylindrical or frusto-conical as is desired in a particular application.

Referring now to the drawings, in Figs. 1 and 2 there is illustrated a cathode ray tube including a neck portion 10 and a flaring portion 11 which connects the neck portion with a closed end portion 12 on which a screen is provided. Within the neck portion 11 there is included an electron gun (not shown) which may be of any suitable standard construction. The tube may be formed entirely of glass or similar insulating material, or the neck portion 10 and the end portion 12 may be formed of glass with the flaring portion 11 formed of metal and the various portions sealed together so that the enclosure may be evacuated. On the inside of the tubular neck

portion 10 there are provided conducting plates which may be supported in any suitable manner. Although it is possible to apply the electrodes directly to the inside surface of a portion of the tube neck, this is not generally satisfactory as the inside surface is not usually sufficiently accurate for this. The electrodes may preferably be deposited on a separate insulating cylinder 13 which may be supported within the tube by members 14 secured to the electron gun structure, as shown in Fig. 2.

The configuration of the conducting plates is best shown in Fig. 3 in which the surface is developed in a plane. It is apparent from Fig. 3 that the conducting plates are formed as four separate electrodes designated 15, 16, 17 and 18. Each electrode includes a central rib or backbone portion 20 which extends longitudinally of the tubular portion of the tube, and wedge-shaped portions 21 having the large ends along the ribs 20 and the reduced portions extending therefrom. The configuration of the electrodes is such that the ribs 20 of the four electrodes are symmetrically positioned at 90° intervals around the neck of the tube and the wedge portions extend from the ribs very close to the adjacent ribs. However, spacing is provided between all parts of adjacent electrodes so that there is no electrical connection therebetween. This spacing is small and the electrodes substantially completely enclose the tubular space. In order to provide the desired potential around the surface of the tubular space so that uniform fields will be provided in the two directions, the wedge-shaped portions have a cross section which varies as a sine wave.

Referring now to Fig. 4, in this figure the electrodes are illustrated schematically with the cross section thereof extending radially rather than longitudinally along the tube. This showing is purely for the purpose of illustrating the fields provided around the space within the tube neck and does not illustrate a structural embodiment of the invention. As shown in Fig. 4, the plates 15 and 16 are positioned to provide a vertical field and are connected to coil 25 from which a voltage is applied to the plates 15 and 17. The center point of the coil 25 is grounded so that the voltages applied to the plates are symmetrical with respect to ground. Similarly the plates 16 and 18 are positioned for providing horizontal deflection and are excited by voltages produced in coil 26 which also has the center point thereof grounded. The voltages applied from the coils 25 and 26 are at greatly different frequencies, with the coil 25 providing relatively low frequency sawtooth waves for producing relatively slowly moving vertical deflection, and the coil 26 providing high frequency sawtooth waves for producing fast horizontal deflection. With respect to vertical deflection the electrodes 16 and 18 are substantially at ground potential and with respect to horizontal deflection the plates 15 and 17 are substantially at ground potential.

The potential at the various points around the inner circumference of the tube neck therefor depends upon the relative area of the interleaved portions of the adjacent electrodes. Considering the potential producing the field for vertical deflection, and assuming that the plates 15 and 17 are at potentials of plus 100 and minus 100 respectively and the plates 16 and 18 are at ground. the potential around the neck at the points *a*, *b*, *c*, etc. will be as shown in the charts at the right and left sides of Fig. 4 respectively. At point *a* only the electrode 15 is effective so that the voltage at this point will be the full plus 100 units. At point *b* the width of the electrode 15 will be .866 and that of electrode 16 will be .5, with respect to the maximum width, so that the effective potential at this point will be plus 63 units. At point *c* the width of the electrode 15 is further diminished and the width of the electrode 16 is increased, with the relative widths being such that the potential at this point is plus 36 units. The electrode 15 does not extend quite to the point *d* and therefore at this point the potential will be that of the electrode 16 only or zero. Continuing around in a clockwise direction, the potential at all points will depend upon the relative widths of the electrode 16 at zero potential and the electrode 17 at minus 100, and at point *e* will be minus 36 units, at point *f* minus 63 units, and at point *g* minus 100 units. The potential on the circumference of the other half of the tube will be as shown on the chart at the left side of the figure with the points *g*, *h*, *j*, *k*, *m*, *n* and *a* having potentials of minus 100, minus 63, minus 36, zero, plus 36, plus 63 and plus 100 respectively.

Now considering the potentials which produce horizontal deflection, it is apparent that for such deflection the electrodes 16 and 18 are operative and the electrodes 15 and 17 are at zero potential. Charts showing the relative potentials for horizontal deflection are shown above and below the cylindrical space in Fig. 3. Starting again with point *a*, the horizontal potential at this point is zero since the plates 16 and 18 do not extend to this point and only the plate 15 is effective which is at zero potential for horizontal deflection. At point *b* the electrode 16 has small width as compared to the electrode 15 and the potential at this point has a value of 36 units considering the potential of electrode 16 as 100 units. Continuing around the tube, the potential at point *c*, for horizontal deflection increases to 63 units and at point *d* is plus 100 units, since only the electrode 16 is effective at this point. Continuing further at point *e* the potential is plus 63 and at point *f* is plus 36. At point *g* only the electrode 17 is effective so the potential for horizontal deflection is again zero. The potential then increases at points *h*, *j* and *k* in a negative direction with the voltages being minus 36 units, minus 63 units, and minus 100 units respectively. At points *m* and *n* the negative voltage decreases to minus 63 units and minus 36 units respectively.

The distribution of the voltage around the cylindrical space is the required distribution to produce linear fields for horizontal and vertical deflection within the cylindrical space. The horizontal and vertical fields extend through the same space and therefore the entire space available for deflecting the beam is effective for producing deflection in both directions.

The present tendency is to shorten the length of tubes so that television receivers can be built in relatively shallow cabinets. Such a construction may be provided using an electrostatic deflection system in accordance with the invention by positioning the deflection electrodes on the flared or frusto-conical section of the tube. Such a construction is shown in Fig. 5. The coatings are completely analagous to those described in connection with Figs. 1, 2 and 3 with the rib portions of the electrodes being symmetrically positioned longitudinally of the tube and maintained at 90° angles with respect to each other. The wedges of the electrodes are of gradually increasing length as the diameter increases but the configuration remains sinusoidal to provide the re-

quired voltage distribution. Fig. 6 shows the development of the electrode surface of Fig. 5. It is obvious that deflecting electrodes may be provided on the cylindrical neck portion and also on the flared portion to increase the amount of deflection provided for the electron beam.

The use of a conical deflection system results in increased deflection sensitivity for a given length. This is very advantageous in tubes having large screens. In actual tests it has been found that a conical surface having a large diameter three times the smaller diameter has a sensitivity twice that of a cylinder of the smaller diameter and the same length. This increased sensitivity provides greatly improved results.

It is apparent from the above that the electrostatic deflecting system in accordance with the invention may be incorporated in a cathode ray tube and the overall structure of the tube and deflection system may all be produced very inexpensively. The deflection electrodes substantially completely enclose the space through which the beam travels so that a maximum amount of deflection can be provided for a given length of travel. This will permit relatively wide angle deflection providing large picture size by relatively short tube structures. The electrodes are positioned at the extremities of the space through which the beam traverses so that very high voltages can be used without causing interference with the action of the beam.

Although certain embodiments of the invention have been disclosed which are illustrative thereof, it is obvious that various changes and modifications can be made therein without departing from the intended scope of the invention as defined in the appended claims.

I claim:

1. A cathode ray tube including a tubular portion formed of insulating material, means for producing a beam of electrons which passes through said tubular portion, and conducting means formed on said tubular insulating portion for deflecting said beam, said conducting means including four symmetrically positioned electrodes all extending longitudinally along said tubular portion and having interleaved wedge-shaped portions.

2. A cathode ray tube including a tubular portion formed of insulating material, means for producing a beam of electrons which passes through said tubular portion, and conducting means formed on said tubular insulating portion for deflecting said beam, said conducting means including four symmetrically positioned electrodes including longitudinally extending rib portions and wedge-shaped portions extending therefrom with the dimensions of said wedge-shaped portions varying substantially as a sine wave.

3. A cathode ray tube including an enclosure having a cylindrical neck portion formed of insulating material, means for producing a beam of electrons which passes through said neck portion, and conducting means within said insulating neck portion for deflecting said beam, said conducting means including four symmetrically positioned electrodes extending longitudinally of said neck portion and having interleaved wedge-shaped portions which are of sinusoidal configuration, said electrodes forming a substantially complete cylindrical surface.

4. A cathode ray tube including a frusto-conical portion formed of insulating material, means for producing a beam of electrons which passes through said frusto-conical portion, and conducting electrodes formed on said insulating frusto-conical portion for deflecting said beam, said conducting electrodes including four symmetrically positioned conducting elements having interleaved wedge-shaped portions.

5. A cathode ray tube including a tubular portion formed of insulating material, means for producing a beam of electrons which passes through said tubular portion, and conducting means deposited on said tubular insulating portion for deflecting said beam, said conducting means including four symmetrically positioned electrodes having interleaved wedge-shaped portions and portions electrically interconnecting said wedge-shaped portions of each electrode, said electrodes substantially completely covering the surface of said tubular portion and being insulated from each other.

6. A cathode ray tube including an evacuated enclosure, a tubular insulating member within said enclosure, means for producing a beam of electrons and for directing the same through said tubular member, four conducting electrodes positioned on the inside surface of said tubular insulating member and symmetrically positioned with respect to each other, each of said electrodes including a longitudinally extending rib with wedge-shaped portions extending therefrom, with the wedge-shaped portions of adjacent electrodes being interleaved to provide a substantially enclosed structure, said longitudinally extending ribs being spaced at substantially 90° with respect to each other and said wedge-shaped portions extending substantially to the longitudinally extending ribs of the adjacent electrodes.

7. A cathode ray tube including an evacuated enclosure, a tubular insulating member within said enclosure, means for producing a beam of electrons and for directing the same through said tubular member, four conducting coatings deposited on the inside surface of said tubular insulating member, symmetrically positioned with respect to each other and insulated from each other, each of said coatings including a longitudinally extending rib with wedge-shaped portions extending therefrom, with the wedge-shaped portions of adjacent coatings being interleaved to provide a substantially enclosed structure, said longitudinally extending ribs being spaced at substantially 90° with respect to each other and said wedge-shaped portions having gradually reduced cross section as said portions extend from said ribs, and being of sinusoidal configuration.

8. An electrostatic deflection system for producing a pair of electrostatic fields extending at right angles to each other within a cylindrical space, said system comprising four groups of conducting electrodes symmetrically positioned about the circumference of said space, each of said conducting electrodes including an elongated portion and reduced portions extending therefrom with the extending portions of adjacent electrodes being interleaved with each other to form a substantially complete conducting enclosure about said space, means for connecting a source of sawtooth voltage waves balanced with respect to a reference potential to one pair of oppositely positioned conducting electrodes, and means for connecting a second source of sawtooth voltage waves balanced with respect to said reference potential to the remaining pair of said conducting electrodes.

9. An electrostatic deflection system adapted

to produce fluctuating electrostatic fields in a space traversed by an electron beam, with said fields being at right angles to the path of said beam and at right angles to each other, the combination including a first pair of oppositely positioned conducting elements positioned on a tubular insulating surface and having oppositely positioned elongated portions and reduced portions extending substantially 90° around said space on either side of said elongated portion, a second pair of oppositely positioned conducting elements positioned on said tubular surface substantially at right angles to said first pair of elements and having oppositely positioned elongated portions and reduced portions extending about said space for substantially 90° on each side of said elongated portions, said reduced portions of adjacent conducting elements being of sinusoidal configuration and being interleaved with each other to substantially completely cover said tubular surface.

10. An electrostatic deflection system adapted to produce fluctuating electrostatic fields in a space traversed by an electron beam, with said fields being at right angles to the path of said beam and at right angles to each other, the combination including a first pair of oppositely positioned conducting elements positioned on a cylindrical surface and having oppositely positioned elongated portions and reduced portions extending substantially 90° around said space on either side of said elongated portion, a second pair of oppositely positioned conducting elements positioned on said cylindrical surface substantially at right angles to said first pair of elements and having oppositely positioned elongated portions and reduced portions extending about said space for substantially 90° on each side of said elongated portions, said conducting elements being insulated from each other, said reduced portions of adjacent conducting elements being interleaved with each other to provide a substantially completely enclosed cylindrical surface.

11. A cathode ray tube including in combination, an evacuated enclosure, means for producing a beam of electrons, an insulating member having an opening for receiving said beam of electrons, four conducting electrodes symmetrically positioned with respect to each other on the surface of said opening of said insulating member, each of said electrodes including a portion extending substantially longitudinally of the path of said beam and portions extending on either side therefrom which taper from substantial widths to points, said tapered portions of adjacent electrodes being interleaved with each other and being insulated from each other.

12. A cathode ray tube including in combination, an evacuated enclosure, means for producing a beam of electrons, four conducting electrodes within said enclosure symmetrically positioned with respect to said beam and to each other, each of said electrodes including a plurality of wedge-shaped portions having the bases thereof positioned along a line extending substantially longitudinally of the path of said beam and conducting portions interconnecting said wedge-shaped portions of said electrode, said wedge-shaped portions of adjacent electrodes being interleaved with each other to form a substantially complete surface.

13. A cathode ray tube including in combination, an evacuated enclosure, means for producing a beam of electrons, an insulating member having a tapered opening for receiving said beam of electrons, four conducting electrodes symmetrically positioned with respect to each other on the surface of said opening of said insulating member, each of said electrodes including a plurality of wedge-shaped portions having the bases thereof positioned along a line extending substantially longitudinally of the path of said beam and conducting portions interconnecting said wedge-shaped portions of each electrode, said wedge-shaped portions of adjacent electrodes being interleaved with each other.

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