Aug. 9, 1938. J. T. WILSON 2,126,694

ELECTRON TUBE

Filed March 26, 1937

Fig. 1

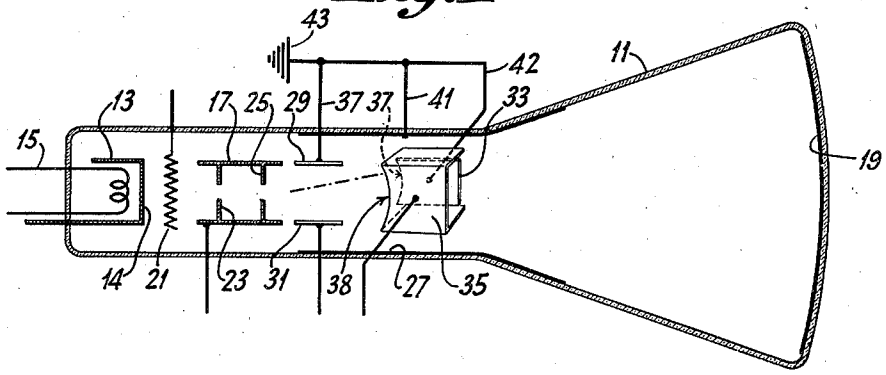


Fig. 2

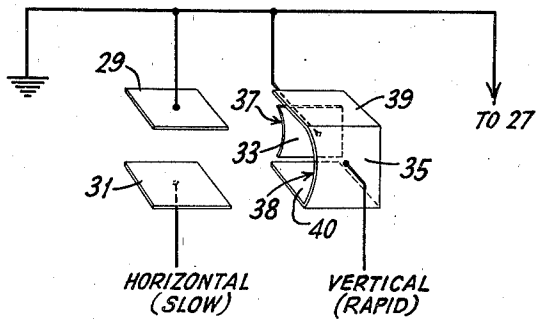
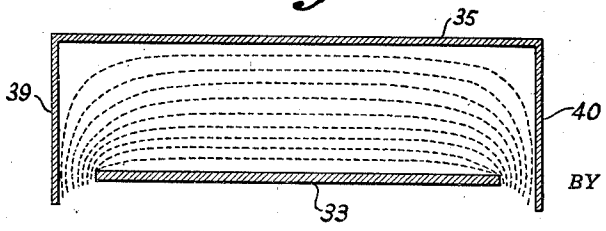


Fig. 3



Fig. 4



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ELECTRON TUBE

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8 Claims. (Cl. 250—27.5)

The present invention relates to electronic tubes, and particularly electronic tubes of the type known in the art as cathode ray tubes. The invention further relates to those types of cathode ray tubes for producing luminous effects and which are known and designated by the trademarks "Kinescope" and "Kinetron" (trade-mark registrations #296,195 and #340,707) as well as tubes of the type used for image signal production and which are known by the trade-mark designations "Iconoscope" and "Iconotron" (trade-mark registrations #325,875 and #342,360) as well as tubes of the class used for frequency multiplication, X-ray purposes and the so-called "beam" tubes.

This application relates to an improved form of tube structure for the same general purposes as the device described by my co-pending application Serial No. 79,341, filed May 12, 1936 and like the earlier application relates to correcting distortions produced within the tube, such as that known as "keystoning".

More particularly, the invention relates to the construction of the electrodes which comprise the deflecting system for deflecting the electron beam developed within the electronic tube due to the co-operative action of an accelerating anode or electrode and an electron emissive cathode which produces an electron beam adapted to impinge upon a luminescent screen to produce luminous traces in accordance with the position of beam impact thereupon. The deflecting electrode system, to which this disclosure is particularly related is positioned intermediate the cathode or electron source, and the electron gun structure producing the cathode ray or electron beam and target, which for light producing tubes is the luminescent screen. When suitable voltages are caused to act upon the beam deflecting electrodes, the produced electron beam is caused to trace predetermined paths across the target or luminescent screen structure.

It is an object of the present invention to provide electrode structure for deflecting the developed electron beam so that the effects of "keystoning" as well as the so-called fringing or de-focussing effects of the spot are avoided. The effect of fringing or de-focussing is well known and is corrected in the types of tubes usually manufactured to a substantial extent through the proper design and construction of the electron gun structure. However, fringing or defocussing of the produced spot upon the screen is to some extent also produced by reason of the shaping and positioning of the deflecting electrode system, and it is an object of the present invention to overcome the fringing or de-focussing effects which is due to the electron beam deflecting system.

"Keystoning", which is one of the distortion effects corrected by the present invention, is that effect which results in electron tubes of the cathode ray type or equivalent types such as X-ray and beam tubes, when the beam developed within the tube is deflected and the maximum length of traverse of the beam under a given deflection voltage at one edge of the screen is greater or less than the extent of traverse for the same deflection voltage across that portion of the screen which is diametrically opposite the first path of traverse. The "keystoning" effect becomes apparent in a pattern of traversal of the electron beam across the target or luminescent screen which becomes substantially trapezoidal in shape rather than either the desired square or rectangular pattern, the matter of whether the desired pattern is square or rectangular depending, of course, upon the ratio of the deflection voltages for deflection of the beam in two mutually perpendicular planes.

Arrangements have been suggested in the prior art to overcome to some extent the detrimental fringing and "keystoning" effects in electron tubes of this nature. While such schemes of the prior art include the positioning of a diaphragm member between two sets of deflecting electrode members or the positioning of a ring-like structure at the edges of the deflecting electrode system most remote from the electron source, it has been found that such structures complicate to a considerable extent the ease with which electron tubes of this type may be manufactured.

Another form of compensating system is described in my above identified copending application and, as disclosed therein, embodies the use of narrow flanges attached to one of the deflecting electrodes for re-shaping the field distribution. While greatly improved results were attainable with this latter system it nevertheless did not serve to correct fully all objectionable "keystoning" and fringing and defocussing within the tube.

Accordingly, it is an object of the present invention to accomplish more efficiently the correction of distortion within cathode ray or electronic tubes, while still permitting more satisfactory manufacturing methods, the improved operational effects of what is considered complicated prior art arrangements.

Other objects of the invention are naturally

those of providing electron tube structure which consists of a minimum number of parts, structure which can be manufactured in quantity to a large extent by the most simplified processes and by the aid of unskilled workmanship and, at the same time, which can be manufactured more cheaply by reason of the lack of additional electrode elements of the prior art.

Still other objects and advantages of this invention will, of course, suggest themselves and immediately become apparent to those skilled in the art by reading the following specification and claims in connection with the accompanying drawing, in which

Fig. 1 represents schematically an electron tube of the cathode ray type wherein the present invention is embodied;

Fig. 2 schematically illustrates in a partially angular view the deflecting electrode members which are positioned within the electron tube shown by Fig. 1, and

Fig. 3 represents the voltage or equi-potential lines between the second set of deflecting electrode plates.

Now, making reference to the accompanying drawing for a further understanding of the nature of the present invention, the electron tube envelope **11**, which is preferably formed of glass or other vitreous material, of the cathode ray type has positioned at one end of a cylindrical neck a cathode **13** which has a coating **14** on its upper surface of suitable material such as barium oxide or strontium oxide, or a combination of these compositions or the equivalent, which emits electrons copiously when heated in any suitable manner. For the purpose of heating the cathode **13** to cause it to emit electrons, a heater element **15** has been shown for heating the cathode indirectly although it will be appreciated that the cathode element **13** may, where desired, be a directly heated cathode. In order to cause the electrons emitted from the cathode element **13**, when the heater element **15** is energized to be formed into an electron beam, there is provided an anode **17** which is maintained at a voltage highly positive with respect to the cathode. As the electrons leave the cathode **13** and are formed into a beam by the accelerating and focussing field produced between the anode **17** and the cathode **13**, these electrons are projected longitudinally of the tube **11** to impinge upon the target or luminescent screen **19** which is suitably supported at the end of the tube remote from the emitter **13** or, where desired, directly upon the inner surface of the end wall of the tube opposite the cathode **13**. As the electrons forming the electron beam impinge upon the luminescent screen structure **19**, they cause it to fluoresce and phosphoresce with the result that light is produced at the point of impact of the beam. Where it is desired to control the intensity of the electron beam which impinges upon the luminescent screen **19**, a grid structure **21** such, for example, as is shown by Nicolson Patent #1,470,696 may be interposed between the cathode **13** and anode **17**. Such a grid structure may consist of a suitably apertured disc member such as has already been shown in the art and which has not herein been illustrated in order to simplify the showing.

Other forms of intensity control of the luminescent spot produced on the tube end wall may, of course, be resorted to without invention and where desired, it is of course obvious that electron tubes of the general type herein shown may be manufactured without the inclusion of the grid member, and such tubes, for example, would find particular application in oscilloscope work where it is not usually desirable or necessary to control the intensity of the resultant luminous effect, although for television usage of a cathode ray tube of the type herein disclosed, a grid or equivalent intensity control element is desirable in order to produce shading effects in the resultant luminescent trace of the electron beam.

As the electrons forming the electron beam are drawn from the cathode **13** and formed into a beam by the application of voltages to the anode **17**, these electrons are arranged to pass through diaphragm members **23** and **25** positioned within the tubular anode **17**. These diaphragm members are suitably apertured at their centers and serve to limit to some extent at least the cross-sectional area of the resultant electron beam. After the electron beam has passed through the diaphragm members **23** and **25** of the first anode **17**, the beam is then subjected to the action of an electrostatic focussing field produced by the cooperative action of the first anode **17** and a second anode **27**. The second anode **27** is maintained highly positive with respect to the first anode **17**, the ratio of the voltage of the first anode and second anode to the cathode is usually being of the order of four to one, or thereabouts, although with respect to this voltage ratio, some degree of tolerance is permissible.

The second anode **27**, as shown by the accompanying drawing, is formed as a metallic coating on the interior surface of the neck of the tube **11**, and is shown as continuing through the neck of the tube to a plane substantially corresponding to the plane of termination of the tubular first anode **17**. Of course, it will be obvious that the second anode structure may be in the form of a second tubular metallic member which is supported in axial alignment with the first anode **17** and thus forming a separate electrode member in the path of the developed electron beam and adjacent the first anode although positioned with greater longitudinal spacing from the cathode than the first anode. It will also be appreciated that the second anode while formed as a coating on the interior surface of the neck portion of the tube **11** may be terminated at a plane even beyond the edge of the deflecting electrode most remote from the cathode **13**, and it will also be appreciated, of course, that the coating which serves the second anode of the interior surface of the tube may extend throughout substantially the entire length of the conical portion of the inner surface of the tube envelope **11**, although these latter suggestions furnish mere modifications and are not illustrated because of the obvious nature of the same to those skilled in the art and because further showing is unnecessary to a complete understanding of the true nature of the present invention.

In order to deflect the produced electron beam which is projected beyond the first anode **17** and through the second anode **27** so that the produced electron beam traverses the screen **19**, two sets of deflecting electrodes **29**, **31** and **33**, **35** are interposed between the beam source and the target. In order to move the beam in two mutually perpendicular directions (desirable for tracing the two dimensional pattern) suitable deflecting voltages are applied to the deflecting electrodes. These applied voltages may be of any desired wave shape, such as sawtooth, sine wave, symmetrical sawtooth or any other form, but for this consideration non-symmetrical sawtooth will

be assumed for explanation purposes. The electrodes **29** and **31** are preferably those electrodes which cause the beam to move relatively slowly in one direction across the screen, for example, as shown the motion would be parallel to the plane of the drawing. The electrodes **29** and **31** preferably are each formed as a rectangular or square shaped plate (see more particularly Fig. 2).

The deflecting electrode members **33** and **35** are those two electrode members which are arranged to deflect the produced electron beam in a direction perpendicular to the direction of deflection produced by the application of voltages to the deflecting electrodes **29** and **31**. These electrodes **33** and **35** are shaped so that one of the deflecting electrodes **33** is preferably a flat surface whose edge **37** nearest the electron source is curved concavely with respect to the electron source. The electrode **35** has its edge portion **38** nearest to the electron source also curved concavely with respect to the source, and the radius of curvature should correspond to that of the deflecting plate electrode **33**. In addition, the electrode **35** has its edges, which are parallel to the axis of the tube, provided with flange members **39** and **40** extending in the direction of the deflecting plate **33** and just slightly overlapping the plane of the deflecting plate electrode **33**. These flanged edges **39** are formed by bending over the upper and lower edges of the deflecting plate electrode **35** or by welding to the deflecting plate electrode **35** a suitable width conducting flange element. It, however, should be understood that the flat area of the deflecting plate electrode **35** along the dimension "*a*" is just slightly in excess of that provided for the flat area of the deflecting plate electrode **33**. This is necessary in order that the flanged edges **39** and **40** shall not touch the surface of the deflecting plate electrode **33** when they are bent over (see more particularly Fig. 2). Therefore, in forming the deflecting electrode member **35** where it is desired to form the flange by bending the electrode member **35** is of slightly greater transverse dimension than the electrode member **33** but as is evident from the voltage distribution curves of Fig. 4 the desired potential distribution is maintained.

When the tube of the type herein disclosed is in operation, the deflecting electrode members **29** and **33** are preferably connected by way of conductors **37** and **42** with the conductor **41** arranged to supply positive potential with respect to the cathode to the second anode member **27**. For convenience, this arrangement has been shown by providing a ground connection **43** for all of the conductors **37**, **41**, and **42**, in which condition it will be appreciated that the cathode **13** is, for example, operated well below ground potential, the exact voltage being such that the ratio of the second anode voltage to the first anode voltage and the first anode voltage to the cathode voltage satisfies the operational conditions necessary to provide suitable focussing and acceleration of the electron beam, and these conditions are well established in the art and set forth in published descriptive literature describing, for example, tubes of the type known as the "RCA–906".

From the foregoing, it will be appreciated that the electron beam as it passes from the electron gun **13**, **21**, **17** and between the deflecting plate pairs **29** and **31** is caused to move in the plane of the drawing when voltages are supplied between the electrode members **31** and **29**, and similarly when voltages are supplied to the deflecting electrode members **35** and **33**, the produced electron beam is caused to move in and out of the plane of the paper (looking at the showing in Fig. 1, for example). As the electron beam is thus moving the curvature of the plates **33** and **35**, shown by the curved surface edges **37** and **38**, will correct for the de-focussing or fringing effects which would normally be due to unequal sensitivity of deflection for the beam as it is moved by the deflecting electrode pair **29** and **31**. The curvature, as shown by the curved edges **37** and **38** in the drawing, is preferably such that the radius from which the curved portions **37** and **38** is struck is equal to the distance from the point of initial beam deflection to the innermost portion of the curve **37** or **38**, as shown for example by the dash-dot line on the drawing in Fig. 1. The flanged portions **39** and **40** of the electrode member **35** will correct for the so-called "keystoning" of the beam trace on the target because of the fact that the sensitivity of deflection, that is, the effective voltage applied to the deflecting electrode to deflect the electron beam within a given distance is greater at the edge than at the innermost portion of the plate.

Referring now to the curves of Figs. 3 and 4, there are illustrated typical potential distribution plots and the equi-potential lines existing between the deflector electrode plate pairs. The curve as shown by Fig. 3 shows, for example, the potential distribution plots for the first set of deflecting electrodes, that is, the set nearest the source of the cathode ray.

The curves for Fig. 4 show a typical potential distribution plot and the equi-potential lines existing between the deflector electrode plates of the second pair of deflector electrode plates. These curves show clearly the potentials existing between the flanged electrodes **35** and the electrode **33**. While neither of these curves of Figs. 3 and 4 show absolute values of voltages it is apparent that the various voltage lines could readily indicate the percentage, for example, of the potential above the second anode voltage at which the free plates **31** and **35** are operated.

In the light of the foregoing, it of course will be obvious to those skilled in the art that various modifications and changes may be made without departing from the spirit and scope of the present invention, and it is therefore believed that any and all of such modifications may be made as fall fairly within the spirit and scope of the hereinafter appended claims.

What I claim is:—

1. In an electron tube, means to develop an electron beam, a plurality of electrodes to deflect said electron beam, said electrodes each having one edge portion thereof concavely curved with respect to the origin of the produced electron beam, and an inwardly extending flange attached to the opposite edges of one of said electrodes and extending in the direction of the other of said electrodes to enclose the projection of the plane thereof.

2. In an electron tube, an electron source, an accelerating electrode and a target surface, a pair of electrostatic deflecting electrodes positioned intermediate the accelerating electrode and the target, said pair of deflecting electrodes each having the inner edge portion thereof which is positioned toward said cathode concavely curved with respect to said cathode, and flange members attached to one of said deflecting electrodes, said flanges being attached to the edges of said electrode extending parallel to the

longitudinal axis of said electron tube and extending toward the other of said electrode members and enclosing the other said member.

3. The electron tube structure claimed in claim 2 comprising, in addition, a second pair of plate electrodes for deflecting the electron beam perpendicularly to the path of said first-named deflecting electrodes, said last-named electrodes being positioned intermediate the first-named set of deflecting electrodes and the electron beam source.

4. An electron tube comprising an electron source, an accelerating electrode and a luminescent screen upon which the electron beam developed by the co-operative action of said electron source and said accelerating electrode is adapted to impinge to produce luminous effects, a pair of oppositely positioned substantially flat deflecting plate electrodes located intermediate the accelerating electrode and the luminescent screen, each of said plate electrodes having the edge portion thereof which is toward said electron source curved at a predetermined radius of curvature, and a flange member attached to opposite edges of one of said deflecting plate members, said flanges being positioned longitudinally of the tube axis and attached to the edges of the plate electrode in such manner as to extend in the direction toward and beyond the plane of the plate electrode member opposite the same.

5. The electron tube structure claimed in claim 4 comprising, in addition, a second pair of deflecting plate electrodes for deflecting the electron beam in a direction normal to the deflection path of the first named deflecting plate electrodes, said second pair of deflecting plate electrodes being located intermediate the first named deflecting plate electrodes and the electron beam source.

6. An electron tube comprising an electron source, an anode adapted when positive voltages are applied thereto relative to the electron source to produce an electron beam, a luminescent screen target area positioned in the path of the developed electron beam and adapted to become luminous at points of impact of the developed electron beam, a pair of electrostatic deflecting plate electrodes positioned intermediate the electron source and the luminescent screen, a second pair of electrostatic deflecting plate electrodes positioned intermediate said first-named pair of deflecting plates and said luminescent screen, and a flange member connected with opposite edge portions of one of said last-named deflecting plate electrodes so that the flange members extend longitudinally of the tube axis and in the direction of and beyond the plane of the opposite one of said last named pair of deflecting plate electrodes.

7. An electron tube comprising an electron source, an anode adapted when positive voltages are applied thereto relative to the electron source to produce an electron beam, a luminescent screen target area positioned in the path of the developed electron beam and adapted to become luminous at points of impact of the developed electron beam, a pair of electrostatic deflecting plate electrodes positioned intermediate the electron source and the luminescent screen, a second pair of electrostatic deflecting plate electrodes positioned intermediate said first-named pair of deflecting plates and said luminescent screen, said second-named deflecting electrodes each having the edge portion toward said electron source curved at a radius of curvature substantially equal to the distance from the point of initial deflection of said electron beam through said first-named deflecting electrodes to the curved edge of the second named deflecting electrode, and a flange member connected with opposite edge portions of one of said last-named deflecting plate electrodes so that the flange members extend longitudinally of the tube axis and in the direction of and beyond the plane of the opposite one of said last named pair of deflecting plate electrodes.

8. An electrostatic electron beam deflecting system comprising an electrode having a base portion and parallel flange portions affixed to the base portion, said base portion having one edge curved and a plane electrode positioned parallel to the base portion of the first named electrode and within the space bounded by the parallel flange portions of the first named electrode, said second named electrode having a curved edge adjacent the curved edge of the first named electrode.

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