CATHODE RAY DEVICE

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My invention relates to improvements in cathode ray tubes of the oscillograph type and particularly in tubes wherein a curvilinear or circular time base is utilized for indicating electrical phenomena.

It has been proposed in tubes of the prior art to utilize a cathode ray tube having a fluorescent screen for measurements wherein the time base is evidenced by a closed curved trace on the fluorescent screen. The time base may be formed on such a screen by electrostatic or electromagnetic means but it has been difficult to display the electron beam of such tubes in a radial direction in response to a signal to be measured inasmuch as the tubes of the prior art have obstructing structure supporting structure either in the path of the cathode ray beam or between the fluorescent screen and the observer.

It is an object of my invention to provide a cathode ray tube suitable for observing transient phenomena by the displacement of a curvilinear or circular time base without the interposition of obstructing structure, and a further object to provide such a tube wherein the sensitivity to electrical phenomena to be measured is improved.

In accordance with my invention I provide a cathode ray tube having a fluorescent screen with means to generate an electron beam and deflect the beam along a curvilinear or circular path and further deflect the beam radially to the said path with electrostatic structure entirely removed from the path of the beam without the interposition of any obstructing medium without the tube. These and other objects, features and advantages of my invention will become apparent and will at once suggest themselves to those skilled in the art to which the invention is directed from the following description taken in connection with the accompanying drawing in which:

Figure 1 is a longitudinal sectional view of a cathode ray tube incorporating my invention; and,

Figure 2 is a cross-section of certain of the electrode structure shown in Figure 1 showing the electrostatic field generated in that structure.

In the illustrative embodiment of my invention as shown in Figure 1, the cathode ray tube comprises an evacuated envelope or bulb having an elongated neck section enclosing an electron gun and a frusto-conical portion closed at one end and provided at the closed end with a target or fluorescent screen which becomes luminescent when bombarded by electrons from the electron gun.

The electron gun assembly is of the conventional type and comprises a cathode from which an electron stream may be drawn, a control electrode connected to the usual biasing battery and a first anode maintained positive with respect to the cathode. The electron stream leaving the first anode is accelerated and concentrated into an electron scanning beam by a second anode which is preferably a conductive coating on the inner surface of the bulb over a portion of the neck and frusto-conical sections. The first anode and the second anode are maintained at the desired positive potentials by a potential source such as the battery. Conventional deflection means such as the electromagnetic coils and may be used to sweep the beam so as to produce a curvilinear or circular luminous trace on the fluorescent screen by applying alternating current to the coils which are leading or lagging the current applied to the coils. It is obvious that conventional electrostatic plates may be substituted for the deflection coils if desired whereupon the deflection plates would be supplied by alternating voltages having the desired phase relationship.

In accordance with my invention I provide between the curvilinear or circular trace beam deflecting means such as the coils and and a target adapted to become luminescent when bombarded with electrons such as the fluorescent screen means for producing a non-homogeneous axially symmetric electrostatic field for deflecting the beam in a radial direction with respect to the curvilinear or circular deflection. A homogeneous electrostatic longitudinal field does not exercise upon an electron moving in the direction of this field any radially directed force but this effect will be produced by a non-homogeneous axially symmetric field for the reason that there is set up a radial component of deflection in addition to a local change in the longitudinal component of the field. Such an electrostatic field produces upon a beam of moving electrons an influence similar to that produced by an optical lens upon the path of luminous rays.

More particularly I provide means for imparting a radial component of velocity to a moving electron beam comprising an electrode assembly including three apertured diaphragms or electrodes, the outer two of which are electrically interconnected. These three electrodes are preferably supported in a substantially field-free space between the coils and and the screen. With reference to Figure 1 I provide between the conventional deflecting means such as the coils and and the screen, two apertured discs or.
diaphragm electrodes 10 and 11 spaced longitudinally along the path of the beam with an intermedately aperture disc or diaphragm electrode for electrically insulated elements the diaphragms 10 and 11 which are electrically connected together. The electrically connected electrodes 10 and 11 are preferably supported in the neck of the tube within the second anode 6, and may have a potential applied thereto through the lead 13, the intermediate disc electrode 14 being provided with a lead 14. The diaphragms 10 and 11 and the diaphragm 12 may be connected indirectly to the second anode 6 through a bridge network of equivalent resistors 15 and 16 so that their mean potential may be maintained equivalent to that of the second anode. The impedance of the network is relatively high, the resistors having a resistance of around 1 megohm so that potentials, which is desired to measure, unbalance the network and produce an electrostatic deflection field between the electrode 14 and the electrodes 11 and 12.

During operation of my new and improved cathode ray tube the deflection means, such as the coils 6 and 9, sweep the cathode ray beam so as to form a curve in a non-linear or circular trace on the screen 2, the beam sweeping out and generating an imaginary cone having its apex at the center of deflection of the coils 6 and 9 and its base on the fluorescent screen 2, the boundary of which are indicated by the lines CA and CB in Figure 1. If it is assumed that radial deflection components exist in or adjacent to the apertures of the diaphragms 10, 11 and 12, additional deflection of the electron beam occurs in the region of these electrodes thereby increasing or decreasing the radial component of the beam produced by deflection coils 6 and 9. The imaginary cone swept out by the beam will, therefore, be modified. This modification of the path of the beam is shown in Figure 1 wherein the lines CA and CB change their direction slightly in the region of the electrodes 10, 11 and 12 which presupposes that the electrode 12, with the divergence of the lines CA and CB as shown, is at a negative potential with respect to the electrodes 10 and 11. The action of my new and improved electrode structure may be further explained with reference to Figure 2 which shows the cross-section of the electrodes 10, 11 and 12 made by a cutting plane lying along the tube axis XY and in which the lines 17 show equipotential regions developed by the application of a potential difference between the electrodes. It will be observed that as the distance from the tube axis XY is increased the angle of inclination of the equipotential lines likewise increases. Since electrons moving through an electrostatic field of this nature are deviated from their initial path by an amount proportional to the angle of inclination of the equipotential lines, the radial component imparted to the electron beam by such an electrostatic field will be proportional to its distance from the axis such as the axis XY.

It is, therefore, preferable to make the apertures of the diaphragm electrodes 10, 11 and 12 so small or the diameter of the imaginary cone swept out by the beam in the region of these electrodes so large that the circularly deflected cathode ray beam will pass through the apertures relatively close to the solid portions of the electrodes. In addition to the radial deflection components produced by the electrostatic field in the apertures of the diaphragm electrodes 10, 11 and 12 there is also a longitudinal component applied to the electron beam which in effect is a combination of accelerating and deflection components. Therefore since lower velocity electrons are more radially deflected than are high velocity electrons, the longitudinal component of the electrostatic field existing in the apertures will determine the extent of the radial deflection imparted to the beam by the field existing between the electrodes. It is, therefore, desirable to provide the electrodes 10, 11 and 12 spaced closely together in the direction of the tube axis. A spacing of 1 mm between these electrodes has been found suitable although for various deflection sensitivities or various applied potentials this spacing may be either less or greater than the above mentioned value.

It will be obvious from the above description taken in connection with the accompanying drawing that my tube is particularly adapted to the measurement of electrical phenomena with the utilization of curvilinear or circular time base and that by the use of my structure I am able to produce a continuous uninterrupted trace on the fluorescent screen and further that the fluorescent screen is unobstructed with respect to the observer in that no structure or aperture is interposed in the path of the light rays emanating from the fluorescent screen. The electrical phenomena in effect will divert the beam from the normal curved path along a substantially straight line normal to the curve and extending in a radial direction which may be observed without any intervening obstructions. Therefore, 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.

1. A cathode ray oscillograph tube comprising an envelope, a target adjacent one end of said envelope adapted to become luminescent when bombarded by high velocity electrons, an electron gun adjacent the opposite end of said envelope and exposed to said target to generate and direct an electron beam along the axis of said envelope, means between the gun and target for sweeping the beam from said gun along a closed curved path on said target, and means comprising three closely spaced apertured disc electrodes surrounding a portion of said envelope and removed from the normal undeflected path of the beam for deflecting the beam from the closed curved path.

2. A cathode ray oscillograph tube having an envelope, an electron emitting cathode to produce a flow of electrons, an anode to produce a focused beam of electrons, a screen adapted to become luminescent when bombarded by electrons from said gun, means to deflect the electron beam from said gun over said screen along a closed curved path, a pair of apertured spaced disc electrodes enclosed within said anode in a substantially field-free space generated by said anode and between said deflection means and said screen and an apertured disc electrode between said pair of disc electrodes to generate therewith a radial beam deflection field, the oper-
3. A cathode ray oscillograph device for measuring electrical phenomena comprising an evacuated envelope, an elongated electron gun to generate a beam of electrons, an electron receiving target exposed to said electron gun and intersecting the longitudinal axis of said gun, beam deflecting means to deflect the beam generated by said gun from the longitudinal axis of said gun and along a closed curved path, a series of three apertured discs perpendicular to the longitudinal axis removed from and surrounding said axis, and means to apply the electrical phenomena to be measured between the central disc and the remaining discs.

4. A cathode ray oscillograph device for measuring electrical phenomena comprising an electron source to generate a stream of electrons, a pair of associated anodes to accelerate and focus the stream of electrons from said source into an electron beam, beam deflecting means to deflect the beam from its normal path, three apertured beam deflecting diaphragms surrounding the normal undeflected path of said beam within one of said anodes and wholly removed from the normal undeflected path of said beam, means to apply a potential difference between the innermost diaphragm and the other two diaphragms for additionally deflecting the beam from its initially deflected path, and an electron receiving target in the path of the additionally deflected beam.

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