Aug. 27, 1940. J. B. SHERMAN 2,213,172

ELECTRODE SYSTEM

Filed March 30, 1937

Fig. 1

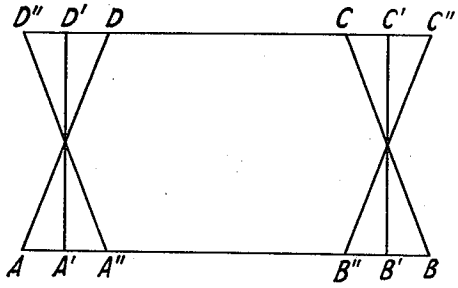


Fig. 2

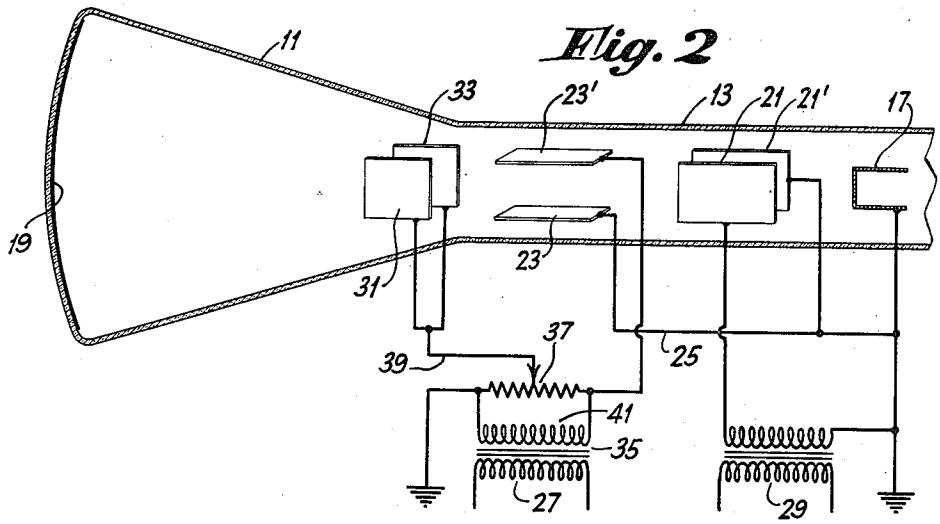
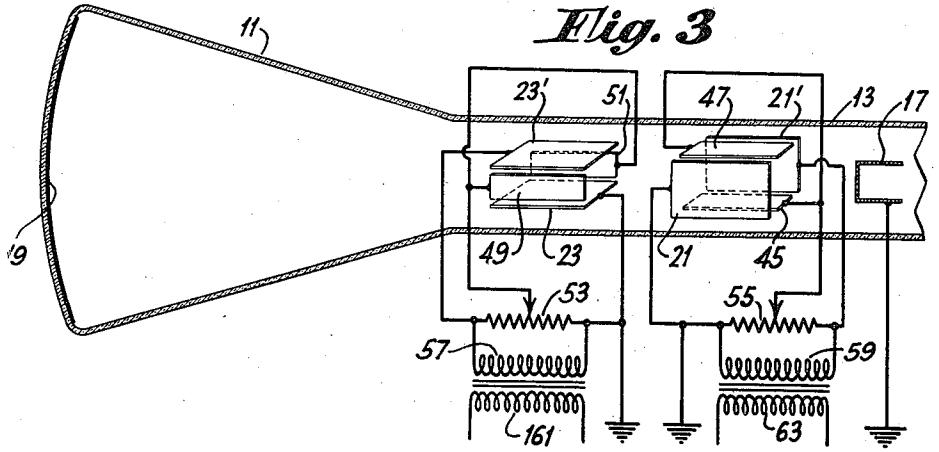


Fig. 3



INVENTOR
J. B. SHERMAN

BY

ATTORNEY

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ELECTRODE SYSTEM

Jesse B. Sherman, New York, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

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5 Claims. (Cl. 250—158)

The present invention relates to electronic tubes and particularly to that class of electronic tubes which have become known in the art as the cathode ray tubes. Tubes of this general type usually comprise an electron gun structure positioned within an enclosing envelope at one end thereof, and a luminescent screen or target located in the opposite end of the envelope and longitudinally spaced from the electron gun. When suitable voltages are applied to the electron gun structure electrode members, which usually comprise a cathode (that is, the electron emitting electrode which may be directly or indirectly heated) and the anode with a control electrode (sometimes termed a "grid") interposed between, there is developed an electron beam or cathode ray which is suitably focused upon the luminescent screen or target to produce thereupon luminous effects under impact of the cathode ray beam. The intensity of the resultant luminous spot or effect is governed both in accordance with the velocity of the impinging electron beam or cathode ray and also in accordance with the electron density of that ray. Tubes of this general character are well known in the art and are sold under the trade name designations "Kinescope" and "Kinetron" (trade-mark registrations #296,195 and #340,707).

In its more specific form this invention relates to the electrode structure by which the electron beam or cathode ray developed within the tube may be deflected across the luminescent screen or target so as to produce a resultant trace of a traveling light spot thereacross which will portray motion of the spot of light (either controlled or uncontrolled in intensity, as desired) on the impact area. While electrode structures for moving a cathode ray beam or pencil across the target or luminescent screen may comprise either electro-magnetic means (deflecting coils), electro-static means (deflecting plates) or a combination of both means, the present invention is principally concerned with the electrostatic type of deflecting electrode systems. Such electrode systems, as known in the prior art, are interposed as a series of two pairs of plate-like electrode members positioned intermediate the electron gun structure and the impact screen or target. With the pairs of plates mutually perpendicular to each other the simultaneous application of different voltages to the different plate pairs will cause the electron beam or cathode ray to impinge upon the screen structure or target at different points and thus trace a two dimensional path thereacross (or for only one active pair of plates a one dimensional path).

It has been found, however, that deflecting electrode pairs of the character above described tend, in many instances, to produce, when deflecting voltages are applied thereto, interacting electrostatic fields which prevent the resultant impact trace of the cathode ray beam on the target or screen from being the usually desired true rectangular pattern. Such failure to trace a true rectangular pattern (by which is meant to be included a square pattern as well) is known as "keystoning" within the tube since when "keystoning" occurs the traced area is substantially trapezoidal in form and resembles to a large extent the shape of a portion of a "keystone."

Various ways and means have been suggested in the prior art for overcoming such defects in cathode ray and the like types of tubes. Such suggestions for overcoming these defects include among other things the use of a shielding electrode positioned between the mutually perpendicular sets of deflecting plates to prevent interacting electrostatic fields. Other forms of systems used for this purpose include the use of shielding electrode members formed as a part of at least one of the deflecting plate electrodes and arranged to be wrapped so as to surround at least a part of the path traversed by the electron beam leaving the deflecting electrodes in the direction toward the impact screen.

While such suggestions of the prior art have enabled the reduction of "keystoning" in tubes of the type herein described they have not, as a general proposition, fulfilled the need for a simplified form of compensating electrode system which can be easily assembled into the tubes in the manufacturing process with the assurance that there will result the desired degree of correction of an annoying and objectionable defect in the tubes as usually considered.

Accordingly, the present invention makes provision for the assembly into the tube in the process of manufacture of additional electrodes used for the compensation of "keystoning" and the so-called "spot-fringing." In addition, the present invention provides suitable compensating means which may be assembled in much the same manner as would be assembled the deflecting electrodes of a tube wherein provisions were made for deflecting the electrodes of the beam in the two mutually perpendicular directions. In other words, the compensating electrode structure to be described herein has the general

appearance of two sets of plate pairs for deflection in two directions and located within the same plane. Such a system is of greatest simplicity from the manufacturing viewpoint and can easily be assembled into the type of tubes herein being discussed by the unskilled factory help usually employed.

Accordingly, it is a primary object of the present invention to provide electrode structure for the deflection of the cathode ray beam or electron pencil in a tube and, at the same time, to provide against the "keystoning" of the trace produced by that electron beam upon the impact target or screen.

A further object of the invention is to provide an electron beam deflecting electrode structure which is simple in its arrangement and which will provide ease of manufacturing while still of maximum efficiency for the purpose set forth.

Still a further object of the invention is to provide and develop an electron tube having contained therein electron beam deflecting means which will overcome the defects of prior art systems, of the types above described, and which will enable the manufacturing of a simpler, cheaper and more efficient cathode ray image producing or image translating or other analogous type of electronic tube.

Other objects of the invention, and further advantages thereof, will naturally suggest themselves to those skilled in the art to which the invention relates from a reading of the following specification in connection with the accompanying drawing, wherein:

Fig. 1 represents schematically the form of electrode structure used to fulfill the aims and objects above outlined;

Fig. 2 represents a slight modification of the system and arrangement of Fig. 1; and,

Fig. 3 shows the form of boundary limits of the wave trace produced from the traversal of the target or screen of the tube with and without keystone correction introduced.

Referring now to the drawing for a further understanding of the invention it will be appreciated from what has been stated above that the "keystoning" of the cathode ray beam upon the target or screen is due, in substantially all of the presently used types of cathode ray tubes wherein only a single pair of deflecting electrode pairs is used for beam deflection in each direction, to the interacting electrostatic fields between these deflecting plate pairs because there is no provision made for reducing or compensating the resulting interacting electrical fields produced between the deflecting plate pairs of electrodes. Further, the objectionable "keystoning" effect also arises because of the influence of the electrostatic charges being carried over to the tube walls (these usually being glass or vitreous material) or in cases where the tube wall is conducting, as is the case where tubes are provided with an elongated second anode in the form of a conducting coat of silver or other material on the wall or inner surface of the tube or in metal tubes, the potential at which the metallic coating is maintained relative to the electron source itself will exercise a definite effect upon the deflecting fields which result with the application of deflecting voltages to the electron beam deflecting electrode pairs.

In the usually known type of cathode ray tube the device consists of an envelope 11 having the neck portion 13 which flares outwardly toward its end portion 15. In the neck portion of the tube is positioned an electron gun structure 17 (shown only conventionally but which may consist for example of a cathode and first anode with a control electrode or grid, and where desired a screen grid, interposed therebetween and also a second anode for focusing and accelerating the electron beam, all of which is known in the art and used in those tubes now sold which are identified, for example, as types "906," "903" and others manufactured by RCA Mfg. Co. Inc. and described fully in catalogs published to describe the operation of such tubes).

In the outwardly flared portion of the tube there is a coating on the inner surface of the tube envelope 11 of a suitable luminescent material 19 which becomes light emitting under the impact of the cathode ray beam issuing from the electron gun structure 17. While this invention is in no way concerned with the materials used for coating the inner surface of the end wall of the tube to produce the luminous effects it may be noted that various materials such as those known as willemite, various zinc sulphides, various ortho and meta salts of zinc, berrylium, cadmium and other similar materials are suitable for this purpose and have already been described in the art.

Interposed between the electron gun structure 17 and the luminescent material 19 in the usual type of tubes now known are the deflecting electrode pairs 21, 21' and 23, 23' of which the pair of plates 21, 21' serve to deflect the resultant electron or cathode ray beam in a direction perpendicularly with respect to the plane of the drawing, for example, and the plate pair 23, 23' serves to deflect the resultant cathode ray beam in a direction parallel to the plane of the drawing, for example. It is usually customary in the art, for tubes using electrostatic electron beam deflecting systems to connect together by a conductor 25 either internally of the tube or externally, as desired, one plate 21', 23 of each of the pairs of deflecting plates and usually this plate of each pair is maintained at the potential of the second anode of the electron gun 17. The other plate 21, 23' of each pair of deflecting plates, not so connected, is then arranged to be energized by an applied voltage from two different sources 27 and 29 which each supply a voltage wave of similar shape but of different frequency in order to advance the cathode ray beam across the luminescent screen 19 rapidly in the direction of traverse produced by the deflecting plate pair 21, 21', for example, and in a perpendicular direction, as caused by voltages applied to the plate pair 23, 23', for example, at a substantially slower rate. This provides for the traversal of the luminescent screen area 19 along a two dimentional path and enables the tube to be used to reproduce images of objects (for example, television usage) or to reproduce wave or electrical phenomena (for example, where various electrical quantities such as voltage, and current, for example, are plotted against time, where the rapid motion of the beam across the screen usually represents time).

It is desirable, and practically essential for some operations and desired character of wave traces on the luminescent screen or target 19 shall be rectangular as shown by the outline A', B', C', D' (see Fig. 3) but without compensation or "keystone" correction the disturbing and interacting effects above described briefly will prevent this desired pattern trace and will produce, instead, a pattern trace closely correspond-

ing to that shown within the boundary limits A, B, C, D (see Fig. 3). Accordingly, in order that the distorted deflection pattern trace A, B, C, D shall be overcome an additional pair of electrode members **31**, **33** is provided intermediate the final deflecting plate pair **23**, **23'** (that is, according to the above assumption, the plate pair used to deflect the electron beam in a direction parallel to the plane of the drawing) and the luminescent screen surface **19**. This last named set of deflecting plate members **31**, **33** is positioned in a direction perpendicular relative to the pair of deflecting plate pair **23**, **23'**. The two flat plate electrode members of the compensating plate pair **23**, **23'** are each preferably maintained at the same potential relative to the plate of the pair of deflecting electrodes **23**, **23'**. The potential of the compensating plate pair **31**, **33** is controlled by the supplied deflecting voltage supplied by way of the transformer **35** from the source of saw-tooth voltage (not shown but which may be of any suitable form such as a relaxation oscillator to develop the saw-tooth voltage, or which may be in accordance with the form of saw-tooth voltage wave producing means shown by Knoop patent, #1,613,954 or Van der Mark et al. #1,927,425). The amplitude of the correcting voltage supplied to the compensating plate pair **31**, **33** of electrode members may be varied and regulated by means of the potentiometer tap connection **37** provided for connection of the conductor **39** connected with the compensating deflector plate electrode members **31**, **33**. This potentiometer **37** preferably shunts the transformer secondary **41** by which the saw-tooth voltage waves of energy are supplied to the signal controlled deflecting electrode **23'** of the plate pair **23**, **23'**.

In addition, it is of course obvious that the compensating plate pair of electrode members **31**, **33** may be positioned either internally of the tube wall or may be positioned externally thereof, as desired. In cases where the compensating electrode members are positioned externally of the tube wall **11** it is, of course, apparent that the magnitude of the controlling voltage impulses which are supplied thereto for the purpose of providing the "keystone" compensation will in most instances be greater than where the plates are positioned internally of the tube wall. In any event the magnitude of the compensating voltage supplied to the compensating electrode members **31**, **33** may be controlled and varied at will by means of the potentiometer construction shown. Further, by providing overcompensation for the "keystoning" effect it is possible to distort the resultant pattern to the form shown by the boundary limits A'', B'', C'', D'' (see Fig. 3). Of course, this form of "keystoning" is usually equally as objectionable in the resultant traced area A'', B'', C'', D'' as in the form of "keystoning" which develops without compensation and is shown, as above noted, by the area included within the boundary limits A, B, C, D (See Fig. 3).

In cases where the compensating deflecting plates are positioned intermediate of the last set of deflecting electrodes and the final luminescent screen structure and are located externally of the tube wall it is often convenient to form the compensating plates merely from the use of two tin-foil members supported outside the tube wall and positioned perpendicularly with respect to the plane of the last set of deflecting electrodes passed by the cathode ray beam before it impinges upon the luminescent screen **19**. Where the compensating electrodes are positioned internally of the tube wall it is usually desirable to provide these electrodes as the usual form of metal electrodes so that rigidity is inherent and ease of manufacture and assembly is provided by the ability to assemble the entire electrode structure by means of the usually used electrode positioning jigs.

By the arrangement of Fig. 2 of the drawing a modification of the system described by Fig. 1 has been shown. In Fig. 2 the compensation is provided by an electrode structure similar in nature to that of Fig. 1 except that the assembly is usually built within the tube. In the form of invention shown by Fig. 2 the compensation for the "keystoning" effect is provided not only by the effect of a single set of compensating plate electrodes but is generally insured together with a freedom from defocusing or fringing by the use of two sets of compensating electrode pairs **45**, **47** and **49**, **51**. These sets of compensating electrode pairs are shown within the boundary limits of both the horizontal and vertical deflecting electrode pairs **21**, **21'** and **23**, **23'** and are each arranged perpendicularly with respect to the deflecting electrode pairs with which each is associated. In the modification shown by Fig. 2 the compensating plate pairs are each supplied with a suitable voltage to provide compensation by means of two separately arranged potentiometers **53** and **55** which shunt the transformer secondary **57**, **59** which supplied the saw-tooth voltage from sources **61**, **63** for producing the deflection of the cathode ray or electron beam across the luminescent screen structure **19**.

While the arrangement of Fig. 1 is usually preferable it is to be noted that the arrangement of Fig. 2 in some instances is desirable, for while the compensating plate pair **45**, **47** associated with the deflecting electrode pair **21**, **21'** to provide the deflection of the cathode ray or electron beam in the direction perpendicular with respect to the plane of the drawing has little or no effect with respect to changing the shape of the pattern resulting from the luminescent screen structure, irrespective of the voltage variations applied by way of the potentiometer connection, the plate pair **45**, **47** does tend to improve the focus of the cathode ray or electron beam upon the luminescent screen **19** and thus tends to provide for a more sharply defined impact point. This focusing of the beam may be varied by the adjustment of the voltage magnitude applied to this first set of compensating deflector plates.

Many and various modifications of the invention from the forms above described and suggested will naturally follow and become apparent to those skilled in the art to which the invention relates and I, therefore, believe myself to be entitled to make and use any of those modifications which naturally follow from the forms by which the invention has been described above and such as fully and fairly fall within the scope of the hereinafter appended claims.

Having now described the invention what is claimed and desired to be secured by Letters Patent is the following:

1. An electron tube comprising an electron gun structure for developing an electron beam, a target adapted to become luminescent under impact of the electron beam, a plurality of pairs of beam deflecting plate electrode members interposed between the electron gun and the target and longitudinally spaced from each other,

said pairs of deflecting plate electrodes being positioned at planes perpendicular to each other so that the electron beam passing therebetween traverses a two dimensional path across the target when electrical energy is applied to the deflecting electrode members, a pair of distortion compensating electrode plates associated with the deflecting electrode plate pair nearest the target and positioned perpendicularly thereto, said plate members having the outer boundary limits thereof confined to the area included by the last-named deflecting plate pair, and a second pair of distortion correcting plate electrode members perpendicularly positioned relative to the deflecting electrode members nearest the electron gun structures.

2. An electron tube comprising means to develop an electron beam, a target upon which the electron beam is adapted to impinge, parallel deflecting electrode means interposed between the electron beam developing means and the target, and a pair of electrodes positioned intermediate the electron beam developing means and target and perpendicular to the deflecting electrode means for compensating for distortion introduced into the pattern traced across the target by the produced electron beam under the control of the deflecting means, said means being conductively associated with said deflecting means, the electrodes of said pair being adapted to be maintained at the same potential and at a potential different from but proportional to that of the deflecting electrode means.

3. An electron tube comprising an electron gun structure for developing an electron beam, a plurality of pairs of parallelly disposed deflecting electrodes, said pairs being positioned mutually perpendicularly and longitudinally spaced relative to each other, a second plurality of pairs of parallelly disposed electrode elements longitudinally spaced relative to each other, means for supporting one pair of each of the second plurality of electrode elements with their boundaries substantially coinciding with the boundaries of each of the first pair, said second pair of electrodes each being perpendicular to the plane of the electrodes of the first pair, and connections for applying energizing potentials to each of the individual electrodes of the first pairs and for simultaneously applying identical energizing potentials to the electrodes constituting the individual pairs of the second plurality of pairs of electrode elements.

4. An electron tube comprising an electron gun structure for developing an electron beam, a target positioned in the path traversed by the electron beam, a plurality of pairs of parallel deflecting plate electrode members interposed between the electron gun and the target, said pairs of deflecting plate electrode members being positioned in planes perpendicular to each other so that the electron beam traverses a two-dimensional pattern on the target when electrical energy is applied to the deflecting electrode members, an additional pair of electrically inter-connected deflecting plates positioned perpendicularly with respect to the deflecting electrode pair nearest the target, the plates of said additional pair of deflecting plates being positioned on opposite sides of the electron beam, and means for maintaining said additional pair of deflecting plates at a potential intermediate the potential impressed across the deflecting electrode pair nearest the target.

5. An electron tube comprising an electron gun structure for developing an electron beam, a target electrode, a plurality of pairs of parallel deflecting plate electrode members interposed between the electron gun and the target electrode, said pairs of deflecting plate electrodes being positioned in planes perpendicular to each other so that the electron beam traverses a two-dimensional pattern on the target electrode when electrical energy is applied to the deflecting electrode members, an additional pair of electrically interconnected distortion correction plate electrode members electrically associated with the deflecting plate electrode pair nearest the target and positioned perpendicular thereto and intermediate the said deflecting electrode pair and said target, and means for maintaining said additional pair of plate electrode members at a potential intermediate the potential impressed across the said deflecting electrode pair nearest the target.

JESSE B. SHERMAN.