United States Patent

Hawes

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[54] CATHODE RAY TUBE HAVING AUXILIARY DEFLECTION PLATE TO CORRECT PINCUSHION DISTORTION

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[22] Filed: **April 6, 1970**

[21] Appl. No.: **23,097**

Related U.S. Application Data

[63] Continuation of Ser. No. 845,740, July 28, 1969, abandoned.

[52] **U.S. Cl.** ....**315/13 R,** 313/78, 313/80, 315/18

[51] **Int. Cl.** **H01j 29/50,** H01j 29/74

[58] **Field of Search**.......................315/13, 13 CG, 6 DC, 18; 313/78, 80

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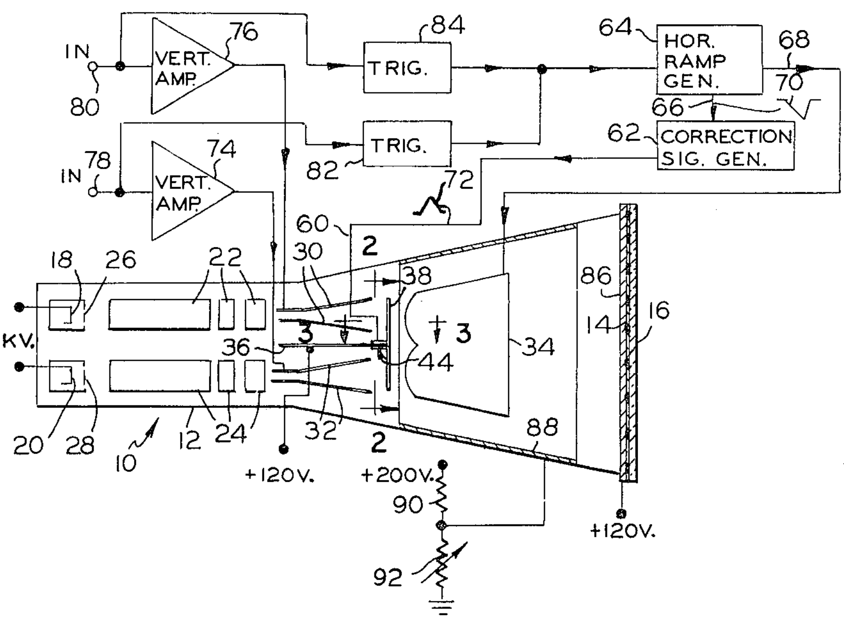
[57] **ABSTRACT**

A cathode ray tube having two electron beams and associated deflection systems is described in which an auxiliary deflection plate is employed between two pairs of vertical deflection plates at their outputs to correct pincushion distortion. A correction signal is produced by a control circuit and applied to the auxiliary deflection plate in response to a ramp voltage input corresponding to the horizontal sweep signal. The correction signal is a positive going peak shaped voltage so that the auxiliary deflection plate tends to vertically deflect the beams away from such plate at both the start and end of the horizontal sweep signal to correct pincushion distortion while not deflecting such beam appreciatively at the center of such sweep signal.

12 Claims, 9 Drawing Figures



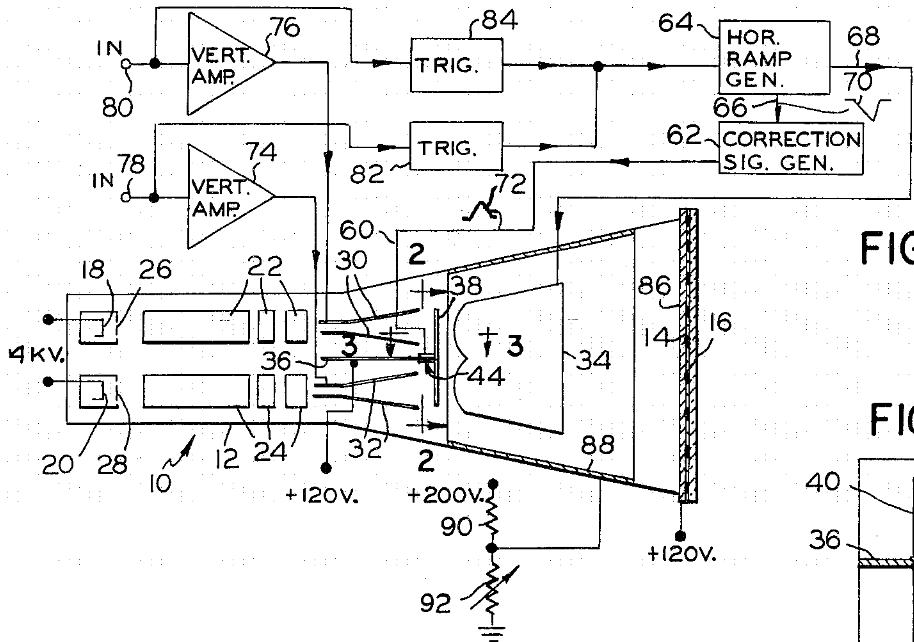


FIG. 1

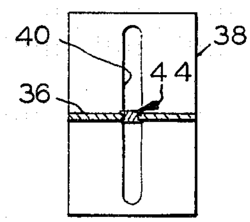


FIG. 2

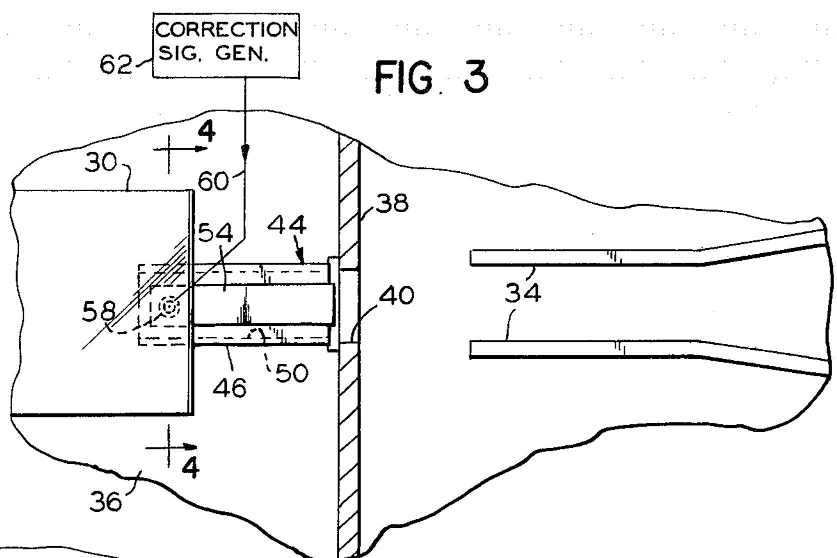


FIG. 3

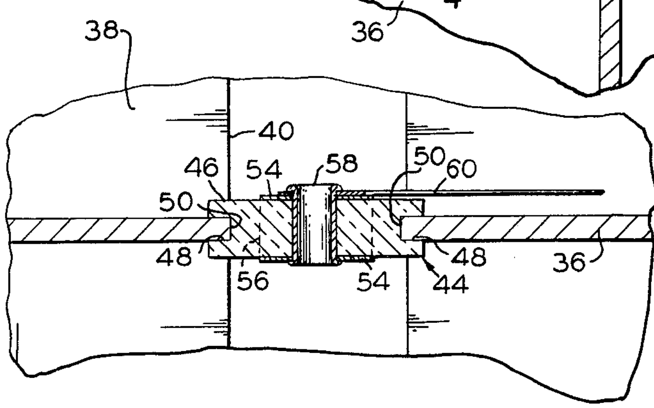


FIG. 4

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FIG. 5A

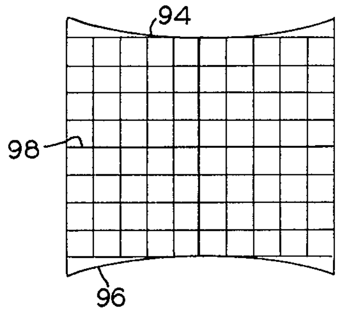


FIG. 5B

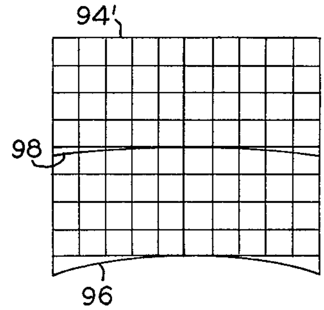


FIG. 5C

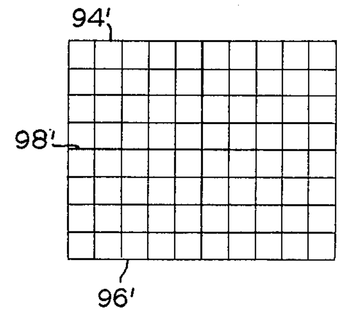


FIG. 6

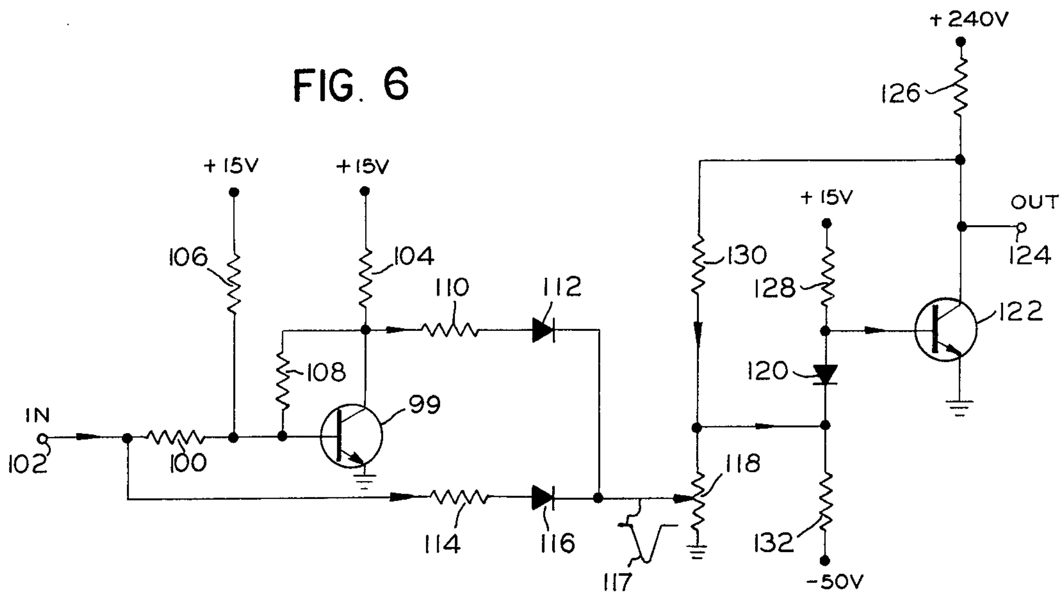
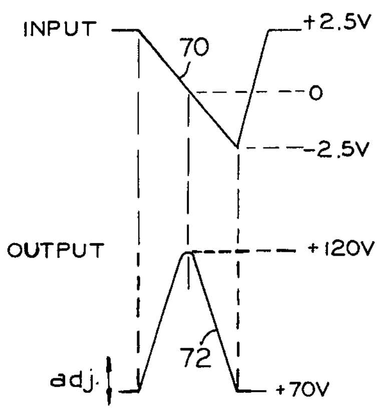


FIG. 7



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CATHODE RAY TUBE HAVING AUXILIARY DEFLECTION PLATE TO CORRECT PINCUSHION DISTORTION

CROSS REFERENCE TO RELATED APPLICATION

The present application is a streamlined continuation of U. S. Pat. application, Ser. No. 845,470, filed July 28, 1969, now abandoned.

BACKGROUND OF INVENTION

The subject matter of the present invention relates generally to electron beam tubes having two beams and associated deflection systems, and in particular to cathode ray tubes having two deflection systems in which an auxiliary deflection plate is positioned between the two pairs of vertical deflection plates at their outputs in order to correct "pincushion" distortion.

Pincushion distortion as used herein refers to the inward bowing of a rectangular display on the fluorescent screen of the cathode ray tube including such distortion of the horizontal trace lines due to nonuniform vertical deflection.

In cathode ray tubes having a single electron beam, it is conventional to correct pincushion distortion by varying the voltage on a wallband electrode coated on the inner surface of the tube envelope and positioned between the output ends of the vertical deflection plates and the fluorescent screen. However in cathode ray tubes having two beams and associated deflection systems, conventional correction of pincushion distortion is not effective with respect to the bottom portion of the upper beam trace or the top portion of the lower beam trace. This lack of effectiveness is due to the orientation of the two beams as they pass through the field formed by the wallband electrode.

The present invention solves this problem by employing an auxiliary deflection plate in the plane of the inter-gun shield between the two vertical deflection systems at the outputs thereof so that such auxiliary deflection plate acts on both the upper beam and the lower beam after it has passed through the vertical deflection plates. Since the amount of pincushion distortion changes in accordance with the horizontal position of the beam, a correction signal is derived from the ramp voltage of the horizontal sweep signal and applied to the auxiliary deflection plate which is of a positive peak shape. This correction signal is a positive going voltage of inverted V-shaped waveform which provides maximum correction at the opposite ends of the horizontal sweep and minimum or no correction at the center of such sweep. The peak voltage of such auxiliary deflection plate is set at the quiescent voltage of the vertical deflection plates at which the beam is centered. It should be noted that the auxiliary deflection plate provides a pincushion correction which is self compensating in that the amount of the corresponding vertical deflection varies inversely with the distance of the beam from such auxiliary deflection plate. Thus most of the correction occurs when the upper beam is in the bottom position of its trace and when the lower beam is in the top position of its trace. This is desirable because the wallband electrode or other conventional correction means can be employed to correct the pincushion distortion of the top portion of the upper beam trace and the bottom portion of the lower beam trace.

It will therefore be one object of the present invention to provide an improved electron beam deflection system for eliminating geometry distortion in the beam display.

Another object of the present invention is to provide an improved cathode ray tube apparatus having two electron beam deflection systems in which pincushion distortion is eliminated from the beam displays in a simple and inexpensive manner.

A further object of the invention is to provide an improved cathode ray tube having two pairs of vertical deflection plates in which an auxiliary deflection plate is employed between the two pairs of plates forwardly of their output ends in order to correct pincushion distortion.

Still another object of the present invention is to provide an improved cathode ray tube apparatus of the type described above in which the auxiliary deflection plate is connected to a control circuit which produces a correction signal in response to the horizontal sweep signal of such tube in order to automatically correct for pincushion distortion.

A still further object of the invention is to provide such an apparatus in which the correction signal voltage is of a positive peaked shape so that such correction voltage is at a minimum in the center of such sweep signal and at a maximum adjacent the opposite ends of such sweep signal.

An additional object of the present invention is to provide such an apparatus with an auxiliary deflection plate of a simple inexpensive construction accurately supported on a shield member between the two pairs of vertical deflection plates in which a ceramic support member is employed with metal coatings on opposite sides thereof interconnected to provide the auxiliary deflection plate and with notches for holding the support member within a slot in such shield member.

BRIEF DESCRIPTION OF DRAWINGS

Other objects and advantages of the present invention will be apparent from the following detailed description of the preferred embodiment thereof and from the attached drawings of which:

FIG. 1 is a schematic diagram of one embodiment of the cathode ray tube apparatus of the present invention;

FIG. 2 is a vertical section view taken along the line 2—2 of FIG. 1 through the auxiliary deflection plate;

FIG. 3 is a horizontal section view taken along line 3—3 of FIG. 1 showing the auxiliary deflection plate on an enlarged scale;

FIG. 4 is a vertical section view taken along the line 4—4 of FIG. 3;

FIGS. 5A, 5B and 5C show rectangular displays formed by an electron beam on the fluorescent screen of a cathode ray tube with different types of pincushion distortion correction;

FIG. 6 is a schematic diagram of an electrical circuit which may be employed to produce the correction signal applied to the auxiliary deflection plate in the tube of FIG. 1; and

FIG. 7 is a diagram of the waveforms of the input and output signals on the circuit of FIG. 6.

DESCRIPTION OF PREFERRED EMBODIMENT

As shown in FIG. 1, the cathode ray tube apparatus of the present invention includes a cathode ray tube 10 or other electron beam deflection device having an evacuated envelope 12 of glass, ceramic or other suitable insulating material with a fluorescent screen 14 of phosphor material coated on the inner surface of a light transparent faceplate portion 16 of such envelope. The tube envelope 12 contains two separate electron guns of conventional type including cathodes 18 and 20 as well as focusing anodes 22 and 24 and control grids 26 and 28 respectively associated therewith. In addition, two separate electron beam deflection systems are provided in the envelope 12 including a first pair of vertical deflections plates 30 and a second pair of vertical deflection plates 32 as well as a single pair of horizontal deflection plates 34 which are common to both deflection systems. A first shield member 36 is provided as an inter-gun shield between the two pairs of vertical deflection plates 30 and 32 and acts to prevent the electrostatic fields of the different pairs of deflection plates from interfering with one another.

A second shield member 38 is provided as an isolation shield between the output ends of the vertical deflection plates and the input ends of the horizontal deflection plates to isolate the vertical deflection fields from horizontal deflection fields. As shown in FIG. 2, the isolation shield 38 is provided with a single aperture 40 which is elongated vertically and in alignment with the output ends of the vertical deflection plates to enable the two electron beams to pass therethrough.

An auxiliary deflection plate 44 is provided between the two pairs of vertical deflection plates 30 and 32 spaced forwardly of the output ends of such deflection plates toward the phosphor screen 14. As shown in FIGS. 3 and 4, the auxiliary deflection plate may include a support member 46 of ceramic material in the form of a flat rectangular plate having a notch 48 along both of its opposite edges for insertion of such plate within a slot 50 formed in the rear edge of the inter-gun shield 36. The slot is of a general U-shape and the ceramic plate is of a rectangular shape about 0.25 inch wide and 0.45 inch long. The opposite sides of the ceramic plate 46 are coated with a pair of conducting layers 54 about 0.11 inch wide of any suitable metal such as gold bonded to the ceramic material. These conducting layers 54 form the auxiliary deflection plate 44 and are interconnected by a portion 56 of the metal coating extending around the right end of the ceramic plate, as shown by dotted lines in FIG. 4. This connection coating portion 56 is narrower than the aperture 40 of the isolation shield 38, thereby electrically insulating the auxiliary deflection plate layer 54 from such shield. The conductive layers 54 are connected by a rivet 58 to a lead conductor 60, such rivet passing through a hole in the ceramic plate 46 and the conductive coatings 54. The lead conductor 60 is secured to a neck pin extending through the envelope wall to connect the auxiliary deflection plate 44 to the output of a correction signal generator 62.

The correction signal generator 62 is connected at its input to the output of a horizontal ramp generator 64 through a lead 66. Another output of the horizontal ramp generator 64 is connected by a lead 68 to the horizontal deflection plates 34 and applies a ramp-shaped voltage as the horizontal sweep signal to such deflection plates. At the same time another ramp voltage 70 corresponding to the horizontal sweep signal is applied to the input of the correction signal generator and the linear leading edge of such ramp voltage causes such signal generator to produce a peak shaped correction signal 72 at its output. The effect of this correction signal is described hereafter in greater detail with respect to FIGS. 5, 6 and 7.

The two pairs of vertical deflection plates 30 and 32 are connected respectively to the outputs of two vertical amplifiers 74 and 76 having their inputs connected to vertical signal input terminals 78 and 80 respectively. The horizontal ramp generator 64 may be triggered in response to the receipt of a vertical input signal at either of input terminals 78 and 80 by providing trigger circuits 82 and 84 having their inputs connected respectively to input terminals 78 and 80 and having their outputs connected to the input of the horizontal ramp generator.

The cathodes 18 and 20 of the tube may each be connected to a negative D.C. supply voltage of −4 kilovolts while the inter-gun shield 36 and the isolation shield 38 as well as a metal coating 86 provided over the phosphor screen layer 14 are connected to a positive D.C. supply voltage of +120 volts. Thus the electron beam is accelerated about 4,120 electron volts before it strikes the phosphor layer 14 to produce a light image of its electron beam display which under most circumstances will be the signal waveform trace of the vertical deflection signal. It should be noted that the conductive layer 86 is a thin film of aluminum which is electron transparent and reflects the light emitted by the phosphor layer to increase the brightness of the display in a conventional manner.

A wallband electrode 88 of conductive material such as gold may be coated on the inner surface of the tube envelope 12 in the region between the vertical deflection plates and the fluorescent screen. This wallband electrode may serve to provide some geometry correction for pincushion distortion and is therefore connected to a variable D.C. voltage of about +120 volts at the common terminal of a pair of series connected voltage divider resistors 90 and 92. The upper terminal of resistor 90 is connected to positive D.C. supply voltage of about +200 volts while the bottom terminal of the lower resistor 92 is connected to ground, such lower resistor being variable to vary the voltage on the wallband electrode.

As shown in FIG. 5A, a rectangular display produced by the upper electron beam passing through vertical deflection plates 30 may be formed with pincushion distortion 94 in its top edge as well as pincushion distortion 96 in its bottom edge due to the nonuniform vertical deflection of the electron beam at the outer extremities of the horizontal sweep. By properly adjusting the voltage on the wallband electrode 88 with variable resistor 92, the pincushion distortion on the upper edge 94 of such display may be corrected to a straight line 94′ as shown in FIG. 5B. In a single beam cathode ray tube this would also correct the pincushion distortion 96 at the bottom of the display. However in a cathode ray tube having two separate deflection systems as shown on FIG. 1, the wallband electrode pincushion correction does not compensate for the pincushion distortion 96 at the bottom of the display formed by such upper beam. Thus as shown in FIG. 5B, the pincushion distortion 96 still exists in the bottom edge of the display and there is also some slight distortion 98 in the centerline of the display. The auxiliary deflection plate 44 corrects the pincushion distortions 96 and 98 and results in a final display in which the bottom edge 96′ and the centerline 98′ are both straight horizontal lines so that such display is entirely free of pincushion distortion as shown in FIG. 5C. It should be noted that the vertical deflection systems are so designed that each deflects its electron beam over the full vertical height of the screen. Therefore a similar display to FIGS. 5A, 5B and 5C is produced by the lower beam except that the pincushion distortion 96 and 98 corrected by the auxiliary deflection plate in this case is reversed and produced on the upper half of the trace while the pincushion distortion 94 corrected by the wallband is on the bottom of the trace.

One control circuit which may be employed as the correction signal generator 62 is shown in FIG. 6. The control circuit includes an inverter amplifier transistor 99 of NPN type having its emitter grounded and its base connected through a coupling resistor 100 of 5.1 kilohms to an input terminal 102. The collector of transistor 99 is connected to a positive D.C. supply voltage of +15 volts through a load resistor 104 of 1 kilohm and has its base connected through a bias resistor 106 of 39 kilohms to a similar supply voltage so that such transistor is quiescently biased conducting. A negative feedback resistor 108 of 5.1 kilohms is connected from the collector to the base of transistor 99 thereby forming an operational amplifier whose gain is approximately 1 as determined by the ratio of the feedback resistor 108 to the input coupling resistor 100.

The collector of the inverter transistor 99 is connected through a coupling resistor 110 of 2.7 kilohms to the anode of a pulse shaping diode 112 while the input terminal 102 is connected through a coupling resistor 114 of 2.7 kilohms to the anode of another pulse shaping diode 116. The cathodes of diodes 112 and 116 are connected together in common with the movable contact of a potentiometer 118 of 1 kilohm. Since transistor 99 is normally conducting, the anode of diode 112 is more negative than the anode of diode 116 so that diode 116 is normally biased conducting while diode 112 is normally biased nonconducting. The negative going ramp voltage 70 applied to input terminal 102 and corresponding to the horizontal sweep signal is transmitted as a negative signal to the anode of diode 116, but is inverted and transmitted as the positive signal to the anode of diode 112. Thus the linear leading edge of input signal 70 tends to turn off diode 116 and turn on diode 112. The resulting signal voltage 117 on the movable contact of a potentiometer 118 has a negative peak shape which starts from a quiescent value and then goes negative to a negative peak value due to the negative going ramp applied to the anode of diode 116. At approximately the midpoint of the ramp voltage 70 diode 116 is rendered nonconducting and diode 112 is rendered conducting thereby causing the voltage on the movable contact of potentiometer 118 to change direction and to go more positive until it returns to its quiescent level due to the positive going ramp applied to the anode of diode 112. This negative signal 117 is transmitted from the upper terminal of potentiometer 118 through a voltage dropping diode **120** to the base of a second inverter amplifier transistor **122** of NPN type. The emitter of transistor **122** is grounded while its collector is connected to an output terminal **124** and to a positive D.C. supply voltage of +240 volts through a load resistor **126** of 56 kilohms. The base of such transistor is connected to a positive D.C. supply voltage of +15 volts through a bias resistor **128** of 9.1 kilohms. A negative feedback resistor **130** of 130 kilohms is connected from the collector of transistor **122** to its base through diode **120** to provide an operational amplifier. The transistor **122** is normally conducting to provide a quiescent output voltage of about +70 volts on output terminal **124** and such transistor inverts the negative input signal **117** to produce the output correction signal **72** having a positive peak voltage of +120 volts as shown in FIG. **7**.

The diode **120** is connected at its anode to the bias resistor **128** and at its cathode to a resistor **132** of 20 kilohms thereby forming a voltage divider with such resistors. The upper terminal of the voltage divider has a potential of +15 volts and its lower terminal is at −50 volts so that the quiescent D.C. bias voltage at the cathode of diode **120** is approximately zero volts. This zero volts potential is also applied to the upper terminal of potentiometer **118** so that there is no potential difference across the end terminals of such potentiometer. Thus the amount of input current flowing through the potentiometer to the transistor **122** at the start of the output signal is determined by the setting of the movable contact on such potentiometer which adjusts the level of the most negative voltage of the correction signal **72**.

As shown in FIG. **7** the input ramp voltage **70** varies linearly from +2.5 volts to −2.5 volts maximum negative peak value while the peaked correction signal **72** changes from a starting voltage of +70 volts up a positive slope to a positive peak voltage of +120 volts at the center of the ramp voltage 70 and then returns down a negative slope to +70 volts. As a result, maximum pincushion correction deflection of the beam away from the auxiliary deflection plate takes place at most negative correction voltage adjacent the opposite ends of the horizontal sweep whereas the minimum or zero correction deflection takes place at the center of such sweep. This is proper because as shown in FIG. **5B**, maximum pincushion distortion occurs at the opposite ends of the horizontal sweep while the minimum pincushion distortion occurs in the center of the horizontal sweep as shown by the downward bowing of the bottom edge **96** of the trace. It should be noted that the auxiliary deflection plate correction of the present invention is self compensating in that the amount of deflection correction due to the repelling of the electron beam is inversely proportional to the distance of the beam from the auxiliary deflection plate. Thus there is very little if any deflection correction when the beam is away from the auxiliary deflection electrode which corresponds to the top of the upper beam trace and the bottom of the lower beam trace. This is desirable since the conventional pincushion correction effected by the wallband coating compensates for pincushion distortion at the top of the upper beam trace and at the bottom of the lower beam trace as stated previously.

It should be noted that during the retrace portion of the horizontal sweep signal a narrow peak pulse of opposite polarity to the correction signal is produced at the output terminal of the correction signal generator **62**. However since the electron beam is blanked and does not strike the phosphor screen during such retrace time as well as the time between sweep signals, this additional peak output signal is of no effect during retrace and for this reason has not been shown in FIG. **7**.

It will be obvious to those having ordinary skill in the art that many changes may be made in the details of the above described preferred embodiment of the present invention without departing from the spirit of the invention. For example, other auxiliary deflection plates can be employed such as a solid metal plate which is supported on and insulated from the inter-gun shield **36** by stand off insulators of glass. In addition, rather than two cathodes, a single cathode may be employed to produce both electron beams transmitted through the two vertical deflection systems. Also while a conventional cathode ray tube has been described, it is also possible to employ the present invention in a bistable charge image storage tube including the type in which the phosphor layer also functions as the storage dielectric. Therefore the scope of the present invention should only be determined by the following claims.

I claim:

1. Cathode ray tube apparatus comprising:

a cathode ray tube having a phosphor screen and containing two electron beam deflection systems each including vertical deflection means and horizontal deflection means, electron beam generating means adjacent said electron beam deflection systems for producing two electron beams, said vertical deflection means defining two pairs of vertical deflection plates with a pair thereof for each of said electron beam generating means auxiliary deflection plate means supported within said tube at a position between said two pairs of vertical deflection plates and having first section means disposed behind output ends of said two pairs of vertical deflection plates and second section means disposed forwardly of said output ends and extending longitudinally toward said phosphor screen, and means for applying an auxiliary deflection signal to said auxiliary deflection plate means.

2. Cathode ray tube apparatus comprising:

a cathode ray tube containing two electron beam deflection systems each including a vertical deflection means and a horizontal deflection means, said vertical deflection means including two pairs of vertical deflection plates positioned on opposite sides of different ones of two electron beams produced in said tube;

auxiliary deflection means including an auxiliary deflection plate supported within such tube by a support means extending between said two pairs of vertical deflection plates and insulated from the auxiliary plate so that said auxiliary plate is positioned between said two pairs of vertical deflection plates and extends forwardly of their output ends toward the phospher screen of such tube; and

control means for deriving a correction signal from a ramp voltage corresponding to a horizontal ramp sweep signal applied to the horizontal deflection means and applying said correction signal to the auxiliary deflection plate so that it deflects the electron beams vertically within such tube in a manner which corrects for geometry distortion of their beam trace on the phosphor screen.

3. Apparatus in accordance with claim **2** in which the tube also includes a wallband electrode coated on the inner surface of a tube envelope of insulative material, and means for applying a geometry correction voltage to said wallband electrode.

4. Apparatus in accordance with claim **2** in which the control means includes a pulse shaping circuit which produces said correction signal output of peak shape having positive and negative slope portions from a linear ramp input signal corresponding to the leading edge of the horizontal sweep signal.

5. Apparatus in accordance with claim **4** in which the control means produces a correction signal whose peak positive voltage occurs in the center of the horizontal sweep ramp and is approximately equal to the quiescent D.C. voltage of the vertical deflection plates so that the beam is not deflected thereby, while the positive slope portion and the negative slope portion on opposite sides of said peak voltage are of more negative voltage than said quiescent voltage and tend to deflect the beam away from the auxiliary deflection plate by an amount directly proportional to said more negative voltage and inversely proportional to the distance of the beam from said auxiliary plate.

6. Apparatus in accordance with claim **2** in which the tube contains two separate electron guns for forming said two electron beams.

7. Apparatus in accordance with claim 6 in which the horizontal deflection means is common to both electron beams and includes two horizontal deflection plates provided on opposite sides of both beams and positioned between the phosphor screen and the vertical deflection plates.

8. Apparatus in accordance with claim 2 in which the auxiliary deflection plate is mounted on a shield means positioned between the two pairs of vertical deflection plates.

9. Apparatus in accordance with claim 8 in which the tube includes a first shield electrode positioned between the two pairs of vertical deflection plates, and the auxiliary deflection plates is supported on said first shield electrode by insulative support means so that said auxiliary deflection plate extends substantially coplanar with said first shield electrode.

10. Apparatus in accordance with claim 9 in which the support means is a plate of ceramic material and the auxiliary deflection plate is provided by two interconnected conductive coatings on the opposite sides of such ceramic plate.

11. Apparatus in accordance with claim 10 in which the tube includes a second shield electrode positioned between the horizontal deflection means and the vertical deflection plates, and provided with beam aperture in alignment with the output ends of the two pairs of vertical deflection plates.

12. Apparatus in accordance with claim 11 in which the first shield electrode is attached to the second shield electrode at the center of the beam aperture to hold the ceramic plate within a slot provided in the edge of the first shield electrode.

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