Jan. 29, 1946. M. W. BALDWIN, JR 2,393,601

DEFLECTING CIRCUIT

Filed July 30, 1942

FIG. 1

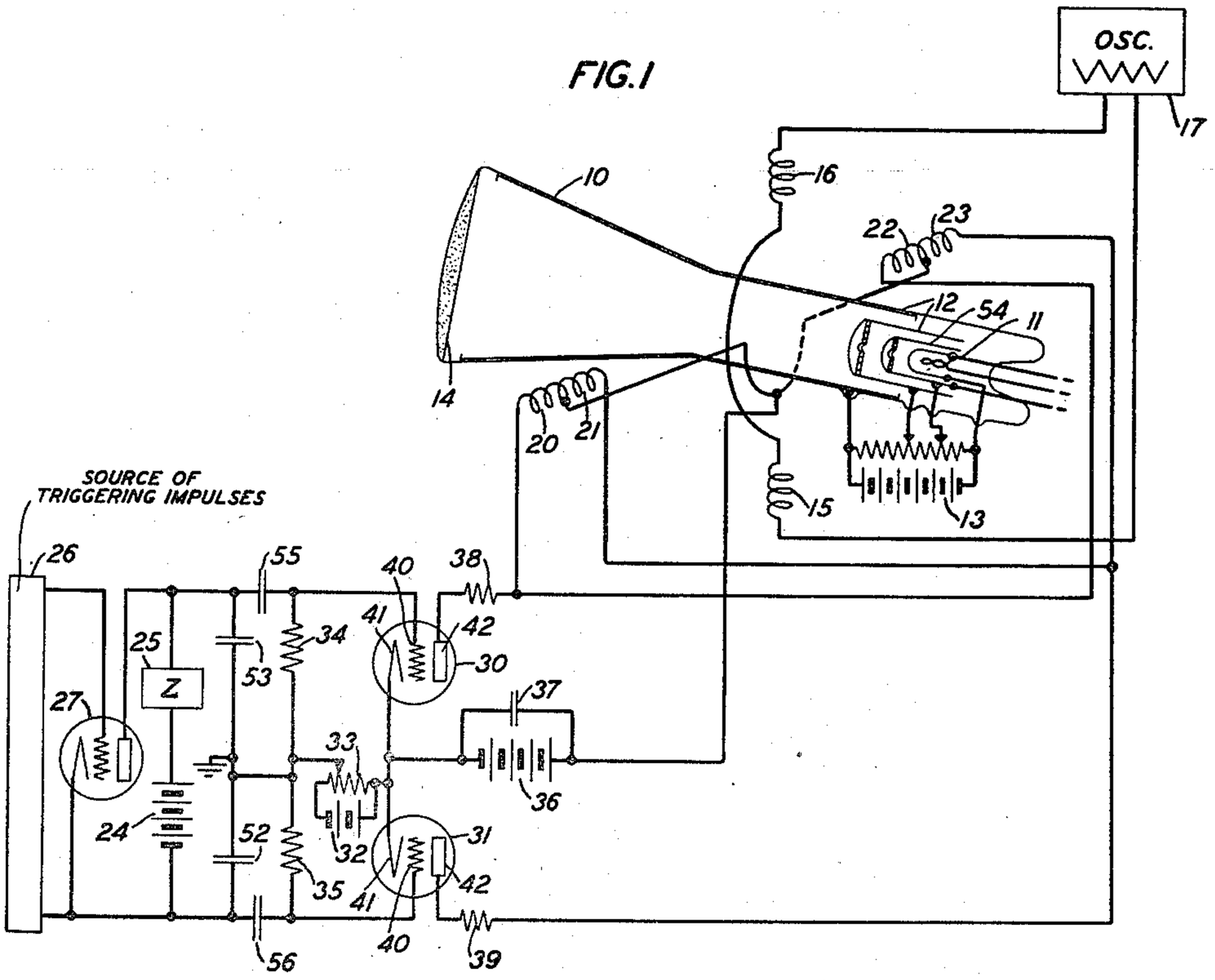



FIG. 2

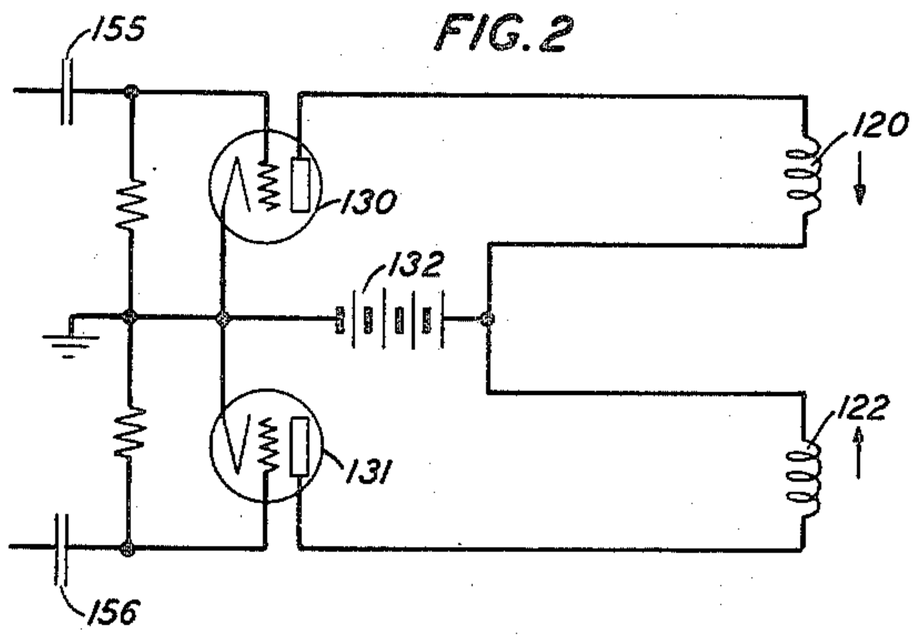
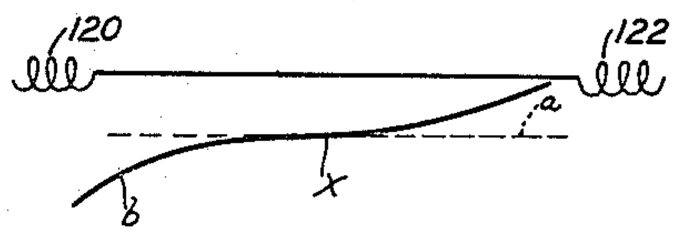



FIG. 3

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2,393,601

## DEFLECTING CIRCUIT

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13 Claims. (Cl. 315—27)

This invention relates to deflecting circuits for cathode ray tubes and particularly to a circuit for and a method of supplying deflecting current to deflecting coils of a cathode ray tube from a push-pull amplifier.

For the purpose of supplying an amplified electric wave to a pair of deflecting coils of a cathode ray tube, it has been found advantageous to employ push-pull amplification in the amplifier stage which supplies energy to the coils in order to balance out second harmonic distortion. When, for example, the vertical deflecting coils on opposite sides of the cathode ray tube are connected in the anode circuits of the two amplifier tubes, respectively, of the push-pull amplifier in a manner to cause the vertical deflection of the cathode ray beam in response to a deflecting electromotive force applied to the input circuit of the push-pull amplifier, it has been discovered that the horizontal deflection of the cathode ray beam does not follow a straight line. This distortion of the scanning path was found to be due to the opposing electromagnetic fields set up in the vertical sweep coils, respectively, when energized by the anode currents of the push-pull amplifier.

For the purpose of avoiding distortion of the scanning path in accordance with the present invention, a portion of each of a pair of deflecting coils is connected in the anode circuit of one tube of a push-pull amplifier while the remaining portion of each of the pair of deflecting coils is connected in the anode circuit of the other tube of the push-pull amplifier so that, at any instant, the coils on opposite sides of the cathode ray tube, respectively, set up aiding magnetomotive forces which are preferably substantially equal. Under this condition, when the anode currents which energize the vertical deflecting coils, for example, have a certain amplitude, the electromagnetic field due to these coils is substantially uniform within the central region of the cathode ray tube through which the cathode ray beam is deflected horizontally.

Fig. 1 of the accompanying drawing is a diagrammatic view of a deflecting circuit for a cathode ray tube; and

Figs. 2 and 3 are diagrams to which reference will be made in describing the invention.

Referring to Fig. 1 of the drawing, there is shown a cathode ray tube which may be of any well-known type such as is employed for scanning a field of view in the process of generating a television current or for producing images under control of a television current, for example. It includes a cathode 11, and anodes 12 and a source of electromotive force 13 for energizing the electrodes 11 and 12 to cause a cathode ray beam to be generated and focussed upon a fluorescent screen 14. The intensity of the cathode ray beam may be controlled by applying a suitable potential to a control electrode 54. Two sets or pairs of deflecting coils are provided for deflecting the cathode ray beam along different coordinates, respectively, the coils 15 and 16 being supplied with energy from a saw-toothed wave oscillator 17 to cause the cathode ray beam to be deflected horizontally at a relatively high frequency and the coils 20, 21 and 22, 23 being energized to cause the cathode ray beam to be deflected vertically at a relatively low frequency.

For generating the vertical deflecting saw-toothed wave, there are provided condensers 52 and 53 of equal capacity connected in series which are charged at a constant rate by current from battery 26 through a constant current device 25 such as disclosed, for example, in Patent No. 2,244,013, granted June 3, 1941 to W. A. Knoop. The directly connected plates of the condensers are grounded. These condensers after being charged are caused to discharge quickly under control of voltage impulses from a source of periodic triggering impulses 26 recurring at the desired frequency, these impulses being impressed upon the control electrode-cathode circuit of vacuum tube 27 to cause the condensers 52, 53 to discharge through the anode-cathode circuit of the tube 27. The saw-toothed wave voltages generated across condensers 52 and 53 are impressed upon the grid-cathode circuits of vacuum tubes 30 and 31, respectively, of a push-pull amplifier, through coupling condensers 55 and 56, respectively. Each tube of the push-pull amplifier has a control electrode or grid 40, a cathode 41 and an anode 42. Biasing potential is applied to the grids of vacuum tubes 30 and 31 from battery 32 and potentiometer 33 through resistors 34 and 35, respectively. The junction point of resistors 34 and 35 and the variable tap of potentiometer 33 is connected to ground. Battery 36 which is shunted by condenser 37 supplies anode current to vacuum tube 30 through windings 20 and 22 connected in parallel and the series resistor 38, the coils 20 and 22 being wound to produce aiding magnetomotive forces. The battery 36 supplies anode current to vacuum tube 31 through windings 21 and 23 connected in parallel and the series resistor 39, the windings 21 and 23 being wound to produce aiding magnetomotive forces. The magnetomotive forces pro-

duced by windings 20 and 22 are opposed to the magnetomotive forces produced by windings 21 and 23 so that when the grids of vacuum tubes 30 and 31 are at the same potential, the resultant magnetomotive force produced by windings 20 and 21 and the resultant magnetomotive force produced by windings 22 and 23 are each substantially zero. If desired, however, the magnetomotive forces produced by the coils 20, 21 and 22, 23 may have a relatively low value such as may be required for positioning the cathode ray beam when no deflecting saw-toothed wave is applied to the input circuit of the push-pull amplifier 30, 31. This result may be realized, for example, by applying to the grid of one of the push-pull amplifier tubes a steady biasing potential different from that applied to the other push-pull amplifier tube.

The advantage of connecting the deflecting coils 20, 21 and 22, 23 in the manner shown in Fig. 1 may be understood from a consideration of Figs. 2 and 3. In Fig. 2, anode current is supplied to tube 130 of the push-pull amplifier from battery 132 through deflecting coil 120 to be positioned at one side of the cathode ray tube and anode current is supplied to tube 131 of the push-pull amplifier from battery 132 through deflecting coil 122 to be positioned on the other side of the cathode ray tube. In order that a resultant deflecting field may be set up due to the currents flowing through coils 120 and 122 when a deflecting wave is applied to the input of push-pull amplifier 130, 131 as in Fig. 1, the coils 120 and 122 must be wound in a manner to set up opposing magnetomotive forces when energized by current from battery 132, as indicated by the arrows. When the currents which flow through coils 120 and 122 are equal, for example, the coil 120 will set up an electromagnetic field which will deflect the cathode ray beam as it approaches that coil in one direction and the coil 122 will set up a field which will deflect the cathode ray beam as it approaches coil 122 in the cpposite direction. This is indicated in Fig. 3 in which the coils 120 and 122 produce the vertical deflecting field, the other pair of coils for deflecting the beam horizontally, such as coils 15 and 16 of Fig. 1, being not shown. As a result the cathode ray beam will be deflected horizontally, nct along a straight line *a* as is desired, but will follow a curved path as shown by the line *b*. When the cathode ray beam is at a position *x* midway between the coils 120 and 122, as shown in Fig. 3, and when the currents through coils 120 and 122 are equal, the resultant field set up by coils 120 and 122 and acting upon the cathode ray beam is zero. As the cathode ray beam approaches coil 120 it is deflected vertically in one direction due to the field set up by coil 120 and as the cathode ray beam approaches coil 122 it is deflected vertically in the opposite direction due to the field set up by coil 122 as indicated by the line *b*. When the current through coil 120 is greater than the current through coil 122, for example, the cathode ray beam will be deflected more by the field due to coil 120 than it is by the field due to coil 122. As a result, the electromagnetic field due to coils 120 and 122, when the energizing currents for these coils have certain amplitudes, varies considerably from one portion to another of the central region of the cathode ray tube through which the cathode ray beam is deflected horizontally.

The distortion of the horizontal deflecting path is substantially avoided by connecting the vertical deflecting coils to the push-pull amplifier in the manner shown in Fig. 1. In that arrangement the magnetomotive force set up by coil 20, 21 on one side of the cathode ray tube and the magnetomotive force set up by the coil 22, 23 on the opposite side of the cathode ray tube are aiding and preferably substantially equal at any instant. As a result, the field set up by coils 20, 21 and 22, 23 is substantially uniform at any instant and the cathode ray beam is deflected horizontally along a substantially straight line due to the energization of the horizontal deflecting coils 15 and 16.

The cathode ray beam is deflected vertically due to a saw-toothed deflecting wave applied to the input circuit of the push-pull amplifier 30, 31. For example, when the grid of vacuum tube 30 becomes more positive and the grid of tube 31 more negative with respect to ground due to an increase in charge on the condensers 52 and 53, the currents in windings 20 and 22 increase and the currents in windings 21 and 23 decrease to set up a vertical deflecting field in one direction. Similarly, when the grid of vacuum tube 31 becomes less negative and the grid of tube 30 becomes less positive due to a decrease in charge on condensers 52 and 53, the currents in windings 21 and 23 increase and the currents in windings 20 and 22 decrease to set up a vertical deflecting field in the opposite direction.

If desired, of course, the horizontal deflecting coils 15, 16 may be energized by deflecting currents supplied thereto from a push-pull amplifier in the same manner in which the vertical deflecting coils 20, 21 and 22, 23 are supplied with deflecting currents, as described above.

What is claimed is:

1. Means for supplying an electromagnetic field for controlling the deflection of a cathode ray beam produced in a cathode ray device having a pair of deflecting coils on opposite sides of the cathode ray beam for producing the electromagnetic deflecting field when suitably energized, which comprises a pair of electric discharge tubes each having a control electrode, an anode and a cathode, means for impressing upon the control electrodes of said tubes, respectively, alternating deflecting potentials which are 180 degrees out of phase with respect to each other, and means for supplying anode current to said discharge tubes through said deflecting coils to cause to be set up by each of said coils a zero field or a relatively weak field for determining the initial position of said beam when the amplitude of said alternating deflecting potentials is zero, and to cause to be set up by said coils fields which are aiding and which simultaneously act upon said beam to move it in one direction or the other with respect to said initial position in accordance with the amplitude of said alternating deflecting potentials.

2. In combination, means for generating a cathode ray beam, deflecting means comprising a pair of coils positioned on opposite sides of said cathode ray beam, respectively, for setting up an electromagnetic field for deflecting said cathode ray beam when suitably energized, a push-pull amplifier, and means for supplying to said deflecting means from said push-pull amplifier electric energy for causing said coils to set up aiding magnetomotive forces.

3. In combination, means for generating a cathode ray beam, means comprising a plurality of windings on opposite sides of said cathode ray beam, respectively, for setting up an electromagnetic deflecting field for said cathode ray beam

when suitably energized, each of said windings having two portions which may be simultaneously differently energized, and means for supplying to said portions, respectively, of each of said windings periodically varying currents which have the same periodicity and which are opposed in phase to cause the two portions of each winding to set up opposing magnetomotive forces and to cause said windings, respectively, to set up resultant magnetomotive forces which are aiding.

4. In combination, means for producing a cathode ray beam, a plurality of windings for setting up an electromagnetic deflecting field for said cathode ray beam when suitably energized, and means for supplying to each of said windings current having a steady direct component upon which an alternating wave is superposed in such a manner that the resultant electromagnetic field set up by each of said windings is substantially zero when the amplitude of said alternating wave is zero.

5. The method of electromagnetically controlling the deflection of a cathode ray beam which comprises setting up at each of two spaced positions between which the cathode ray beam may be deflected a plurality of component magnetomotive forces each having a direct and alternating component and combining said magnetomotive forces to produce a resultant electromagnetic field having alternating components only, the direct component being substantially suppressed.

6. The method of electromagnetically deflecting a cathode ray beam which comprises setting up at each of two positions between which the cathode ray beam may be deflected two opposed unidirectional magnetomotive forces, and varying said magnetomotive forces in opposite directions simultaneously to produce at each of said positions a resultant alternating magnetomotive force having substantially no steady component.

7. The method of supplying deflecting current from the output of a push-pull amplifier having two electric discharge tubes to deflecting coils positioned on opposite sides of a cathode ray beam produced in a cathode ray tube, which comprises connecting different substantially equal portions of each of said coils in the output circuit of different tubes, respectively, so that the resultant magnetomotive force produced by each of said coils is substantially zero when equal currents flow through said portions, respectively, and applying deflecting potential in opposite phase to the input circuits of said tubes, respectively, to cause the magnetomotive forces set up by said portions, respectively, of each of said coils to change in opposite directions simultaneously and thereby produce a resultant electromagnetic field for deflecting said cathode ray beam.

8. Apparatus for deflecting a cathode ray beam produced in a cathode ray tube comprising a pair of coils positioned on opposite sides, respectively, of said cathode ray beam, a push-pull amplifier comprising a pair of electric discharge devices each having an anode, a cathode and a control electrode, means for connecting the opposite ends of each coil to said anodes, respectively, means for connecting a portion of each coil between its ends to the cathode of each of said electric discharge devices to complete the anode current circuit for each of said electric discharge devices, said anode current circuits including a source of anode current, and means for supplying to the control electrode-cathode circuits of said electric discharge devices, respectively, varying electromotive forces which vary in opposite directions simultaneously.

9. In combination, means for generating a cathode ray beam, a pair of coils positioned on opposite sides of said cathode ray beam for producing an electromagnetic field for deflecting said cathode ray beam, a push-pull amplifier circuit comprising electric discharge means having a pair of anodes, a pair of control electrodes and a pair of cathodes, a common source of anode current connected between each of said cathodes and a terminal for each of said coils between its end terminals, means for connecting the end terminals of each of said coils to said anodes, respectively, and means for impressing upon said control electrodes, respectively, with respect to said cathodes, varying deflecting potentials which are out of phase with respect to each other.

10. In combination, means for generating a cathode ray beam, a pair of coils positioned on opposite sides of said cathode ray beam for producing an electromagnetic field for deflecting said cathode ray beam when suitably energized, a push-pull amplifier circuit comprising a pair of electric discharge devices each having a cathode, an anode and a control electrode, a common source of anode current connected between each of said cathodes and a mid-tap for each of said coils, means for connecting the ends of each of said coils to said anodes, respectively, to complete the anode-cathode circuit of each of said electric discharge devices, a pair of condensers and a source of charging current therefor connected in series circuit, means in said circuit for maintaining the charging current substantially constant, means for periodically discharging said condensers, and means for impressing the alternating components of the voltages across said condensers between the control electrode and cathode of said electric discharge devices, respectively, to cause the anode current of one of said devices to change in one direction while the anode current of the other device simultaneously changes in the opposite direction.

11. In combination, means for generating a cathode ray beam, deflecting means comprising a pair of coils positioned on opposite sides of said cathode ray beam, respectively, for setting up an electromagnetic field for deflecting said cathode ray beam, a push-pull amplifier, and means for supplying to said deflecting means from said push-pull amplifier varying electric energy for causing said coils to set up varying magnetomotive forces which are aiding and simultaneously substantially equal at any instant.

12. In combination, a cathode ray tube having means for generating a cathode ray beam, two pairs of coils on opposite sides of said cathode ray tube for producing under control of energy supplied thereto an electric field for deflecting said cathode ray beam along a coordinate, and means for supplying to the coils, respectively, of each of said pairs of coils periodically varying currents of the same periodicity the amplitude of one of which is increasing while the amplitude of the other is simultaneously decreasing to cause to be set up by said pairs of coils, respectively, magnetomotive forces which are aiding and by the coils, respectively, of each pair component magnetomotive forces which are opposing.

13. In combination, a push-pull amplifier, a cathode ray tube having means for generating a cathode ray beam, means for deflecting said beam along a first coordinate, means for deflecting said cathode ray beam along a second coordinate sub-

stantially perpendicular to the first coordinate comprising means for setting up magnetomotive forces on opposite sides of said cathode ray tube, respectively, when energized, and means comprising said push-pull amplifier for supplying varying energy to said last-mentioned means to cause the magnetomotive forces set up on opposite sides of said cathode ray tube to be aiding, thereby causing the field intensity due to said magnetomotive forces to be substantially uniform at any instant over the region through which said cathode ray beam is deflected along said first coordinate.

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