

June 3, 1958

B. E. DENTON

2,837,692

CATHODE RAY BEAM DEFLECTION APPARATUS

Filed Aug. 19, 1953

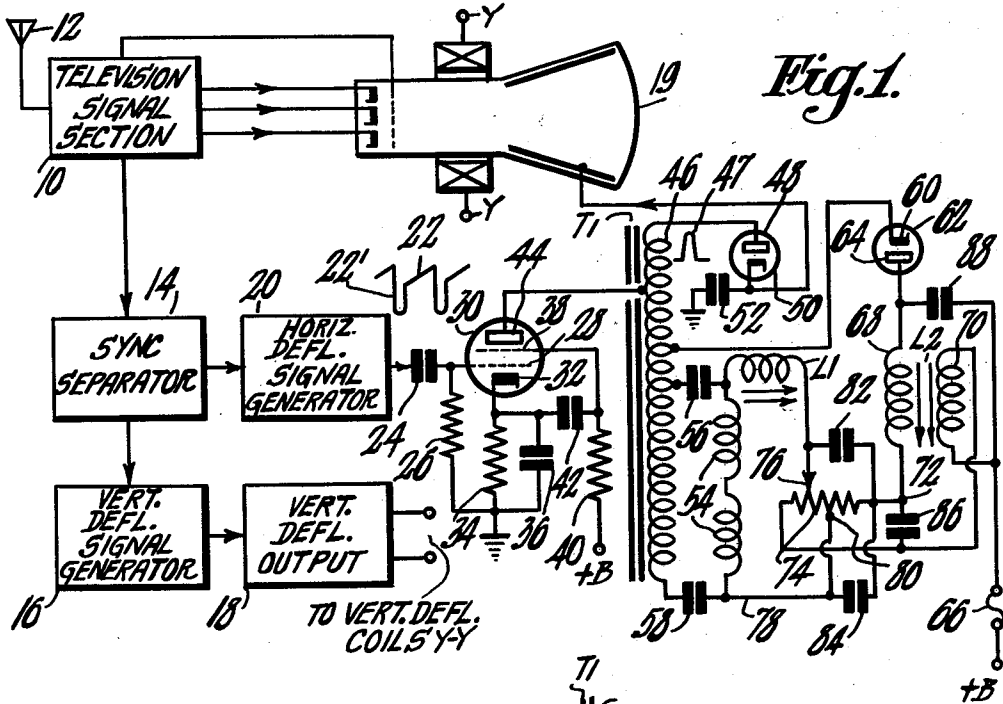


Fig. 1.

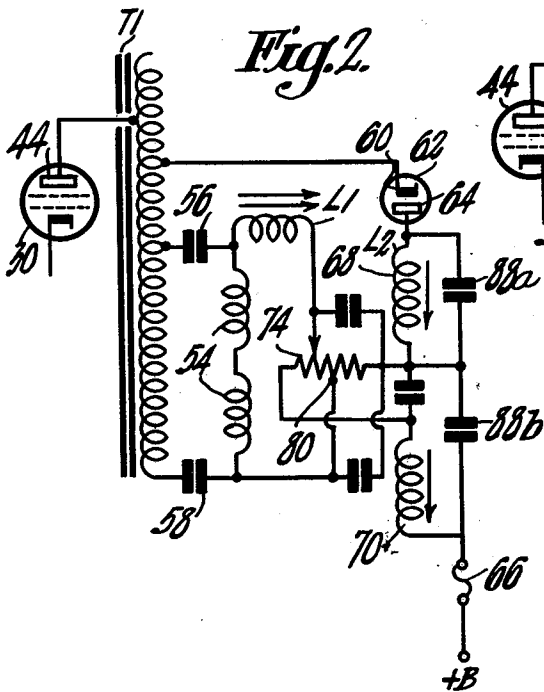


Fig. 2.

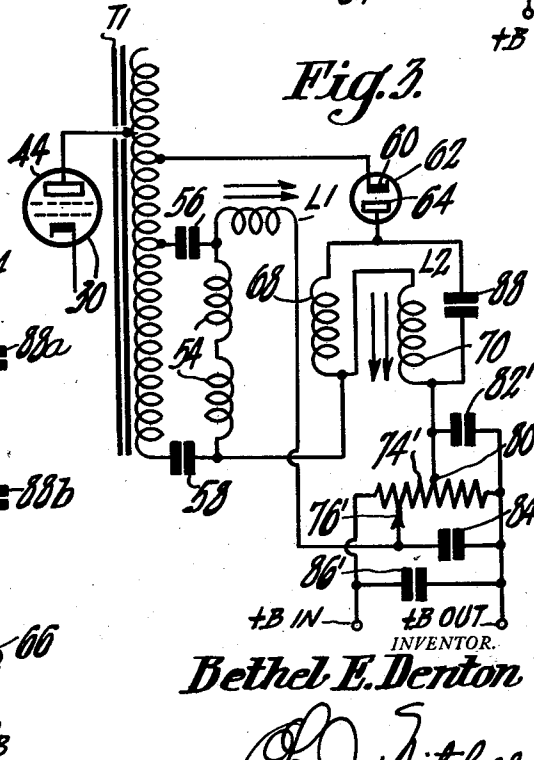


Fig. 3.

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CATHODE RAY BEAM DEFLECTION APPARATUS 5

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Application August 19, 1953, Serial No. 375,190 10

18 Claims. (Cl. 315—27)

The present invention relates to new and improved deflection apparatus suitable for, but not necessarily limited to, use in the deflecting of one or more electron beams in a cathode ray tube, such, for example, as a television image-reproducing kinescope.

In the evolution of commercial television apparatus, both of the black-and-white and color varieties, there have been developed various forms of deflection apparatus having as their primary aim that of effecting linear deflection of a cathode ray beam or beams in as efficient a manner as possible. For example, the now well-known "reaction scanning" involves the principle of reclaiming certain energy from a deflection circuit which would otherwise be lost in damping resistors and the like. More specifically, in reaction scanning, a horizontal discharge amplifier tube is supplied with a suitable sawtooth waveform on its control electrode, including the well-known "peaking component." The discharge tube, assuming the electron beam is at its central or "rest" position, is rendered conductive by the linearly rising portion of the sawtooth, thereby driving a sawtooth current in a given direction through the associated deflection coils which are or may be coupled to the anode of the discharge tube by means of a transformer. At the peak of the sawtooth input waveform, current in the deflection coils is at its maximum value for the given direction and the electron beam is accordingly at its extreme lateral position. At that instant, the control electrode of the discharge tube experiences the large negative peaking pulse which drives the tube past cutoff, thereby resulting in the collapse of flux in the transformer and deflection coils, which are caused to resonate at a natural frequency determined by their inductance and associated stray capacitance. Such action occurs during the "retrace" or "flyback" portion of the deflection cycle which consumes substantially one half cycle of such oscillation. At the end of flyback time, the natural inclination of the resonant circuits described is that of continuing to oscillate. In order to prevent such oscillation and afford linear scanning, damping means such as a diode is provided across the deflection coils and associated transformer for damping the oscillation. More specifically, the damping diode is rendered conductive so that it conducts the stored energy from the coils and it is the diode conduction which furnishes the scanning deflection energy for approximately the first half of beam deflection. At generally the time in which energy in the deflection circuits is reaching zero value, the discharge tube is again rendered conductive by the sawtooth waveform on its control electrode, thus causing current to flow through the deflection transformer and yoke to complete the scanning cycle.

As is well known to persons skilled in the art, the "junction" of the currents of the damper diode and discharge tube is lacking in linearity, despite attempts to match the non-linear operating characteristics of the two tubes in an effort to bring about a linear summation of currents. Thus, there have been proposals such as that described and claimed in U. S. Patent 2,440,418 granted

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April 27, 1948, to S. I. Tourshou for effecting linearity by means of a linearity inductance coil, which, in conjunction with associated capacitive means, produces a linearity correcting waveform, which, when applied to the anode circuit of the horizontal discharge tube to control its conduction, corrects for the inherent non-linearity. Such linearity devices are now well known and do not constitute a part of the present invention. As will appear more fully hereinafter, however, the present invention provides a novel linearity coil arrangement which affords certain beneficial results not obtainable with heretofore known devices.

It is, therefore, a primary object of the present invention to provide new and improved means for effecting linearity of deflection in apparatus of the reaction scanning type.

As is well known in the art, the beam accelerating potential for application to the image reproducing kinescope is efficiently produced by rectifying and filtering the high voltage pulses produced by the above-described flux collapse during flyback portions of the deflection cycle. As will be appreciated from the delicate nature of correcting for non-linearity of scanning, it is extremely important to prevent interference by the flyback pulses with the linearity correcting waveform.

Hence, it is another object of the invention to provide deflection linearity correcting means, which means are maintained substantially free of deleterious interference by high voltage flyback pulses.

The constant development of deflection apparatus has also included additional energy conservation means known as "B Boost," such as that described and claimed in U. S. Patent No. 2,598,134, granted May 27, 1952, to Otto H. Schade. Briefly, "B Boost" provides capacitive means for receiving and storing energy from the damper diode of a reaction scanning circuit during that portion of the cycle in which the diode is conductive. The capacitive storage means is ordinarily in series with both the space current circuit of the diode and the B+ terminal of the horizontal discharge tube, so that the stored energy is effectively added to the normal B+ potential for application to the discharge tube during its active portion of the deflection cycle. It is, as will be apparent, quite desirable to maintain the "B Boost" potential free of the horizontal flyback pulses in order that proper operation of the discharge tube remain unimpaired.

In view of the foregoing, it is a further object of the present invention to provide a novel reaction scanning apparatus in which "B Boost" action is available and is nevertheless maintained free of flyback pulses.

Still another important adjunct of a cathode ray tube is means for adjustably centering the beam or beams within the tube as by means of a variable amplitude, variable direction, direct current which is caused to flow through the deflection coils such that the "rest" position of the beam or beams is brought to a desired position at the center of the tube screen.

It is a further object of the present invention to provide novel D.-C. centering means for the cathode ray beam or beams, which centering means is intimately associated with linearity correcting circuitry and which inserts its D.-C. at a point of low impedance, thereby simplifying greatly the problem of insulation.

The matter of centering is particularly acute in the case of color image reproducing kinescopes in which it has been found that conventional magnetic centering such as is employed with black and white kinescopes is impracticable for use, for reasons of maintaining color purity.

Hence, it is a still further object of the present invention to provide novel circuitry including intimately related linearity control and D.-C. centering, all at a point

of low impedance in the deflection circuit, particularly well-suited for color television.

In general, the present invention provides, according to its broader aspects, a linearity-correcting inductance which is tapped at or near its center, which tap is connected to the bottom of the deflection transformer and coils, the arrangement of the linearity coil portions and its associated means for effecting "tight" or close coupling between the coil portions being such as to afford a canceling arrangement for whatever flyback pulses appear at the junction of the two coil portions. Moreover, in accordance with another aspect of the invention, D.-C. centering current is inserted into the deflection coils via the tapped central portion of the linearity coil, the width control coil normally associated with such apparatus serving the function of providing a D.-C. return path to the deflection coils themselves. By reason of the novel arrangements described herein, D.-C. centering, linearity-correction and the provision of pulse-free B Boost are made possible in a simplified yet extremely effective manner.

Additional objects and advantages of the present invention will become apparent to persons skilled in the art from a study of the following detailed description of the accompanying drawing in which:

Fig. 1 is a block and schematic diagram of a television receiver embodying the principles of the present invention;

Fig. 2 illustrates schematically another form of the invention; and

Fig. 3 is a schematic diagram of still another form of the invention.

Referring to the drawing and, more particularly, to Fig. 1 thereof, there is shown a television signal section 10 adapted to receive via antenna 12 a composite television signal which may, for example, constitute a color television signal train. Block 10 may include the usual R.-F., I.-F., video detection and color signal separation circuits well known in the art. Since such circuitry does not constitute a part of the present invention it need not be discussed in detail here. In accordance with conventional techniques, there is provided a synchronizing pulse separator 14 which removes horizontal and vertical sync pulses from the detected composite signal and applies the vertical pulses to a vertical deflection signal generator 16. The vertical generator 16, synchronized by the received pulses, produces, for example, a sawtooth waveform of field frequency which is amplified by the vertical output circuit 18 and applied to the vertical deflection coils normally associated with the kinescope 19. The kinescope may, by way of illustration, comprise a three gun image reproducing device such that the component color signals derived by the signal section 10 may be applied respectively to the several beam intensity-controlling electrodes within the kinescope.

A horizontal deflection signal generator 20 is also synchronized by the pulses from sync separator 14 and produces a voltage waveform 22 such as that shown at its output terminal. This waveform is applied via coupling capacitor 24 and grid leak resistor 26 to the control electrode 28 of a horizontal discharge tube 30. The cathode 32 of the horizontal discharge tube is illustrated as deriving self-bias by means of a conventional resistor 24 bypassed by capacitor 36 and connected to ground. The screen electrode 38 is connected via a dropping resistor 40 to a source of positive potential +B and is bypassed conventionally to the cathode as by means of a capacitor 42. The anode 44 of the tube 30 is tapped to a suitable point on auto-transformer T₁ which includes the usual step-up winding 46 for applying high voltage flyback pulses 47 to the anode 48 of a high voltage rectifier diode 50. The rectified flyback pulses are filtered by a capacitor 52 to provide high potential

D.-C. voltage suitable for application to the beam accelerating anode of the kinescope. The horizontal deflection coils 54 are connected to spaced points on transformer T₁ but are isolated therefrom by means of capacitors 56 and 58 for reasons to be explained more fully hereinafter. Connected to a point on transformer T₁ on or spaced above the upper connection of the deflection coils is the cathode 60 of a conventional damper diode 62 whose anode 64 is connected to a source of +B via fuse 66 in a manner to be described.

Also included in the circuit with damper diode 62 is a linearity correcting inductance coil L₂ comprising coil portions 68 and 70, the junction point of which is terminal 72. Connected to terminal 72 is one end of a D.-C. centering potentiometer 74, the other end of which is connected to the upper terminal of linearity coil portion 70. The bottom of coil 70 is, in turn, connected to fuse 66 and +B.

Thus, it will be seen that +B potential for the anode 44 of horizontal discharge tube 30 is provided by the following path: Fuse 66, coil 70, potentiometer 74, coil portion 68, diode 62 and the transformer winding between the cathode 60 of the damper tube and the tap to which its anode 44 is tied.

The circuitry of Fig. 1 further includes a width control coil L₁ which performs the function of varying the amplitude of the deflection current in coils 54 by varying the effective inductance of the circuit in a manner now well known in the art. Normally, the width control coil is connected to a point on the transformer above the lower connection of the deflection coils. According to the present invention, however, width control coil L₁ is connected at one end to the top of horizontal deflection coils 54 and its other end terminates in a slider 76 in contact with a point on centering potentiometer 74. The bottom of the deflection coils 54 is connected via lead 78 to a center tap 80 on the centering potentiometer 74 such that, in accordance with conventional D.-C. centering operation, direct current flow through potentiometer 74 produces a voltage drop thereacross of such polarity that positioning of slider 76 on one side of its center tap 80 causes a direct current of given direction to flow through the deflection coils, while positioning of slider 76 on the other side of the center tap results in current flow through the deflection coils in the opposite direction. Hence, the beams within the associated kinescope may be caused to have a rest position at any desired location on the kinescope screen. Capacitors 82, 84 and 86 furnish a low impedance to horizontal scanning frequency alternating currents around the potentiometer.

Also associated with the linearity coil L₂ is a capacitor 88 whose capacity in conjunction with the inductance of coil L₂ forms a resonant circuit having a natural frequency somewhat lower than the horizontal scanning frequency, all of which is in accordance with prior art principles as taught, for example, in the above-cited Tourshou patent. In other words, capacitor 88 is of such value as to cause coil L₂ to tune over the proper range for producing a somewhat parabolic waveform employed in controlling the operation of the circuit for effecting linearity of scan. It should, moreover, be noted at this point that linearity coil L₂ is in the form of a tightly wound bifilar arrangement for providing extremely close coupling between the coil portions 68 and 70 for reasons which will become apparent later. Since the connection of the linearity coil L₂ to the transformer T₁ is made at the lowermost terminal of the latter, the amplitude of the flyback pulses resulting from the collapse of flux at the termination of a scan period will be substantially smaller than that which would be present at some higher impedance point on the transformer. That is to say, the tapped point between the coil portion 68 and 70 of the linearity control L₂ is separated from +B (which is A.-C. ground) by only the impedance of coil portion

70 which, by virtue of its close coupling with coil portion 68, effects a cancellation of any flyback pulses which may appear at terminal 72 tending to excite the linearity coil. In other words, any effort to excite one of the coil portions 68 or 70 excites the other portion equally and oppositely, thereby, "bucking out" the pulses. Applicant has found that, by tapping the inductance L_2 at or near its center, there is provided a very convenient low impedance point for the insertion of the D.-C. centering current which is made practicable by the novel connection of width control inductance L_1 directly to the upper terminal of deflection coils 54. Thus, the width control coil L_1 serves as a D.-C. return path to the deflection coils 54, as follows:

Tracing from $+B$, the path includes fuse 56, coil portion 70, that part of potentiometer 74 to the left of slider 76, width control coil L_1 and the deflection coils 54 to the center tap 80 of potentiometer 74. As persons skilled in the art will appreciate, conventional linearity coil arrangements as employed in conjunction with black-and-white receivers, for example, involve a tapped impedance circuit in which the tap is between two capacitors across the linearity coil. Since such capacitors do not permit the passage of direct current, it is impossible with such known arrangements to insert the D.-C. centering at that point. In accordance with the present invention, however, the linearity coil itself provides a D.-C. path for the centering current, thereby greatly simplifying the necessary circuitry. Because of the bypassing afforded by capacitors 82, 84 and 86, flyback pulses appearing at lead 78 are shunted directly to terminal 72 which, as described supra, is a low impedance point in the circuit, namely, a point separated from A.-C. ground by only the small impedance of linearity coil portion 70.

In the interest of completeness of description, it should be noted that the B Boost derived from the conduction of damper diode 62 during the first half of scanning time is developed substantially entirely across capacitor 58. In order that this action may be more readily understood, the overall operation of the deflection circuit should be considered. In operation, waveform 22 is applied to the controlling electrode 28 of the horizontal discharge tube 30. Assuming a condition in which the deflection circuit has been in operation, and that it has reached a point wherein the deflection has reached its extreme righthand position, with tube 30 conducting a sawtooth of current through the deflection coils 56, the peaking component 22' of the control signal suddenly drives tube 30 into a non-conductive state. The abrupt removal of excitation from the transformer and deflection circuits causes a sudden collapse of flux, with the result that energy in the transformer, deflection coils and their associated capacitance causes high frequency oscillation, which, according to present standards, may be in the neighborhood of 71 kilocycles. This high frequency oscillation effects retrace of the electron beam or beams to their extreme lefthand position on the kinescope screen. At that point, scanning again commences, this time through the conduction of damper diode 62 in accordance with the principles of reaction scanning. During the conduction of diode 62 (i. e., while the beam is traversing the screen from its extreme left hand position toward center), energy is stored in capacitors 56 and 58, thereby developing the well known B Boost voltage which is available at the bottom point transformer T_1 for application to the anode 44 of the horizontal discharge tube. As the conduction of the diode approaches a point where its operation becomes non-linear, waveform 22 on the control electrode of the horizontal discharge tube renders the latter tube conductive to continue with the sawtooth deflection current.

By reason of the use of isolating capacitor 56, in addition to capacitor 58, the deflection coils 54 are effectively maintained separate, D. C.-wise, from the transformer T_1 . Otherwise, the transformer would act as a short cir-

cuit for direct current, thus precluding the service of capacitor 58 as a B-Boost storage means.

In view of the foregoing, it should now be apparent that the circuit of Fig. 1 permits, by virtue of its novel arrangement, adjustment of the linearity control coil L_2 , insertion of D.-C. centering and the picking off of B Boost, all at a low impedance point in the circuit, namely, the tap 72 between the portions 68 and 70 of the linearity coil.

The circuit of Fig. 2 illustrates another form of the invention which theoretically provides substantially the same advantages as those available through the use of the circuit of Fig. 1, the primary distinguishing feature between the two circuits residing in the fact that the linearity coil in Fig. 2 is not wound as a bifilar coil. More specifically, in the circuit of Fig. 2, wherein like reference numerals indicate parts corresponding to those of Fig. 1, there is shown the horizontal discharge tube 30 whose anode 44 is connected to a point on output transformer T_1 for driving a sawtooth of current through the deflection circuit. In Fig. 2, the fact that linearity coil L_2 is not wound as a bifilar coil results in a looser coupling of the coil portions 68 and 70 than that which may be obtained with the circuit of Fig. 1. Thus the leakage reactance within the linearity coil is sufficient to result in undesirable ringing thereof, so that it is necessary to employ two capacitors 88a and 88b in place of the single capacitor 88 of Fig. 1. Otherwise, the circuit of Fig. 2 operates in substantially the manner of Fig. 1, with the exception that the use of two capacitors 88a and 88b renders the circuit more critical of adjustment. It will be noted that the D.-C. path for centering current in Fig. 2 includes coil portion 70, potentiometer 74, width control L_1 , and the deflection coils 54 to the center tap 80, just as in Fig. 1. It should also be noted that, as in the case of Fig. 1, the circuit of Fig. 2 is susceptible of a simple fusing arrangement in which a single fuse 66 connected between the source of positive potential $+B$ and the bottom of linearity coil portion 70 serves to protect the entire linearity and centering arrangement.

In the circuit of Fig. 3 which illustrates still another form of the invention, like reference numerals indicate components corresponding to those of the preceding two figures. More particularly, the circuit of Fig. 3 is similar to that of Fig. 1, for example, in that it includes a horizontal discharge tube 30 whose anode circuit includes a portion of the auto transformer T_1 , the horizontal deflection coils 54 being coupled A. C.-wise to the bottom section of the transformer by means of D.-C. isolating capacitors 56 and 58. A damper tube 62 has its cathode 60 connected to a point on transformer T_1 above the deflection coils, while the anode 64 of the damper diode is connected to a linearity control inductance L_2 . In the case of Fig. 3, the linearity coil L_2 has its sections 68 and 70 wound together to form a bifilar coil in order to afford the extremely close coupling described in connection with the circuit of Fig. 1. In the circuit of Fig. 3, however, the direct current centering component is not inserted at the center tap of the linearity coil L_2 , but is conducted through section 70 of the coil in the following manner:

Tracing from the terminal bearing the designation $+B$ In, the path includes a portion of potentiometer 74, slider tap 76', width control coil L_1 , deflection coils 54 and linearity coil section 70 to center tap 80'. Capacitors 82', 84' and 86' serve to bypass horizontal scanning frequency alternating components around the centering potentiometer 74'. Capacitor 88 in shunt with the linearity coil L_2 tunes the coil to form a tank circuit having a resonant frequency slightly less than scanning frequency, just as in the case of Fig. 1, such that the operation of the linearity correcting arrangement is substantially identical to that described supra. In order to prevent the deflection coils 54 from overloading the linearity coil section 70 across which they are tied, it is necessary to make certain that the combined inductance of the deflection

coils and the width control coil L_1 is high compared to the impedance of the linearity coil section 70, thereby providing an effective shunt across it. Stated otherwise, it will be understood that if the impedance of L_1 and the deflection coils 54 were small as compared to that of coil 70 there would be a tendency to load the linearity circuit, thereby impairing its resonance. By using the large inductance width coil L_1 , there is afforded an effective D.-C. choke. In this regard, it should be noted that, in Fig. 3, the uppermost terminal of the deflection coils 54 is not returned to the center tap of the linearity coil L_2 but is connected to the bottom of coil section 70 so that the yoke is effectively in shunt with that section.

In the operation of the circuit of Fig. 3, the width control coil L_1 serves three primary purposes, namely, controlling deflection amplitude, affording a D.-C. return path for the deflection coil centering current and acting as a choke in the manner set forth. The width control and choke functions are, of course, closely associated, thus indicating the novel cooperation between the components of the circuit.

By way of summary, therefore, it should be borne in mind that, whereas prior art arrangements of the type in question ordinarily connect the cathode of the damper diode through a linearity coil to a point intermediate the ends of the deflection transformer, at which point the flyback pulses are of large magnitude of the order of 3,000 to 5,000 volts, such prior art circuits do not employ a tapped linearity coil and cannot insert direct current centering at the center of the coil. According to the principles of the present invention, the large voltage pulses produced during flyback present no problem, since the bottom of the deflection transformer is connected to a point near A.-C. ground (i. e., a point separated from A.-C. ground by only the linearity correction waveform). Thus, it will be appreciated that this invention makes it possible to connect the linearity coil to the bottom of the transformer, while still permitting the insertion of D.-C. centering. Moreover, the operation of B Boost is enhanced by reason of the fact that it is taken off at a point of low impedance in the circuit where flyback pulses are of no consequence.

While the invention has been described in accordance with certain specific embodiments, it should be realized that the embodiments described are illustrative of the principles and should not be construed as limiting. For example, although the several embodiments are concerned with an auto transformer, it is possible to employ the concept of the invention with ordinary primary-secondary transformers, in which event the isolating capacitors 56 and 58 might be eliminated, since the B Boost could be in the transformer primary and be isolated from the secondary winding, while the secondary winding could serve as the D.-C. return path for the deflection coil centering current.

Other changes and modifications will also suggest themselves to persons skilled in the art, so that the scope of the invention should be determined by the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Electromagnetic deflection apparatus for effecting linear deflection of a cathode ray beam, which comprises: a source of deflection current; an electromagnetic winding; means for coupling said source to said winding to cause current to flow therein for a predetermined portion of a deflection cycle; a unilaterally conductive electronic damping device connected in damping relation with said winding; a linearity control circuit in series with said damping device and including a bi-part inductance coil and capacitive means in shunt with said coil; potentiometer means for delivering a direct current centering component to said winding, and means connecting said potentiometer means between the two parts of said line-

arity control coil and in a series direct current path with said linearity control coil.

2. Electromagnetic reaction scanning apparatus for effecting linear deflection of a cathode ray beam, which comprises: a source of deflection current; an electromagnetic winding; means, including a transformer, for coupling said source to said winding to cause current to flow therein for a predetermined portion of a deflection cycle; a unilaterally conductive electronic damping device connected in damping relation with said winding; a linearity control circuit in series with said damping device and including a bi-part inductance coil and capacitive means in shunt with said coil; potentiometer means for delivering a direct current centering component to said winding, and means connecting said potentiometer means intermediate the ends of said linearity control coil and in series therewith for direct current.

3. Electromagnetic deflection apparatus for effecting linear deflection of a cathode ray beam which comprises: a source of deflection current; an electromagnetic deflection winding; means for coupling said source to said winding to cause current to flow therein for a predetermined portion of a deflection cycle; a unilaterally conductive electronic damping device connected in damping relation with said winding; a point of alternating current ground potential; a linearity control circuit in series with said damping device and said point and including a bi-part inductance coil and capacitive means in shunt with said coil; potentiometer means for delivering a direct current centering component to said winding; and means connecting said potentiometer means intermediate the ends of said linearity control coil, said inductance coil and at least a portion of said potentiometer being in a series direct current path from said point of alternating current ground potential to said damping device.

4. Electromagnetic deflection apparatus for effecting linear deflection of a cathode ray beam which comprises: a source of deflection current; an electromagnetic deflection winding; means for coupling said source to said winding to cause current to flow therein for a predetermined portion of a deflection cycle; a unilaterally conductive electronic damping device connected in damping relation with said winding; a linearity control circuit in series with said damping device and including a bi-part inductance coil and capacitive means in shunt with said coil; potentiometer means for delivering a direct current centering component to said winding; means for connecting one end of said deflection winding to a point on said potentiometer means; and means coupling the other end of said winding to a point intermediate the ends of said bi-part inductance coil, said inductance coil being connected in a direct current path between said damping device and a source of direct current potential.

5. Apparatus as defined by claim 4 wherein the two portions of said bi-part coil are bifilar wound.

6. Apparatus as defined by claim 4 wherein said means for connecting said one end of said winding to said potentiometer includes an inductance.

7. Apparatus as defined by claim 6 wherein said bi-part inductance is a bifilar coil.

8. Electromagnetic reaction scanning apparatus for causing linear deflection of a cathode ray beam, which comprises: a deflection waveform amplifier; a transformer having a winding in circuit with the space current path of said amplifier; an electromagnetic deflection winding; means coupling said deflection winding to said transformer; a unilaterally conductive damping device connected in parallel with said deflection winding; a linearity control circuit in series with said damping device, said linearity control circuit comprising a bi-part inductance coil and capacitive means in shunt with said bi-part coil forming a resonant circuit; a point of direct current potential; means connecting said point of direct current potential to one end of said deflection winding; and means defining a direct current path from the other end of said

deflection winding to a point intermediate the ends of said bi-part coil, said bi-part inductance coil being connected in a direct current path between said damping device and said point of direct current potential.

9. The invention as defined by claim 8 wherein said last-named means comprises a resistance.

10. The invention as defined by claim 8 wherein said transformer has a high impedance point and a low impedance point; said low impedance point being coupled to said point intermediate the ends of said bi-part coil.

11. The invention as defined by claim 8 wherein said bi-part inductance comprises a bifilar wound coil.

12. The invention as defined by claim 8 wherein said transformer comprises an autotransformer, said means for coupling said deflection winding to said transformer comprising a first capacitor connecting one end of said deflection winding to a first point on said autotransformer and a second capacitor connecting the other end of said deflection winding to a second point on said transformer spaced from said first point.

13. The invention as defined by claim 12 wherein said transformer has a low impedance end, said second point on said transformer being located at said low impedance end.

14. Electromagnetic reaction scanning apparatus for causing linear deflection of a cathode ray beam, which comprises: a deflection waveform output amplifier having an anode; an autotransformer having a high impedance end and a low impedance end; means connecting said anode to a high impedance point on said transformer; an electromagnetic deflection winding; a first capacitor coupling one end of said winding to a point on said transformer intermediate said low impedance point and said point of connection of said anode; a second capacitor coupling the other end of said winding to said low impedance point of said transformer; a unilaterally conductive damper device having a cathode and an anode; means connecting said cathode to a point on said transformer intermediate said connections thereto of said amplifier anode and said first capacitor; a source of direct current potential; means including a bi-part linearity controlling inductance coil and capacitive means in shunt therewith defining a resonant circuit; means connecting the two parts of said inductance coil in series for direct current; a connection between said anode of said damper device and one end of said coil; means connecting the other end of said coil to said potential source, and means including said deflection winding defining a direct current path from said source to a point intermediate the ends of said bi-part linearity coil.

15. Electro-magnetic scanning apparatus for causing linear deflection of a cathode ray beam, which apparatus comprises: a deflection waveform output amplifier; a transformer having a winding in circuit with the space current path of said amplifier; an electro-magnetic deflecting winding; means coupling said deflection winding to said transformer; a unilaterally conductive damping device having first and second electrodes; means connecting one of said electrodes to said transformer; a linearity control circuit comprising a bi-part inductance coil and capacitive means in shunt with said bi-part coil forming a resonant circuit, the two parts of said inductance coil being connected in a series direct current path; a source of direct current potential; potentiometer means; means connecting said potentiometer in a series direct current path between the other electrode of said damping device and said potential source; means connecting one end of said deflection winding to a point intermediate the ends of said bi-part linearity coil; and means forming a direct current connection between the other end of said winding and a point on said potentiometer means.

16. The invention as defined by claim 15, said potentiometer means being connected between the two parts of said linearity coil.

17. The invention as defined by claim 15, said potentiometer means being connected between said source of potential and said linearity coil.

18. The invention as defined by claim 15 wherein said last-named means comprises an inductance coil of such value that the combination of its inductance and the inductance of said winding is large as compared to the inductance of said linearity coil.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,837,692

June 3, 1958

Bethel Edward Denton

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, line 28, for "oil" read ~~oil~~ coil --; line 68, for "parallel" read -- damping relation.

Signed and sealed this 31st day of March 1959.

(SEAL)
Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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