

March 4, 1958

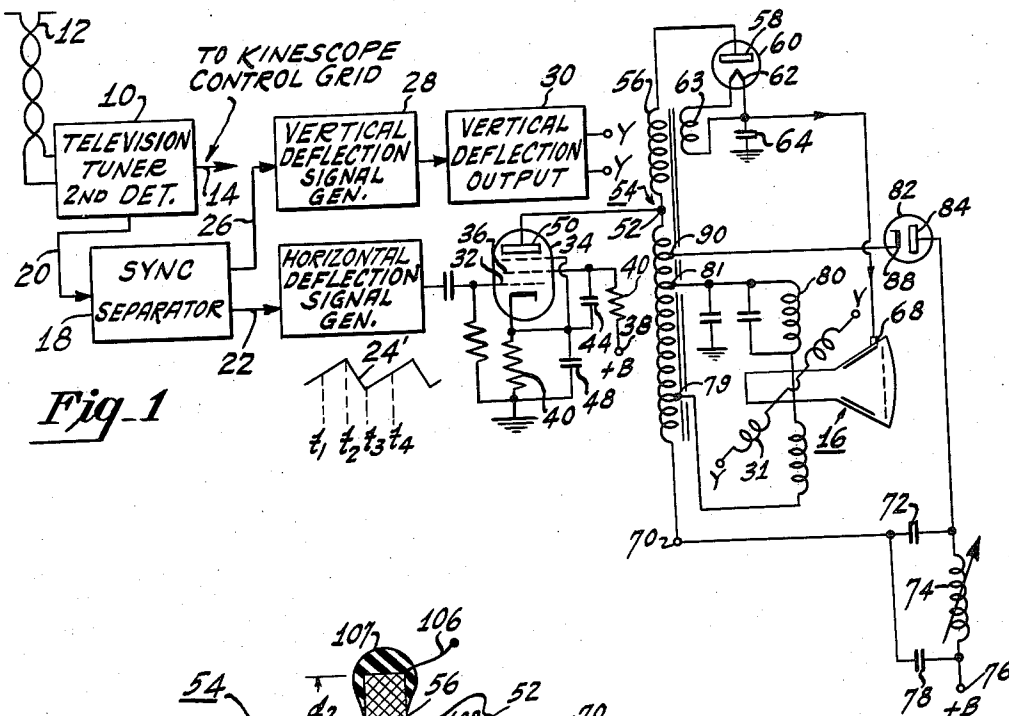
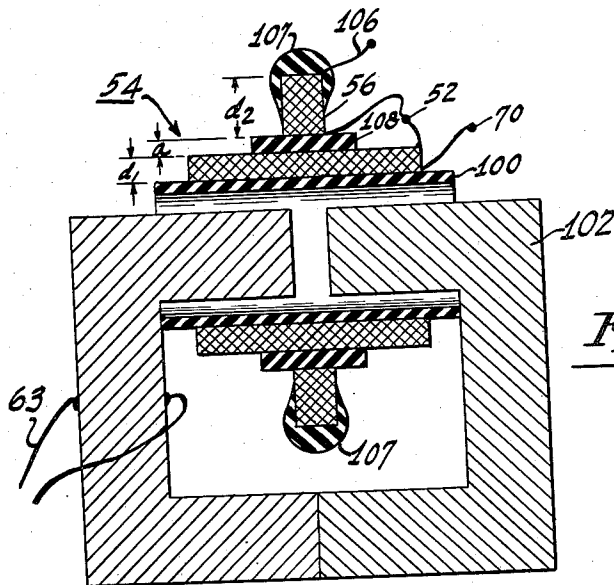
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2,825,849

CATHODE RAY TUBE DEFLECTION AND HIGH VOLTAGE APPARATUS

Filed June 29, 1954

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig- 2

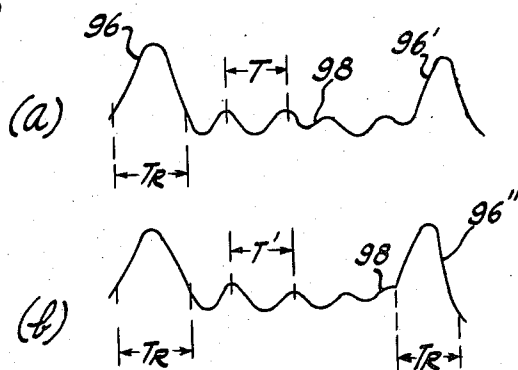
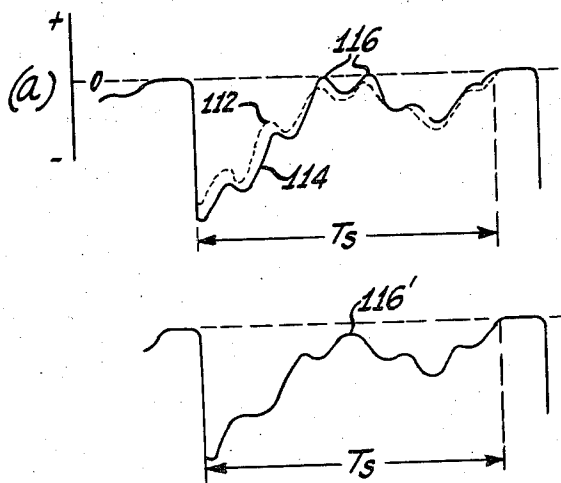


Fig- 3



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CATHODE RAY TUBE DEFLECTION AND HIGH VOLTAGE APPARATUS

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Application June 29, 1954, Serial No. 439,956

5 Claims. (Cl. 315—27)

The present invention relates to new and improved apparatus for furnishing both the high unidirectional potential for a cathode ray tube anode and the electromagnetic energy for causing an electron beam within such tube to scan a predetermined pattern.

More particularly, this invention relates to an improvement in the well-known combination high voltage and deflection output transformer such as is conventionally employed in conjunction with television receiver kinescopes.

Since electromagnetic deflection coils have a certain amount of inductance, some stored energy is present in the coils at the end of each deflection cycle. It is possible, through the use of a damping tube or diode, to use a portion of such stored energy for producing a part of the voltage variations employed in deflecting the cathode ray beam during the initial portion of the next succeeding scanning cycle. Such action is well-known and is termed "reaction scanning." The deflection coils also have certain inherent desirable capacities which, together with their inductance, produce tuned circuits having predetermined frequencies. During the "go time," which is the time of the useful trace of the scanning beam, energy is stored in the magnetic field of the transformer and deflection coils. The energy contained in the coils is permitted to produce a half cycle of free oscillation during the "flyback time" and, at the end of such half cycle of oscillation, the damper diode is employed to control or absorb the remaining energy, whereby to suppress substantially completely the remaining cycles of oscillation. Since it is desirable that the high voltage or accelerating potential required for operation of the kinescope also be derived in an efficient manner, it has become customary to combine the functions of deflection and high voltage derivation in a single apparatus in which use is made of the inductive nature of the deflection circuits. That is to say, most present-day television horizontal deflection circuits include means such as a power amplifier tube for driving a sawtooth current wave form through a transformer which couples the sawtooth energy to the deflection coils. Through the agency of a voltage step-up winding, the flyback pulses produced in the circuit inductances during the scanning retrace intervals are applied to a rectifier tube and filtered to afford a high-unidirectional potential for application to the final anode of the kinescope. Stated otherwise, at the end of the deflection scanning cycle, when the output or power tube is driven to cut-off, whereby the deflection voltage source is removed from the coils, the energy contained in the transformer, including the step-up winding, causes relatively higher frequency oscillation to be set up. Such higher frequency oscillation (as distinguished from the desired oscillation which is employed in the retrace deflection of the scanning beam) has been the source of such difficulties in practice as the production of "raster ringing" which manifests itself in the production of alternate dark and light vertical bars, on usually the lefthand side of the raster. In view of

such undesirable effects which result from velocity modulation of the beam spot intensity, prior workers in the art have proposed many and varied schemes for reduction of such ringing. The present applicants, on the other hand, have found that the high frequency ringing may be properly harnessed whereby to afford increased efficiency in both the deflection and high voltage deriving functions of such apparatus.

It is a primary object of the present invention, therefore, to provide novel deflection and high voltage transformer means for use in high efficiency deflection and high voltage production.

By way of background, and as has been alluded to briefly above, it will be understood that, in the case of the well-known "auto transformer" arrangement, the damper tube conducts heavily at the end of retrace time, thereby approximating a short circuit across what may be considered as the secondary winding of the transformer. During the latter portion of the scanning period, the horizontal output tube conducts heavily, whereby to approximate a short circuit across what may be considered the primary and secondary portions of the auto transformer. As will be appreciated by those skilled in the art, there exists a leakage inductance between the high voltage step-up winding ("tertiary" winding) and the remaining portion of the auto transformer, which leakage inductance is responsible, at least in part, for the ringing or high frequency oscillation mentioned supra.

The present invention has for another of its objects that of controlling the frequency of the ringing which results from the leakage inductance and its associated inherent capacities in such manner as to provide increased high voltage and greater deflection efficiency.

In general, the present invention provides means for controlling the frequency of the described ringing in such manner as to phase the ringing wave form so that the ringing voltage combines with the flyback pulses to increase their amplitude and, secondly, combines with the current through the damper tube in a manner calculated to increase the amount of sawtooth current which may be applied to the system by the power tube, whereby to increase the efficiency of the deflection system proportionately. In accordance with the present invention, such control of the ringing frequency is afforded by spacing the tertiary or step-up winding radially from the concentrically wound primary-secondary winding of the autotransformer. This spacing, when of the proper value, decreases the frequency of the ringing in an amount sufficient to phase it correctly so as to aid the flyback pulses and the deflection current.

As will be appreciated, the present invention requires only a simple change in existing deflection and high voltage transformers in order to bring about the improved results set forth herein. 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 illustrates, by way of block and schematic circuit diagram, a typical television receiver including a combination horizontal deflection and high voltage transformer arrangement in which the present invention may be advantageously employed;

Fig. 2 illustrates certain voltage wave forms to be described;

Fig. 3 illustrates current wave forms useful in describing another aspect of the invention; and

Fig. 4 is a simplified sectional view of a transformer constructed in accordance with the invention.

Referring to the drawing, and more particularly, to Fig. 1 thereof, block 10 represents that portion of a typical television receiver which includes a radio fre-

quency amplifier, converter, intermediate frequency amplifier stages and the second detector. Details of these circuits are well-known to those skilled in the art and need not be described further. Examples of suitable circuits, however, may be found in an article entitled "Television Receivers," by A. Wright in the March 1947 issue of the RCA Review.

The input terminals of receiver 10 are provided with composite television signals which are intercepted by an antenna 12. These signals are amplified by the receiver and demodulated in the usual manner so that they appear at output terminal 14, which terminal is indicated for connection to the beam intensity controlling electrode of the cathode ray image-reproducing device 16. The video signals demodulated within the receiver 10 are or may be suitably clipped to provide horizontal and vertical synchronizing pulses for application to the sync separator circuit 18 via lead 20. The horizontal sync pulses then appearing at output terminal 22 of the sync separator are applied for synchronization of the horizontal deflection signal generator or oscillator 24, while the vertical synchronizing pulses are applied via lead 26 to the vertical deflection signal generator 28. The output of the vertical deflection generator 28 is conventionally connected for driving the vertical deflection output amplifier 30 which, in turn, drives a suitable sawtooth current of field frequency through terminals Y—Y and the vertical deflection winding 31.

The output of the horizontal deflection generator 24 is coupled to the control electrode 32 of a horizontal deflection output discharge tube 34. Suitable biasing potential for the discharge tube screen electrode 36 is conventionally supplied from a source of positive potential indicated at terminal 38 as "+B" through a screen dropping resistor 40 which is, in turn, bypassed to the cathode 42 via a capacitor 44. A self-biasing cathode resistor 46 whose value is chosen in accordance with the desired operating bias for amplifier 34 is connected in the cathode circuit of the tube and is bypassed by capacitor 48.

The anode 50 of amplifier 34 is connected to a terminal 52 of an auto-transformer 54 which includes an auxiliary step-up winding 56 connected to the anode 58 of a high-voltage rectifying diode 60. The cathode filament 62 of a rectifier 60, energized by a winding 63 on the transformer 54, is connected to ground through a filter capacitor 64, so that high voltage for the final anode (not shown) of kinescope 16 may be applied to the high-voltage terminal 68. The lower terminus 70 of the auto-transformer 54 is connected through a "B-boost" capacitor 72 and a linearity control inductance 74 to a source of "+B" potential at terminal 76.

Another capacitor, such as that indicated at 78, across which is developed a portion of the "B-boost" voltage, and which aids in the linearity control action of the inductance 74, is directly connected from the auto-transformer terminal 70 to the "+B" terminal 76. The horizontal deflection winding 80 of the cathode ray deflection system is connected in shunt with that portion of the auto-transformer between terminals 79 and 81. The damping device which comprises, by way of illustration, the diode 82, is connected in damping relation with the yoke winding 80 through the "B-boost" capacitor 72 and the linearity inductance 74 taken in combination with the capacitor 78. Accordingly, the anode 84 of damper diode 82 is connected with the "+B" terminal 76 through the linearity inductance 74, while the diode cathode 88 is connected to a suitable point 90 on the auto-transformer.

As thus far described, the apparatus of the drawing is in accordance with conventional practice. Since the operation of reaction-scanning apparatus is well-known, it need not be described in detail here. A full analysis of such operation is given, for example, in an article

entitled "Magnetic Deflection Circuits," RCA Review, September 1947, by O. H. Schade. Briefly, however, it is to be noted that the bias on the horizontal output tube 34 is so adjusted that, during operation, the driving sawtooth waveform 24' which is provided by the horizontal deflection generator, will produce anode-cathode conduction during a period corresponding to only a little more than half the deflection cycle. Hence, it may be assumed that the horizontal output tube 34 is rendered conductive by the sawtooth waveform 24' during only that time between instants t_1 and t_2 , during which interval anode-cathode current will pass from the positive power supply terminal 76 through the inductance 74 and through the diode 82 to the transformer 54. Such current flow induces some deflection voltage and current in the transformer which causes a substantially linear rise in deflection current through the yoke winding 80. At time t_2 , corresponding to the commencement of the "retrace" interval of the deflection cycle, the discharge tube 34 becomes non-conductive and the magnetic field in the auto-transformer and yoke then collapses, causing oscillation of the primary resonant circuit (i. e. the yoke and its distributed capacitance) at its self-resonant frequency which is normally at least four to five times that of the deflection frequency.

After one-half cycle of free oscillation, the voltage appearing across the horizontal winding 80 is of such polarity as to cause the diode 82 to conduct, thereby damping the energy magnetically stored in the yoke. The direction of the damping current through the diode 82, in accordance with well-known reaction scanning principles, provides the first portion of the sawtooth through the winding 80, which portion corresponds to the interval between instants t_3 and t_4 of the sawtooth 24'. By the time t_4 is reached, the horizontal discharge tube 34 will have been rendered conductive and this time, by reason of the bias across capacitors 72 and 78, the diode 82 will not conduct as heavily, thereby causing most of the horizontal output tube anode current to flow through the auto-transformer section between terminals 90 and 70.

Also during the retrace interval (i. e. between times t_2 and t_3) the collapse of the magnetic field in the auto-transformer and yoke as above described results in the production of a high, unidirectional pulse across the transformer tertiary winding 56. The amplitude of such pulse is proportional to the quantity

$$L \frac{di}{dt}$$

where L is the inductance of the circuit and

$$\frac{di}{dt}$$

represents the rate of change of current therein. By virtue of the voltage step-up action of the tertiary winding 56 of the transformer 54, the pulse is increased in amplitude to provide additional high voltage potential, after rectification by the diode 60, for the kinescope terminal 68. In addition to the desired voltage pulse produced by the transformer during the retrace interval, there is additionally produced a ringing voltage train following the pulse of a frequency which is determined by the usual formula

$$f = \frac{1}{2\pi\sqrt{LC}}$$

where L is the inductance of the circuit and C its capacity, including distributed capacity of the transformer tertiary winding. The high voltage pulse and its associated ringing voltage is illustrated by the wave forms (a) and (b) of Fig. 2, wherein, as may be seen, the high voltage pulse 96 is followed by a ringing voltage 98 having a period equal to "T." Normally, as may be

5

noted from a study of the prior art, the ringing voltage has constituted a source of difficulty insofar as its effects upon deflection linearity is concerned. The present invention, as has been set forth briefly, exploits the ringing voltage in such manner as to increase both the amount of high voltage which may be obtained and the amount of deflection afforded by the circuit.

Referring again to wave form (a) of Fig. 2, it may be seen that the final half cycle of the ringing wave form 98 (i. e. that immediately preceding the second flyback high voltage pulse 96') is at or near its minimum value. It has been found through experiment that such phasing of the ringing wave form effectively decreases the amplitude of the pulse 96' as through a process in the nature of algebraic subtraction of the voltages. It has been found by the present applicants that, by properly phasing the ringing wave form 98 with respect to the commencement of the retrace time, it is possible to increase the amplitude of the ensuing high voltage pulse. Specifically, such control of the phasing of the ringing wave form 98 is afforded by the present invention through means for controlling the period of the ringing wave form and changing it from the period "T" of wave form (a) to the longer period "T'" of wave form (b) in Fig. 2. Where the period "T" is of the proper value, the final portion of the ringing voltage train 98 will be at or near its maximum value immediately preceding the commencement of the retrace period T_r. With the ringing voltage phased as in wave form (b) of Fig. 2, it effectively adds to the high voltage pulse 96' to increase its amplitude.

As those skilled in the art will appreciate, it is necessary to maintain the duration of the retrace interval at its proper value, so that any arrangement for changing the period of the ringing voltage should be one which produces no appreciable difference in the retrace time. In particular, it has been found by the present applicants that the period of the ringing voltage train may be increased from its value "T" to the longer value "T'" by decreasing the ringing frequency and, specifically, by increasing the leakage inductance between the tertiary winding 56 and the primary winding of the transformer which may be considered as that part between terminals 52 and 70. While it would be possible to effect such a change in the ringing frequency, for example, by increasing the number of turns of the tertiary coil, thereby increasing the leakage inductance, such an arrangement would be undesirable since it would necessarily increase the distributed capacity of the tertiary winding and, additionally, and even more significantly, would change the turns ratio through which the existing tertiary capacity loading is reflected across the deflection winding 80 and, since this transfer is proportional to the square of the number of turns, the retrace time would undesirably be substantially increased. Also, while it is possible to increase the ringing period by adding capacity to the rectifier end of the tertiary winding, such an arrangement is impractical since it would increase the retrace time and lower the amplitude of the flyback pulse.

As may be found in basic text books dealing with matters of the present variety, the leakage inductance between two concentric windings of a transformer is proportional to the quantity

$$cN^2 \left(a + \frac{d_1 + d_2}{3} \right) \times 10^{-9} \text{ henry}$$

where "c" is the length of a turn midway between innermost and outermost layers, "a" is the distance between the two windings, conductor to conductor, "d₁" and "d₂" are the build-ups of the two windings (all of the foregoing dimensions being expressed in inches) and "N" is the number of turns of the winding to which the leakage inductance is referred. Since the build-up "d₁" of the primary winding of the transformer 54 in Fig. 1 is nor-

6

mally fixed by such considerations as the primary impedance direct current resistance, flux density in the core and minimum primary to secondary leakage inductance, the present invention affords a control of the leakage inductance of the tertiary winding with respect to the rest of the winding by changing the parameter "a," namely, the distance measured radially between the windings. As may be determined from the foregoing expression for leakage inductance, the leakage inductance is therefore increased as a direct function of the spacing between the tertiary winding and the remainder of the transformer and, secondarily, by the increase in the mean winding diameter (referring to the parameter "c"). At the same time, as will be understood from the following formula, the distributed capacity of the tertiary winding is increased only by the increase in the mean diameter of the tertiary winding:

$$C (\text{distributed}) = \frac{0.3ck(T-1)}{dT^2} 10^{-12} \text{ farad}$$

where "c" is the mean length of turn of the winding; "l" is the length of winding (i. e. wire traverse); "d" is the distance between layers (all in inches); "T" is the number of layers of wire in the winding; and "k" is the average dielectric constant of the insulation material. Since the turns ratio is not increased, however, and since the change in the radial spacing parameter "a" produces only a small amount of additional capacitive loading, the present invention affords the desired increase in the ringing frequency without changing the length of retrace time appreciably.

Fig. 4 illustrates by way of a simplified, vertical sectional view, a combination deflection and high voltage transformer such as that illustrated schematically in the circuit diagram of Fig. 1 and, in the interest of clarity, reference numerals identical to those used in Fig. 1 designate corresponding portions of the structure of Fig. 4. In Fig. 4, the transformer 54 includes a first winding from terminal 52 to the terminal 70 which comprises the "primary" winding of the transformer. This winding is cylindrically arranged about a cylinder 100 formed of a suitable insulating material. An iron core in the form of two C-shaped members 102 and 104 is provided in a conventional manner. The ends of the C-shaped members 102 and 104 within the insulating cylinder or coil form 100 may be spaced, as shown, for the purpose of eliminating saturation due to plate current (D. C.) flowing from terminal 90 to terminal 52. The tertiary winding 56 starts at the point 52 and ends at the lead 106 which is adapted for connection to the anode 58 of the high voltage rectifier diode 60 and is suitably coated with insulating material 107. The tertiary winding 56 is wound concentrically with respect to the primary winding and, in accordance with the present invention, is spaced therefrom a predetermined distance "a" by means of an insulating spacer 108 of the proper thickness. The spacer may, for example, be made of such material as a phenol formaldehyde resin. Normally, as will be recognized by those skilled in the art, the aim of transformer designers in the past has been that of winding the tertiary or step-up winding as close to the primary winding as is possible since the concern was with reducing the leakage inductance as much as possible in an effort to decrease the ringing. In accordance with the present invention, however, the additional spacing member 108 for spacing the tertiary winding 56 from the primary winding by a predetermined distance "a" is employed for the express purpose of increasing the leakage inductance between the two windings in such manner as to increase the period of the ringing voltage attributable to the leakage inductance, whereby to phase the ringing voltage with respect to the commencement of the retrace interval as shown in wave form (b) of Fig. 2. The specific values of the various physical dimensions of the transformer windings will, of course, vary as a func-

tion of the desired amplitude of deflection and the value of the high voltage to be produced. In the interest of providing a specific example, however, the following dimensions of an actual transformer built in accordance with the invention for use in a 70° deflection and 17 kilovolt high voltage arrangement are herein presented, as follows:

Inner diameter of the primary winding (i. e. outer diameter of the coil form 100) = 0.550"

Outer diameter of primary winding = 1.057"

Inner diameter of tertiary winding = 1.214"

Thickness of spacing cylinder 108 ("a") (i. e. 1/2 difference between its outer and inner diameters) = 0.080"

From the foregoing, it may be seen that the spacing member 108 of the present invention increases the leakage inductance between the tertiary winding and the primary winding of the transformer 54 in such manner as to decrease the ringing frequency. Such frequency decrease may be selected, moreover, to be of the proper amount for phasing the ringing voltage as shown in wave form (b) of Fig. 2 so that the ringing voltage is at or near its maximum peak value at the commencement of the retrace interval.

Although the following does not specifically constitute a part of the present invention, it should be noted in the interest of completeness of description that the ringing effect upon the deflection linearity is minimized in accordance with the circuitry of Fig. 1 by virtue of the connection of the lower end of the horizontal deflection winding 80 at the point 79 on the transformer 54, which point is spaced in potential from the bottom of the winding (terminal 70) or A. C. ground. This connection of the deflection winding at a higher impedance point than ground is a well-known expedient for reducing the effects of ringing upon deflection linearity and is effective in the case of the present invention wherein the leakage inductance between the tertiary and primary windings of the transformer is intentionally increased for the purposes set forth.

Another important advantage afforded by the present invention, as stated supra, is that of increasing the efficiency of the deflection circuit itself. Briefly, this action is accomplished by virtue of the fact that the spacing between the tertiary and primary windings of the transformer also changes the phase of the leakage inductance ringing voltage which is coupled into the damper tube circuit. Specifically, and as is well-known, the amount of horizontal driving voltage which may be impressed upon the deflection transformer 54 by the horizontal output tube 34 is limited by the damper tube current. That is to say, maximum permissible "drive" is normally attained when the damper tube current is reduced to zero in the vicinity of the middle of the scanning line, such cessation of damper tube conduction being manifested by a bright vertical line in the center of the kinescope raster. As stated above in connection with the general description of the deflection circuit operation, it is the damper tube current (between times t_3 and t_4) which furnishes approximately half of the deflection energy in each horizontal line scan. It has been found that, for optimum performance of such a reaction scanning arrangement to be realized, it is necessary for the driver tube 34 to furnish an excess of current to the deflection circuits, so that the damper tube may conduct continuously during the "go time." A typical current wave form through a damper tube such as the tube 82 in Fig. 1 is illustrated by wave form (a) of Fig. 3, in which the "go time" or scanning period is designated as " T_s ." By virtue of the connection of the damper diode as shown, current therethrough is in the negative direction as is necessitated by the requirement that the damper current deflect the electron beam within the kinescope to the opposite side of its central position from that direction in which the driver tube current deflects it. The dotted line portion 112 of the damper current wave

form (a) of Fig. 3 represents the current for a given amount of drive from the horizontal output tube 34. As amount of drive is increased, the current through the damper tube also increases as indicated by the solid line portion 114 of the wave form. The rippled portions of the wave form are the result of the ringing energy from the leakage inductance of the transformer which is coupled into the damper tube circuit. The minima or peaks 116 of the damper tube current wave form are at the zero reference line and indicate damper tube cutoff, which constitutes the limiting condition for the amount of drive which may be furnished by the tube 34. Since the efficiency of the circuit is generally proportional to the amount of drive which may be successfully applied to the circuit, it is desirable to increase the current through the damper tube (i. e. in the negative direction) so that the peaks 116 do not reach zero or, stated otherwise, so that the damper tube is not cut off during the middle of the scanning line. The present invention performs the desirable function of increasing the damper tube current during the middle portion of the scanning line by so phasing the ringing voltage train of the leakage inductance that it adds to the damper tube current in such manner as to increase that current (in its negative direction) by adding a negative half cycle of the ringing energy to the damper tube current during the central part of the scanning line interval, thereby preventing the damper tube current from being cut off. The phasing of the ringing voltage as accomplished in the interest of increasing the amplitude of the high voltage pulses has been found to be substantially the proper phase for increasing the damper tube current during the middle of the scanning line, and as illustrated in wave form (b) of Fig. 3. That is to say, the spacing of the tertiary winding 56 from the primary winding of the transformer 54 which increases the leakage inductance therebetween whereby to increase the period of the ringing voltage train provides a negative half cycle of ringing voltage near the peaks of the damper current wave form of Fig. 3(a) so that the resultant damper current is changed to that shown by wave form (b) of Fig. 3 wherein the peak 116' is more negative than the zero reference. Thus, the amount of drive which may be furnished by the horizontal output tube 34 is increased so that greater deflection efficiency is possible.

From the foregoing, it will be understood that the present invention provides a novel combination high voltage and deflection transformer in which the high voltage step-up winding is spaced radially from the primary winding an amount sufficient to increase the leakage inductance between the two windings in such manner as to change the phase of the leakage ringing voltage train whereby to (1) increase the amplitude of the high voltage pulses and (2) increase the amount of drive which may be furnished to the deflection circuit.

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

1. A combined deflection and high voltage transformer for use in conjunction with a cathode ray tube, said transformer comprising: a first transformer winding having an input terminal adapted for connection to a source of deflection energy and a pair of output terminals for connection to an electromagnetic deflection winding; a second transformer winding electrically connected serially with and physically concentric with respect to said first winding in such manner as to be in energy transfer relationship therewith, said second winding having an output terminal for connection to a rectifying circuit of the type adapted to rectify recurrent flyback voltage impulses produced in said transformer whereby to produce a high, unidirectional potential for application to such cathode ray tube, said transformer having inherent capacity whereby to form a resonant circuit with the inductance of said transformer of such character as to produce ringing of a certain frequency; and means for

spacing said second winding radially outwardly from said first winding a substantial distance greater than the minimum distance and sufficient to increase the leakage inductance between said first and second winding by such an amount as to decrease said certain frequency by a predetermined amount.

2. A combined deflection and high voltage transformer for use in conjunction with a cathode ray tube, said transformer comprising: a first transformer winding having an input terminal adapted for connection to a source of deflection energy and a pair of output terminals for connection to an electromagnetic deflection winding; a second transformer winding electrically connected serially with and physically concentric with respect to said first winding in such manner as to be in energy transfer relationship therewith, said second winding having an output terminal for connection to a rectifying circuit of the type adapted to rectify recurrent flyback voltage impulses produced in said transformer whereby to produce a high, unidirectional potential for application to such cathode ray tube, said second winding having inherent capacity and leakage inductance between said second winding and said first winding of a certain value forming a resonant circuit with said capacity whereby ringing is produced at a given frequency determined by the values of said leakage inductance and said inherent capacity; and means for spacing said second winding radially from said first winding by a predetermined substantial distance greater than the minimum distance such that said leakage inductance is increased in an amount sufficient to decrease said given ringing frequency by a predetermined amount.

3. A combined deflection and high voltage transformer for use in conjunction with a cathode ray tube, said transformer comprising: a first transformer winding having an input terminal adapted for connection to a source of deflection energy and a pair of output terminals for connection to an electromagnetic deflection winding; a second transformer winding electrically connected serially with and physically concentric with respect to said first winding in such manner as to be in energy transfer relationship therewith, said second winding having an output terminal for connection to a rectifying circuit of the type adapted to rectify recurrent flyback voltage impulses produced in said transformer whereby to produce a high, unidirectional potential for application to such cathode ray tube, said second winding having inherent capacity and leakage inductance between said second winding and said first winding of a certain value forming a resonant circuit with said capacity whereby generally sinusoidal ringing is produced at a given frequency determined by the values of said leakage inductance and said inherent capacity, said given frequency being such that said ringing is in a certain phase relationship with respect to such flyback impulses; and means for spacing said second winding radially from said first winding by a predetermined substantial distance greater than the minimum distance such that said leakage inductance is increased in an amount sufficient to decrease said given frequency by a predetermined amount whereby to alter said phase relationship between said ringing and such flyback impulses.

4. A combined high voltage and deflection transformer for use in conjunction with a cathode ray tube reaction scanning circuit of the type including driver means for furnishing a sawtooth current waveform during a portion of the scanning time and a unilaterally conductive damper device for furnishing deflection current during the remainder of the scanning time, and in such manner that such damper device current reaches a minimum value at a certain point in the scanning cycle, said transformer comprising: a first transformer winding having an input terminal adapted for connection to such driver means, a pair of output terminals for connection to an electromagnetic

deflection winding; and a terminal for connection to such damper device; a second transformer winding electrically in series with and physically concentric with respect to said first winding in such manner as to be in energy transfer relationship therewith, said second winding having an output terminal for connection to a rectifying circuit of the type adapted to rectify recurrent flyback voltage impulses produced in said transformer whereby to produce a high, unidirectional potential to such cathode ray tube, said second winding having inherent distributed capacity and leakage inductance between said second winding and said first winding of a certain value forming a resonant circuit with capacity whereby generally sinusoidal ringing is produced at a given frequency determined by the values of said leakage inductance and said inherent capacity, said given frequency being such that said ringing is in a certain phase relationship with respect to such damper current minimum value; and means for spacing said second winding radially from said first winding by a predetermined substantial distance greater than the minimum distance such that said leakage inductance is increased by an amount sufficient to decrease said given ringing frequency by a predetermined amount whereby to alter said phase relationship between said ringing and such damper current.

5. A combined high voltage and deflection transformer for use in conjunction with a cathode ray tube reaction scanning circuit of the type including driver means for furnishing a sawtooth current waveform during a portion of the scanning time and a unilaterally conductive damper device for furnishing deflection current during the remainder of the scanning time, and in such manner that such damper device current reaches a minimum value at a certain point in the scanning cycle, said transformer comprising: a first transformer winding having an input terminal adapted for connection to such driver means, a pair of output terminals for connection to an electromagnetic deflection winding; and a terminal for connection to such damper device; a second transformer winding electrically in series with and physically concentric with respect to said first winding in such manner as to be in energy transfer relationship therewith, said second winding having an output terminal for connection to a rectifying circuit of the type adapted to rectify recurrent flyback voltage impulses produced in said transformer whereby to produce a high, unidirectional potential to such cathode ray tube, said second winding having inherent distributed capacity and leakage inductance between said second winding and said first winding of a certain value forming a resonant circuit with capacity whereby generally sinusoidal ringing is produced at a given frequency determined by the values of said leakage inductance and said inherent capacity, said given frequency being such that said ringing is in a certain phase relationship with respect to such damper current minimum value; and means for spacing said second winding radially from said first winding by a predetermined substantial distance greater than the minimum distance such that said leakage inductance is increased by an amount sufficient to decrease said given ringing frequency by a predetermined amount whereby to alter said phase relationship between said ringing and such damper current so that said ringing increases such minimum value of damper current.

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