March 4, 1958 C. C. IDEN 2,825,850

CATHODE RAY TUBE DEFLECTION AND HIGH VOLTAGE APPARATUS

Filed March 31, 1955 2 Sheets-Sheet 1

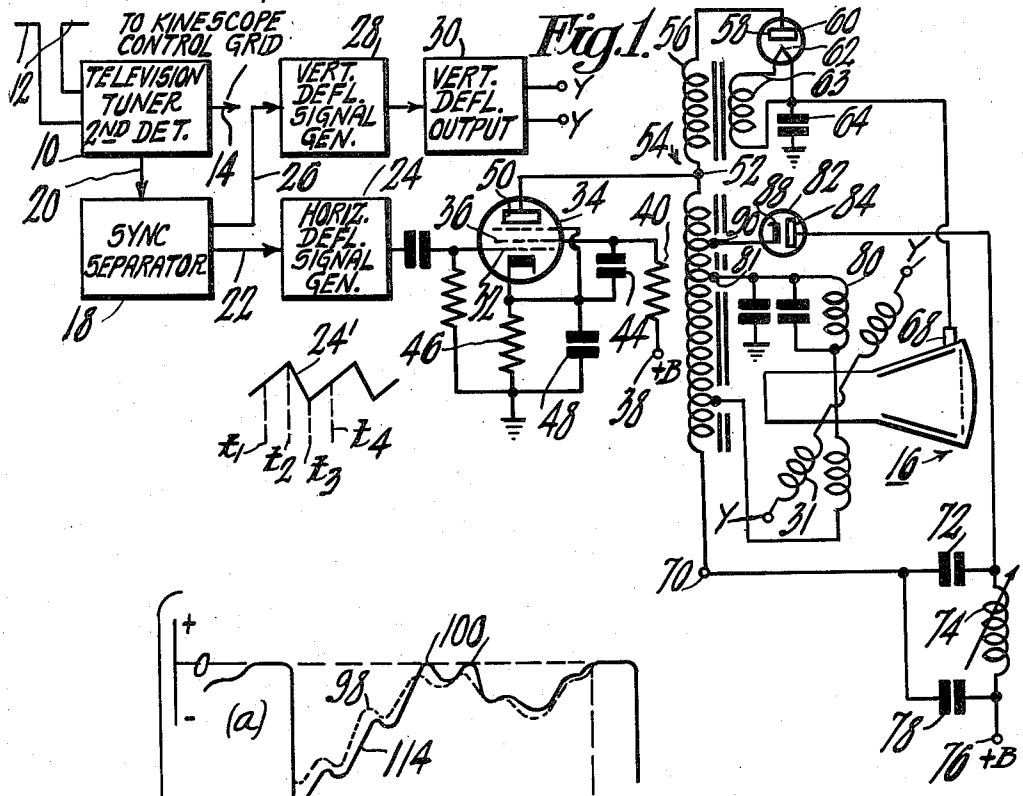


Fig. 1.

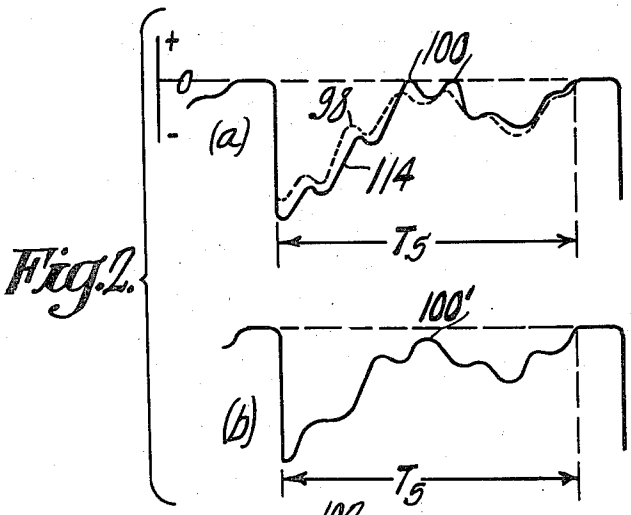


Fig. 2.

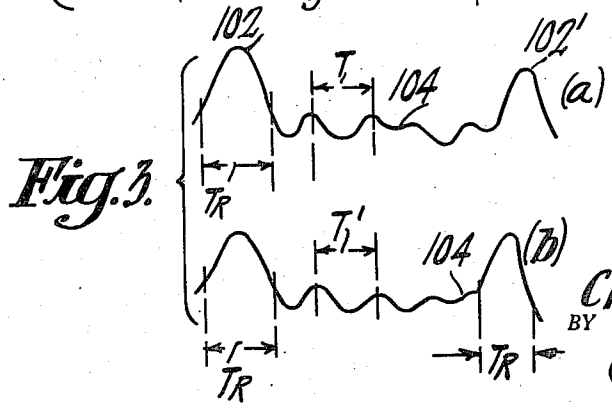


Fig. 3.

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Fig. 4.

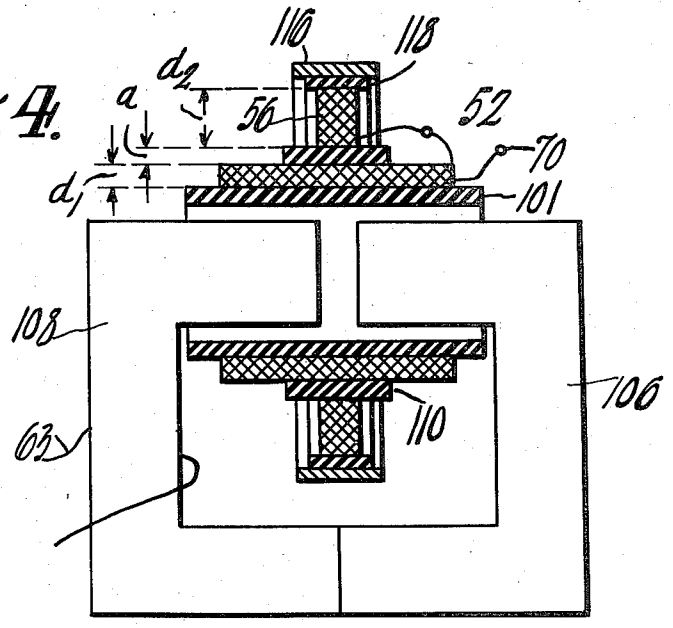
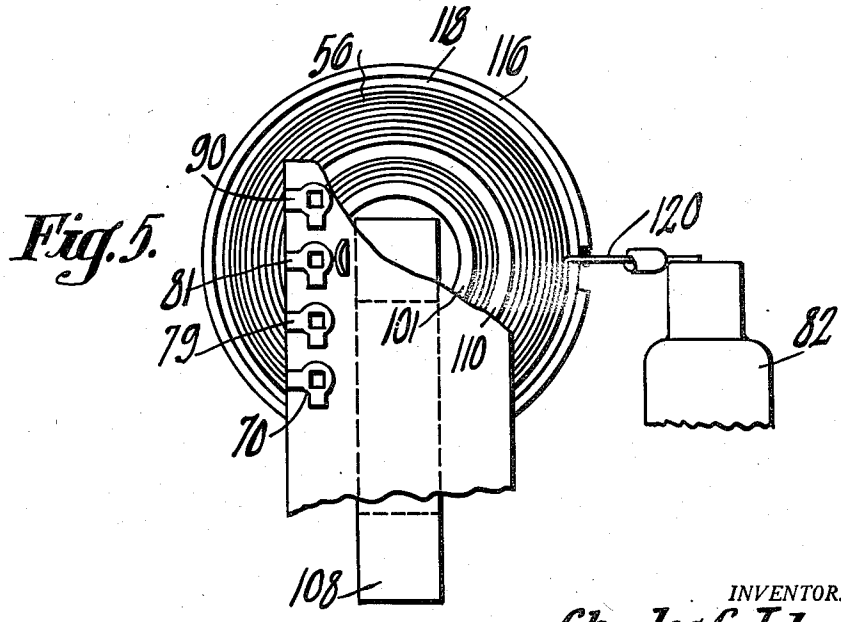


Fig. 5.



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CATHODE RAY TUBE DEFLECTION AND HIGH VOLTAGE APPARATUS

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Application March 31, 1955, Serial No. 498,194

7 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 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 distributed 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 time 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. The present applicant has found that the high frequency ringing may be properly harnessed whereby to afford increased efficiency in the deflection function of the apparatus while controlling its high voltage-deriving function.

It is a primary object of the present invention 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 controlled high voltage and optimum 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 increasing the distributed capacity-to-ground of the tertiary or step-up winding of the auto transformer. This increased capacity, when of the proper value, controls the frequency of the ringing to phase it correctly with respect to 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:

Figure 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;

Figure 2 illustrates certain current waveforms to be described;

Figure 3 illustrates voltage waveforms useful in describing one aspect of the invention; and

Figures 4 and 5 are simplified views of a transformer constructed in accordance with the invention.

Referring to the drawing, and more particularly, to Figure 1 thereof, block 10 represents that portion of a typical television receiver which includes a radio frequency 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 23 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, by-passed 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 the 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, 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 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 collapse, 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 and 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.

As pointed out in U. S. patent application Serial No. 439,956 filed jointly by the present applicant and P. M. Lufkin on June 29, 1954, 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 between terminals 52 and 70.

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, "d_1" and "d_2" 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 "d_1" of the primary winding of the transformer 54 in Figure 1 is normally fixed by such considerations as the primary impedance direct current resistance, flux density in the core and minimum primary to secondary leakage inductance, control of the leakage inductance of the tertiary winding with respect to the rest of the winding may be had 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:

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

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.

An important advantage afforded by the increased leakage inductance resulting from spacing the tertiary winding from the primary-secondary winding and the resultant ringing re-phasing is that of increasing the efficiency of the deflection circuit. 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, 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 about 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 32 in Figure 1 is illustrated by wave form (*a*) of Figure 2, 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 98 of the damper current waveform (*a*) of Figure 2 represents the current for a given amount of drive from the horizontal output tube 34. As the amount of drive is increased, the current through the damper tube also increases as indicated by the solid line portion 114 of the waveform. The rippled portions of the waveform 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 100 of the damper tube current waveform 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 100 do not reach zero or, stated otherwise, so that the damper tube is not cut off during the middle of the scanning line. The damper tube current during the middle portion of the scanning line may be increased 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 rephasing of the ringing voltage required for increasing the efficiency of deflection has been found to be as illustrated in waveform (*b*) of Figure 2. This 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 so that the resultant damper current is changed to that shown by waveform (*b*) of Figure 2 wherein the peak 100' 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.

It has also been found, as pointed out in the above-cited patent application, that the phasing of the ringing voltage as accomplished in the interest of increasing the amplitude of deflection or deflection efficiency is substantially the proper phase for increasing the amplitude of the high voltage pulses which are rectified to provide a high unidirectional potential for application to the kinescope anode. The high voltage pulse and its associated ringing voltage is illustrated by the waveforms (*a*) and (*b*) of Figure 3, wherein, as may be seen, the high voltage pulse 102 is followed by a ringing voltage 104 having a period equal to "T." It may be seen from waveform (*a*) of Figure 3 that the final half-cycle of the ringing waveform 104 (i. e. that immediately preceding the second flyback high voltage pulse 102') is at or near its minimum value. Experimentation has shown that such phasing of the ringing waveform effectively decreases the amplitude of the pulse 102' as through a process in the nature of algebraic subtraction of the voltages. It is, however, possible to increase the amplitude of the ensuing high voltage pulse by properly phasing the ringing waveform 104 with respect to the commencement of the retrace time. Thus, when the tuning of the transformer is adjusted as by providing a spacer between the primary-secondary winding of the transformer and the tertiary winding to increase the leakage inductance of the transformer so that the period of the ringing waveform is changed from the period "T" of waveform (*a*) of Figure 3 to the longer period "T'" of waveform (*b*) of Figure 3, the final portion of the ringing voltage train 104 will be at or near its maximum value immediately preceding the commencement of the retrace period T_r. Thus the ringing voltage, phased as in waveform (*b*) of Figure 3, effectively adds to the high voltage pulse to increase its amplitude.

The present invention provides novel means affording additional control over the tuning of a transformer of the type in question for increasing its efficiency. Where, for example, the operational requirements of such a transformer are such that the frequency of the ringing voltage cannot be completely controlled by the spacing of the tertiary winding thereof from its primary-secondary winding or where the value of the high voltage flyback pulses to be produced necessitates the use of a smaller number of turns for the tertiary winding than that which affords the necessary amount of distributed capacity and leakage inductance, as explained, the requisite tuning of the transformer may be accomplished through the agency of the present invention which, in a simple and inexpensive manner, increases the distributed-capacity-to-ground of the tertiary winding. Since the frequency of the ringing is, as has been explained, inversely proportional to the square root of the product of the leakage inductance and the distributed capacity, such increased distributed ca-

pacity of the tertiary winding can be advantageously employed in maintaining the LC product constant.

That is to say, and assuming by way of example that the spacing between the primary-secondary winding and the tertiary winding of a transformer has been adjusted to provide a leakage inductance of the proper value which, when tuned with the capacities of the transformer, affords a ringing voltage of the proper phase as illustrated by the waveforms of Figure 2 but that the high voltage pulses are greater than required for a given transformer design, reduction of the number of turns of the tertiary winding, while effective to reduce the amplitude of the high voltage pulses, has been found to de-tune the transformer in an undesirable manner so that it no longer affords the optimum efficiency for deflection. The reason for such de-tuning will be understood as stemming from two facts. First of all, the reduction in number of turns of the tertiary winding necessarily decreases the distributed capacity of the tertiary winding to ground. Secondly, since the leakage inductance is generally proportional to the square of the number of turns of the winding, that parameter is also decreased. The decrease of both distributed capacity and the leakage inductance thus brings about a change in the frequency of ringing. If such a frequency change is so great as to render its correction by additional spacing between the windings impracticable for some reason, the correction thereof may be made in accordance with the present invention as now will be explained.

Figure 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 Figure 1, and, in the interest of clarity, reference numerals identical to those used in Figure 1 designate corresponding portions of the structure of Figure 4. The transformer **54** includes a first winding from terminal **52** to terminal **70** which comprises the "primary-secondary" winding of the transformer. This winding is cylindrically arranged about a cylinder **101** formed of a suitable insulating material. An iron core in the form of two C-shaped members **106** and **108** is provided in a conventional manner. The ends of the C-shaped members **106** and **108** within the insulating cylinder or coil form **101** may be spaced apart several mils, 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 "finish" lead **106** which is adapted for connection to the anode **58** of the high voltage rectifier diode. The tertiary winding **56** is wound concentrically with respect to the primary winding and is spaced therefrom a predetermined distance "*a*" by means of an insulating spacer **110** of the proper thickness, which spacer may, for example, be made of such material as a phenol formaldehyde resin. Electrically connected to the "finish" lead of the tertiary winding **56** is a copper strap **116**. The copper strap **116** is of such length as to surround a substantial portion of the periphery of the tertiary winding **56**, as shown in the view of Figure 5. A strip **118** of insulating material (e. g. 0.003-inch kraft paper) serves to insulate the copper strap **116** from the tertiary winding **56**. As may also be seen from the showing of Figure 4, the copper strap is of greater width than the width of the winding **56**, for purposes which will become more apparent hereinafter.

The following specifications afford a specific example of a transformer constructed in accordance with the present invention for providing 90° deflection and 15 kilovolts of high voltage in an arrangement employing a horizontal output tube of the 6BQ6 type and a rectifier of the designation 1X2B: the primary-secondary winding comprises 910 turns (plus or minus 1%) of 0.007 heavy formex wire, layer-wound, with one thickness of 0.005-inch kraft paper between layers. The winding, having **85** turns per layer with a traverse of 0.875-inch, is tapped at points corresponding to the terminals **73**, **81**, **90** and **52** (Figure 1) at 100 turns, 570 turns, 620 turns and its terminus.

The tertiary winding comprises 1100 turns (plus or minus 1%) of 0.0045 heavy formex wire, layer-wound, 24 turns per layer, with a traverse of 0.250-inch, one thickness of 0.003 kraft paper being inserted between the layers for insulation.

The insulating spacer **108** between the primary-secondary winding and the tertiary winding for the described transformer has a wall thickness of 0.220-inch. The copper strap employed has dimensions of ½-inch by 7¼-inches and is of 0.003-inch in thickness and is electrically connected to the finish lead **106** of the tertiary winding and to the lead **120** which is connected to the anode of the 1X2B rectifier tube, the strap being wrapped around the tertiary winding in the direction of the winding.

In order to provide a quantitative understanding of the action of the copper strap in tuning the transformer as explained above, the following illustrative data are presented regarding a test transformer: With a tertiary winding of 1200 turns, the leakage inductance of the transformer was found by measurement to be approximately equal to 97.7 millihenries (i. e. from the high voltage winding to the damper tube). With 50 turns of the tertiary winding removed, the measured leakage inductance was 91.3 millihenries (a difference of approximately 6.4 millihenries). Under the first conditions, the frequency of ringing was found to be 138 kilocycles per second, while the frequency of ringing under the second described conditions was 142.5 kilocycles per second. By substituting the measured values of leakage inductance and frequency in the formula $F=\frac{1}{2}\pi\sqrt{LC}$, the distributed capacities for the two cases were found to be only slightly different. Specifically, the distributed capacity for the first case (with 1200 turns) was calculated to be approximately 13.6 $\mu\mu$f. The second case (1150 turns) the distributed capacity was calculated to be approximately 13.5 $\mu\mu$f., so that the loss of distributed capacity is measured in fractions of a microfarad. The function of the copper strap surrounding the tertiary winding of the transformer is, as has been stated, that of making up the deficiency of the lost distributed capacity and leakage inductance, so that the capacity added by the strap may be calculated as being approximately 1 $\mu\mu$f. This additional capacity thus returns the frequency of ringing to its proper value (i. e. 138 kilocycles per second, as indicated above) and in a simple, inexpensive manner.

It has also been found, in general, that the capacity added to the transformer by the copper strap around the tertiary winding varies generally in proportion to the length of the copper strap and to its width. As a practical matter, experimentation has shown that the capacity added by the strap is most noticeable when the strap is near the essentially grounded portion of the ferrite core (the lower portion in Figs. 4 and 5).

Measurements have also shown that the use of the copper strap for tuning the transformer for optimum ringing increases the retrace time by a matter of only a tenth of a microsecond, which increase in time is so slight as to be readily remedied, if desired, by making a slight adjustment in the capacitive loading of the yoke itself. That is to say, the loading effect of the capacitor shown in Figure 1 as connected between terminal **81** on the transformer and ground may be decreased slightly by connecting the ungrounded plate of the capacitor to a lower impedance point on the transformer which has the effect of shortening the retrace time.

From the foregoing, it will be recognized that the present invention provides novel but effective means for tuning a transformer of the type in question for optimum deflection deficiency and in a manner which is substantially independent of the number of turns of the winding thereof. The tuning may, therefore, be made in accordance with the present invention independently of

the required amplitude of the stepped-up flyback pulse which is applied to the high voltage rectifier.

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

1. A deflection and high voltage transformer comprising first and second serially connected inductive windings concentrically disposed with respect to each other; an insulating spacer member between said first and second windings for spacing one of said windings radially from the other in such amount as to provide a predetermined leakage inductance between said first and second windings; and capacitive means connected to the outer one of said concentrically disposed windings, said windings having distributed capacity which forms a ringing circuit with such leakage inductance having a certain resonant frequency, said capacitive means being of such value as to tune said inductance and distributed capacity to a frequency lower than said certain frequency.

2. A cathode ray tube deflection and high voltage transformer comprising a first cylindrical, inductive winding adapted to be connected at one end to a deflection output amplifier and at its other end to a source of operating potential; a second cylindrical winding around said first winding and concentric therewith; a connection between one end of said second winding and said end of said first winding and such amplifier, said windings having distributed capacity in circuit therewith forming a ringing circuit having a resonant frequency determined by such capacity and the inductance of said windings including leakage inductance therebetween; and capacitive means connected electrically to the end of said second winding remote from the end connected to said first winding for increasing the capacity of such ringing circuit in such manner as to alter the frequency of such ringing.

3. A deflection and high voltage transformer for use in conjunction with a cathode ray tube and adapted to couple energy from a deflection amplifier to an electromagnetic deflection winding and to a rectifying circuit for producing a high unidirectional potential for application to an electrode of such tube, said transformer comprising: a primary winding adapted for connection to both such amplifier and to such deflection winding; a second winding serially connected to said primary winding for coupling energy to such rectifying circuit, said second winding being concentric with and around said primary winding, said transformer having inherent capacity forming a part of a resonant circuit of such character as to produce ringing of a certain frequency; and a strap of conductive material electrically connected to the end of said second winding remote from its connection to said first winding, said strap surrounding a selected portion of said second winding.

4. 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; means for spacing said second winding radially outwardly from said first winding a distance sufficient to produce a leakage inductance between said first and second windings greater than that available in the absence of said spacing means, said windings having distributed capacitance forming a ringing circuit with such leakage inductance having a certain frequency; and means forming a capacitive path from said output terminal of said second winding to a point of fixed potential for tuning such ringing circuit to a frequency lower than said certain frequency.

5. 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 of such character as to produce ringing of a certain frequency; and capacitive means connected to said output terminal of said second winding for increasing the capacity of said transformer in such manner as to change the period of such ringing.

6. 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; 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; means for spacing said second winding radially from said first winding by a predetermined distance such that said leakage inductance is increased in an amount sufficient to decrease said given ringing frequency to a lower frequency; and means comprising a conductive member connected electrically to said output terminal of said second winding for increasing the capacity across said second winding in such manner as to decrease said frequency of ringing below said lower frequency.

7. 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 of cylindrical form 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; 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 a strap of conductive material connected electrically at one end to said output terminal of said second winding and disposed in conformity with the periphery of said second winding for decreasing the frequency of such ringing.

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