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ELECTRON BEAM DEFLECTION CONTROL SYSTEM

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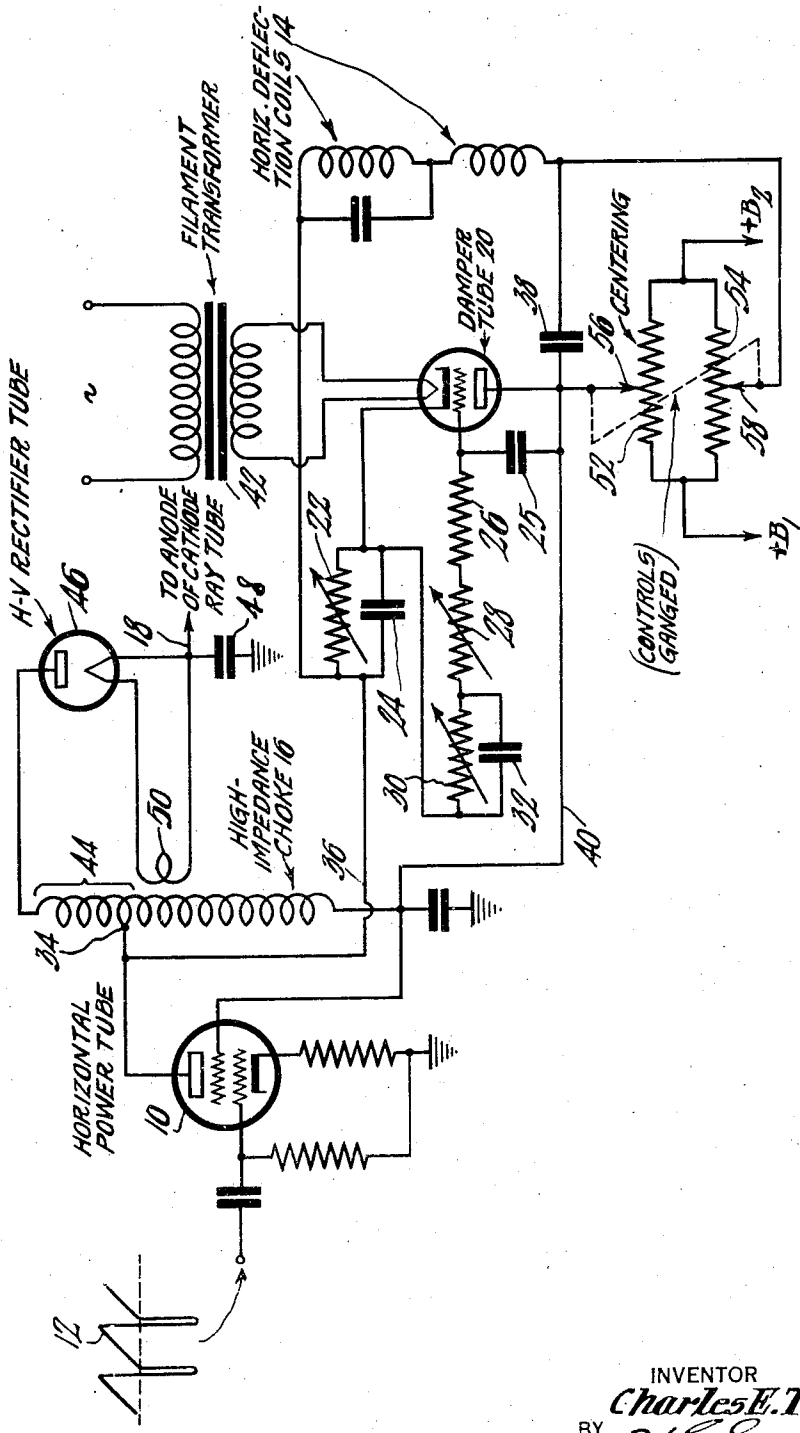

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ELECTRON BEAM DEFLECTION CONTROL SYSTEM

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The present invention relates to television systems, and more particularly relates to means for deflecting the electron scanning beam of an image-reproducing cathode ray tube, as well as to means for supplying relatively high potentials for application to the cathode ray tube accelerating electrodes.

Horizontal, or line, deflection circuits of television receivers frequently include one or more power output tubes from which energy is supplied to a pair of cathode ray beam deflection coils through an output transformer. In order to reduce the high-frequency oscillations which normally occur following the retrace periods of the cathode ray beam, a suppressor, or damper, tube is customarily connected across either the primary or secondary winding of this output transformer.

The relatively high potentials which are necessary to provide for the acceleration of the cathode ray beam are usually obtained either from a separate RF (radio-frequency) power supply unit, or a rectified 60 cycle power supply unit, not directly associated with the deflection circuit, or else they may be obtained by utilizing the surges of voltage developed across the deflection circuit inductance during the beam snap-back, or retrace, intervals when no portion of the image is being reproduced. To insure that these voltage surges are of sufficient amplitude, in cases where the latter method is employed, a step-up winding may be added to the output transformer, the voltage pulses developed across this winding being rectified and filtered prior to their application to the electrodes of the cathode ray tube.

While the use of an output transformer between power tube and deflection coils is advantageous in permitting yokes of various impedances to be properly matched to a power tube having a fixed internal resistance, nevertheless the relatively high cost of such transformers is an important factor in the production of certain classes of television receiving units. Furthermore, unless the coupling between the primary and secondary windings of the transformer is very tight, excessive losses result and the Q of the circuit is lowered.

It has been found that a system such as the above may be changed into a so-called "direct-drive" arrangement to effect "unity" coupling between power tube and deflection coils. A choke the impedance of which is high compared to that of the deflection coils is so arranged as to permit adjustment of the direct current component of yoke current by means of "centering" potentiometers. Furthermore, the high-impedance end of this choke may be connected to the anode of the high-voltage rectifier tube, thereby supplying an accelerating potential for the electron scanning beam. Not only is the cost of such a choke considerably lower than that of a suitable two-winding transformer, but, in addition, higher circuit efficiency may be obtained, since coupling losses are not a factor.

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Generally, more cathode ray tube anode voltage is required than can be obtained with the rectifier anode connected directly to the power tube anode. To meet this requirement, the high impedance choke is herein shown as a portion of an autotransformer which steps-up the surge voltage (appearing during retrace at the power tube anode) to a higher peak voltage at the rectifier anode.

The core of the autotransformer which forms part of the present invention requires at most but one section, or leg, and, in addition, may have its physical dimensions held to a minimum. In fact, it has been found that in certain instances the core element may be omitted altogether with beneficial results, since such an expedient reduces the flux transfer between the ends of the choke winding and helps to maintain constant the plate voltage of the power output tube.

When no core is employed, relatively large oscillations and other distortion of the waveform of the power tube output voltage will appear at the high-impedance end of the choke, or, in other words, at that end of the choke connected to the anode of the high-voltage rectifier tube. With a filter condenser of proper capacitance in series with the rectifier tube, however, these variations will have no appreciable effect on the stability of the cathode ray tube anode voltage. Furthermore, from an operating standpoint, there is no necessity for the waveform of the voltage applied to the high-voltage rectifier tube to be similar to the waveform of the voltage output of the power tube, as long as the peak amplitude of the former is sufficient to provide for the acceleration of the electron scanning beam. Due to the loose coupling between the coil portions, moreover, any voltage waveform distortion at the high-impedance end of the autotransformer will not feed back into the deflection circuit, and hence will not adversely affect the linearity of scan.

An additional winding may be coupled magnetically to the autotransformer windings for sup-

plying heater potential to the high voltage rectifier.

A deflection and power supply system in accordance with the present invention, or, in other words, a direct-drive system utilizing choke coupling, results in a high voltage being developed across the "line" deflection coils during retrace. This requires a yoke having higher impedance "line" deflection coils than commonly used, and is readily obtained by reducing the size of the wire employed in winding the yoke and by increasing the number of turns. With coil winding apparatus now in use, however, the difference in cost between a yoke of the latter type and one of standard low impedance is not appreciable. Also, certain inherent advantages reside in the use of high-impedance yokes, among these being lower eddy current losses within the copper of the coil winding.

One object of the invention, therefore, is to provide a "bridging" element for cathode ray beam deflection circuits of the "direct-drive" type, this "bridging" element acting to provide accelerating potentials for the cathode ray beam, as well as to permit "centering" current adjustment in the yoke circuit. The high voltage rectifier tube portion of the circuit may have its heater voltage supplied by an auxiliary winding magnetically coupled to the "bridging" element here mentioned.

A further object of the invention is to provide a coupling or "bridging" element for cathode ray beam deflection and high-voltage circuits which is simple in construction and relatively inexpensive to manufacture.

Other objects and advantages will be apparent from the following description of a preferred form of the invention and from the drawing, the single figure of which is a cathode ray beam deflection and high voltage circuit in accordance with the present invention.

Referring now to the drawings, there is illustrated a circuit for deflecting the electron beam which is developed within a cathode ray tube (not shown) at horizontal, or line-scanning, frequency. This circuit includes a horizontal power output tube 10 having at least an anode, a cathode, a control electrode, and a screen electrode. The power output tube 10 (such as a tube of the "807" type, for instance) is adapted to provide, when voltage variations which may be such as indicated in the drawing by the reference character 12 are applied to the control electrode thereof, a current output of substantially sawtooth configuration to a pair of horizontal deflection coils 14 connected effectively in shunt with a high-impedance choke, or autotransformer, 16.

The horizontal deflection coils 14, in combination with a pair of vertical, or field, deflection coils, preferably form part of a yoke assembly encircling the neck of the cathode ray tube (not shown) to the second anode of which an accelerating potential is supplied over the conductor 18.

Across the horizontal deflection coils 14 is connected the series combination of a damper tube 20 and a parallel resistance-condenser network 22, 24, the function of these elements being to damp out high-frequency oscillations which are produced in the deflection circuit following the retrace, or snap-back, portion of each deflection cycle.

In order that linear deflection may be produced, it is necessary that the rate of change of the current in the deflection coils 14 be maintained substantially constant during the deflection cycle.

The action of the damper tube 20 is such that the current flow therethrough supplements the plate current output of the power tube 10 to bring about a current flow through the horizontal deflection coils 14 which varies linearly with time.

The voltage variations applied to the control electrode of the damper tube 20, and the normal bias of this control electrode must, therefore, be so adjusted as to give the desired waveform to the anode current permitted to flow through the damper tube. The means for obtaining such a voltage variation includes a differentiating network comprising a condenser 25 and resistors 26, 28, and 30, the lower plate (in the drawing) of condenser 25 being connected to the anode of the damper tube 20. Bias for the control electrode of damper tube 20 is obtained by means of the grid current flow through the parallel resistor-condenser combination 30, 32, one end of resistor 30 being connected to the cathode of damper tube 20, as illustrated. Adjustment of resistor 28 varies the waveform of the voltage on the control electrode of the damper tube, and hence this element acts as a linearity control. Adjustment of rheostat 22 in shunt with capacitor 24 is a further control of linearity of beam deflection.

The anode of power output tube 10 is connected to a tap 34 on the choke 16. This tap 34 is also joined, by means of the conductor 36, to the upper end (in the drawing) of the horizontal deflection coils 14. The lower end of the horizontal deflection coils 14 is connected through blocking condenser 38 to the anode of the damper tube 20, and also to the low-impedance end of the choke 16 by means of the conductor 40. Thus, as far as alternating-current components in the deflection circuit are concerned, the lower portion of the choke coil 16 is effectively connected in parallel relation with the deflection coils 14, and also with the series combination of damper tube 20 and parallel resistance-condenser combination 22, 24.

In the arrangement illustrated, the cathode of the damper tube 20 (such, for instance, as a type 6AS7–G tube) is operated at high potential. Hence, in order to provide for proper operation of the system, the heater or filament of the damper tube 20 is supplied with energy through a filament isolating transformer 42 constructed with low capacitance between primary and secondary windings as well as high voltage insulation between windings. In cases where the damper tube 20 is designed with suitable insulating characteristics between its cathode and heater, however, the isolation transformer 42 may be omitted.

The upper portion of the choke 16 acts in effect as a transformer step-up winding, and is indicated in the drawing by the reference numeral 44. The upper, or high-impedance, end of this step-up winding 44 is connected to the anode of a high-voltage rectifier tube 46, which, by way of example, is a type 8016 tube. The filament of the rectifier tube 46 is connected to ground through the filter condenser 48, this filament being supplied with filament heating current from a filament winding 50 on the choke 16.

Since the anode of the power output tube 10 is directly connected by means including the conductor 36 to the high-impedance end of the horizontal or line deflection coils 14, it will be appreciated that the waveform of the anode voltage of power tube 10 will be maintained across the deflection coils. As above brought out, the damper tube 20 acts to suppress high-frequency

current oscillations which occur following retrace, the action of damper tube **20** being controlled in part by the action of the differentiating network **25, 26, 28**.

The winding **44** acts to step-up the voltage appearing on the anode of power output tube **10**, and thus permits rectifier tube **46** to build up a relatively steady D.-C. potential across the filter condenser **48**, the output of this filter condenser then being applied over the conductor **18** to the second anode of the cathode ray image producing tube. If desired, a voltage divider arrangement (not shown) may be used to obtain lower voltages for the other electrodes of the cathode ray tube, as well as for focussing purposes. Since there is very loose coupling between the high-impedance end of the step-up winding **44** and the remainder of the autotransformer **16**, the voltage on the upper end of winding **44** may have a waveform which is at variance with the waveform of the voltage appearing on the anode of the power tube **10**, this variance being due primarily to an oscillation, or "ringing," of winding **44**. However, if the filter capacitor **48** is of proper value, these fluctuations will not appreciably affect the regulation of the D.-C. output available from conductor **18**. Obviously, if further filtering is required, additional filter components of known character may be added to the system illustrated.

Centering of the cathode ray beam is achieved by the use of two resistors **52** and **54** connected in parallel relation as shown. The joined ends of these resistors **52** and **54** are respectively connected to two sources of positive potential, represented in the drawing as $+B_1$ and $+B_2$. In practice, the value of the source of potential $+B_2$ was chosen to be approximately 10 volts higher than the value of the source of potential $+B_1$, although obviously this difference depends in part upon the values of the remaining components of the circuit.

Resistor **52** is provided with an adjustable tap **56** which is connected to the anode of damper tube **20**. Resistor **54** is provided with an adjustable tap **58** which is connected to the low-impedance end of the horizontal deflection coils **14**. In other words, these two taps **56** and **58** are separated electrically by the blocking condenser **38**.

Taps **56** and **58** are intended to be ganged, as shown by the broken lines in the drawing, so that a movement, say, of tap **58** to the right (or toward a higher voltage value), will result in a corresponding movement of tap **56** to the left, or, in other words, toward a lower voltage value. The difference in voltage thus established between taps **56** and **58** causes current to flow from tap **58** through the horizontal deflection coils **14**, conductor **36**, the lower portion of choke **16**, partially through tube **20** when conducting, and conductor **40** to tap **56**, this current flow through the horizontal deflection coils **14** effecting a centering of the cathode ray beam in a known manner.

It should be noted that the screen electrode of power output tube **10** is connected to tap **56** through the conductor **40**, and thus is provided with a suitable operating potential from this source. The screen electrode of power output tube **10** may, however, be operated at a lower or adjustable potential.

The following tube types and component values have been found suitable in practice for obtaining the results stated herein. However, it is to be clearly understood that these tube types and component values are being given merely as examples, and that substitutions may be made therefor as found convenient or desirable:

Power output tube **10**=Type 6BG6G
Rectifier tube **46**=Type 1B3-GT/8016
Damper tube **20**=Type 6AS7-G
$+B_1$=350 volts
$+B_2$=360 volts
Resistors **52** and **54**=100 ohms each
Capacitor **38**=1 mf.
Resistor **22**=5000 ohms
Resistor **30**=100,000 ohms
Capacitor **32**=.02 mf.
Resistor **28**=250,000 ohms
Resistor **26**=50,000 ohms
Capacitor **25**=100 mf.
Capacitor **24**=4 mf.
Inductance of deflection coils **14**≧10 millihenries for single 6BG6G. (Proportionately lower inductance is desirable when additional 6BG6G are paralleled with the original output tube, or a single tube of higher plate current rating is substituted.)

Having thus described the invention, what is claimed is:

1. In a cathode ray beam deflection and high-voltage system: a pair of cathode ray beam deflection coils; a power output tube including at least an anode, a cathode, and a screen electrode; an autotransformer; means for connecting the anode of said power output tube to a point on said autotransformer winding intermediate the ends thereof, so that a portion of said autotransformer winding lies in the anode-cathode circuit of said power output tube; means for connecting one terminal of said pair of cathode ray beam deflection coils to the said intermediate point on said autotransformer winding; a source of anode potential for the said power output tube connected to the remaining terminal of said pair of cathode ray beam deflection coils; and a source of screen potential for the said power output tube connected both to the said screen electrode and to that end of the said autotransformer winding which lies in the said power output tube anode-cathode circuit, said source of anode potential being of a different value than said source of screen potential, whereby a centering current for the said cathode ray beam representative of the difference between the values of the said two sources of power output tube potential will flow through the said cathode ray beam deflection coils and also through that portion of the said autotransformer winding which lies in the anode-cathode circuit of said power output tube.

2. In a cathode ray beam deflection and high-voltage system: a pair of cathode ray beam deflection coils; a power output tube including at least an anode, a cathode, and a screen electrode; an autotransformer; means for connecting the anode of said power output tube to a point on said autotransformer winding intermediate the ends thereof, so that a portion of said autotransformer winding lies in the anode-cathode circuit of said power output tube; means for connecting one terminal of said pair of cathode ray beam deflection coils to the said intermediate point on said autotransformer winding; a source of anode potential for the said power output tube connected to the remaining terminal of said pair of cathode ray beam deflection coils; a source of screen potential for the said power output tube connected both to the said screen electrode and to that end of the said autotransformer winding

which lies in the said power output tube anode-cathode circuit, said source of anode potential being of a different value than said source of screen potential, whereby a centering current for the said cathode ray beam representative of the difference between the values of the said two sources of power output tube potential will flow through the said cathode ray beam deflection coils and also through that portion of the said autotransformer winding which lies in the anode-cathode circuit of the said power output tube; and means for rectifying and filtering the voltage developed across the entire winding of said autotransformer so as to obtain therefrom a substantially smooth cathode ray beam accelerating potential.

3. A cathode ray beam deflection and high-voltage system according to claim 2, in which said rectifying and filtering means includes an electron discharge device having a heater element, an auxiliary winding on said autotransformer, and means connecting said heater element to said auxiliary winding.

4. In a cathode ray beam deflection circuit, a power output tube including at least an anode and a cathode and adapted to deliver a cyclically varying current output, an autotransformer having a portion of its winding connected in the anode-cathode circuit of said power output tube, a pair of cathode ray beam deflection coils connected effectively in shunt with the said portion of said autotransformer winding, a source of anode potential for the said power output tube connected in series with said pair of cathode ray beam deflection coils and means including a rectifier for deriving a direct voltage from the entire winding of said auto-transformer.

5. A cathode ray beam deflection circuit in accordance with claim 4, and wherein said rectifier has an anode electrode and a cathode electrode, one of said electrodes connected to the opposite

end of said autotransformer winding from that included in the anode-cathode circuit of said power output tube and a direct voltage output terminal connected to the other of said electrodes.

6. In a cathode ray beam deflection circuit, a power tube having at least an anode, a cathode and a screen electrode, and adapted to deliver a cyclically varying current output, an autotransformer having a portion of its winding connected in the anode-cathode circuit of said power tube, a pair of cathode ray beam deflection coils connected effectively in shunt with the said portion of said autotransformer winding, a source of anode potential for said power tube connected in series with said pair of cathode ray beam deflection coils, and a source of screen potential for said power tube connected both of said screen electrode and to that end of the said autotransformer winding lying in the said power tube anode-cathode circuit.

7. A cathode ray beam deflection circuit in accordance with claim 6, in which said source of anode potential is of a different value than said source of screen potential, whereby a substantially constant current representative of the difference in value of said potential sources will flow through said pair of cathode ray beam deflection coils.

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