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HIGH-VOLTAGE GENERATOR

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9 Claims. (Cl. 315—19)

1

This invention relates to cathode ray sweep circuits and more particularly to improvements in combined circuits providing beam deflection means as well as a high unidirectional voltage power supply of the general type now used in the television art.

Deflection circuits for cathode ray tubes generally fall into two classes, namely electrostatic and electromagnetic. It has been the tendency of modern television receiver design to employ the electromagnetic type of deflection since this system offers advantages in obtaining higher definition pictures due to the attainment of better dynamic beam focus and makes possible greater deflection system efficiencies when accelerating potentials in excess of approximately 6000 volts are employed for cathode ray beam acceleration.

For high voltage generation it has been found convenient to include, in electromagnetic type deflection circuits, an output transformer having an impulse step-up winding on its core which increases the effective magnitude of the high voltage transients produced by the retrace phase of the sawtooth deflection cycle. These transient pulses are then rectified and filtered to provide a high unidirectional potential for application to the accelerating anode of the associated cathode ray tube. The combination deflection circuit and high voltage supply derived in this fashion provides a definite step toward the economizing and size reduction of the television receiver. However, the stringent requirements upon horizontal output transformer performance needed for operation at sweep frequencies of 15,750 C. P. S. demanded a type of construction which was inherently expensive. Even at best the present type of output transformer designed for linking the output tube to the deflection yoke imposes certain losses which establish a limit to the efficiency realizable in such a deflection circuit. A method for increasing the efficiency and lowering the cost of electromagnetic deflection circuits used for cathode ray tube beam deflection is disclosed, for example, in the U. S. Patent No. 2,482,737 by Hubert R. Shaw, issued September 20, 1949. The increased efficiency and cost reduction made possible by the Shaw (supra) deflection system resides in the elimination of the conventional output transformer employed to match the output vacuum tube to the electromagnetic deflection yoke winding, by substituting a direct connection from the output tube to the deflection yoke. Efficiency of operation in the accomplishment of the ends proposed in the Shaw system is obtained by the

2

provision of a low impedance driving source for the output tube. However, elimination of the horizontal output transformer dispenses with the very device with which is frequently associated the auto-transformer pulse step-up winding used to derive a high potential power supply for the cathode ray tube.

It is therefore a purpose of this invention to provide an improved combination deflection circuit and power supply which eliminates the need for an output transformer in horizontal deflection systems and yet provides a high unidirectional potential for cathode ray tube operation.

It is further an object of this invention to provide an efficient means for reducing the source impedance of a deflection signal as used in an electromagnetic deflection system having the output tube directly connected to the deflection yoke, wherein said impedance changing means is also employed to derive a high unidirectional potential.

It is still another object of this invention to provide a combination deflection circuit and high unidirectional potential power supply for cathode ray tube operation wherein the output tube for the deflection system is directly connected to the electromagnetic deflection yoke, said high voltage being derived from the deflection signal at a point prior to the yoke circuit so as to eliminate necessarily costly construction of electromagnetic impedance matching devices heretofore employed to match the output tube to the yoke circuit and also provide a source of high transient potential for rectification in deriving said high potential.

It is finally a purpose of this invention to provide a combination high voltage power supply and deflection circuit for cathode ray tube operation wherein the magnitude of the high voltage generated, although dependent upon the amplitude and waveform of the deflection signal applied to excite the combination circuit, is substantially independent of loading imposed upon the deflection signal output circuit.

Other features and advantages will be apparent from the following description of the invention when considered in connection with the accompanying drawing wherein:

Fig. 1 represents an embodiment of the present invention.

In the drawing reference character 10 indicates a vacuum tube having applied to its control grid 12 a series of synchronizing pulses 14, which establish the repetition rate of the sawtooth deflection signal generated for the deflection sys-

tem. The vacuum tube 10 and its associated circuit is operated as a conventional condenser charge and discharge type of sawtooth generator having sawtooth condenser 16 connected to its plate electrode 18, the other terminal of sawtooth condenser 16 being connected to ground through variable peaking resistor 20. According to the well established operation of such a sawtooth waveform generator, condenser 16 is allowed to linearly charge from potential source 22 through charging resistor 24, the rate and linearity of charge being adjustable by the value of resistance 24. After condenser 16 has obtained a suitable degree of charge, a synchronizing pulse 14 causes the control grid 12 of the vacuum 10 to swing sufficiently positive to establish a heavily conducting condition in the vacuum tube 10 thereby presenting a low impedance path between the plate 10 and ground through the vacuum tube. This operates to discharge condenser 16 and provides the retrace portion of the sawtooth deflection cycle. The sawtooth waveform so generated may be given a peaking component which is a function of the value of variable resistor 20 placed in series with sawtooth condenser 16 and ground. The generated sawtooth waveform (with peaking component) is represented by curve 47.

The sawtooth voltage appearing across condenser 16 and ground is coupled to control grid 26 of vacuum tube 28 through coupling condenser 30. Control grid 26 of vacuum tube 28 is supplied with a suitable bias potential through resistor 31 by adjustable potentiometer 32 connected across bias supply 34. Vacuum tube 28 is connected to operate as a cathode-follower type of amplifier by placing cathode follower resistor 36 in series with the connection of cathode 38 to the bias supply or negative terminal 34 of a source of potential. As explained in more detail in the above referenced application, this connection effectively transforms the high impedance source of deflection signal obtained by connection to sawtooth condenser 16 to a low impedance source of deflection signal now appearing across cathode-follower load resistor 36. The reduction in impedance by this method is well known to the art and consequently demands no further specific description.

Vacuum tube 28 is preferably of the screen grid type of electron tube and has its screen 39 supplied with a suitable operating potential through variable resistance 40, which is in turn connected to a positive source of potential at terminal 42. In order to stabilize the voltage appearing on the screen grid 39, a by-pass condenser 44 to ground is conventionally provided. The plate 46 of the cathode follower tube 28 is connected to the primary winding 48 of an auto-transformer 50. The secondary winding 52 of the auto-transformer 50 is in turn connected to plate 54 of vacuum tube 56 having its cathode 58 connected with the accelerating anode 60 of cathode ray tube 62. The pulsating D. C. voltage appearing at the cathode 58 is adequately filtered by input capacitor 64, filter resistor 66 and the stray capacitance (not shown) between accelerating electrode 60 and ground.

The deflection signal 68 appearing across the cathode follower resistor 36 is applied to the control grid 70 of output vacuum tube 72. An electromagnetic deflection yoke 74 is connected in series with the plate 76 of vacuum tube 72 and its source of D. C. plate potential 78. A reaction scanning damping circuit comprising vacuum

tube 80 and storage circuit 82 is connected across the deflection yoke winding to recover some of the stored magnetic energy in the winding at the beginning of the retrace phase of the deflection cycle. A D. C. potential for screen grid 84 of output vacuum tube 72 is supplied through dropping resistor 86 and is stabilized through bypass condenser 88.

In the operation of the above circuit the low impedance source of deflection signal appearing across cathode resistor 36 of vacuum tube 28 serves to provide a source of deflection signal capable of driving the control grid 70 of vacuum tube 72 well into grid conducting regions and therefore renders tube 72 capable of providing high peak plate currents through the deflection yoke 74 in the output circuit of the vacuum tube. The reaction scanning circuit associated with the vacuum tube 80 and storage circuit 82 are disposed to supply the first part of the deflection cycle through the deflection yoke 72 in accord with well known principles of magnetic energy recovery in deflection systems described, for example, in an article entitled "Current oscillators for television sweep circuits" by G. C. Sziklai appearing in the periodical *Electronics*, vol. 19, September 1946, pp. 120-123. Through adjustment of potentiometer 32 which establishes the value of operating bias on control grid 26 of vacuum tube 28 and which determines the average current permitted to flow through resistance 36, the effective bias of tube 72 may be regulated to permit its plate current conduction for that portion of the deflection cycle not provided by the action of the reaction scanning circuit. As heretofore stated, the advantages of the low impedance driving of output tube 72 in conjunction with the direct connection of deflection yoke 74 to the output circuit is more fully described, for example, in the U. S. patent application of Shaw referred to above.

It is preferable, although not necessary, that the impedance changing cathode follower vacuum tube 28 be a multigrid electron tube, therefore having its operating characteristics, as far as cathode follower operation is concerned, primarily established by the potential applied to screen grid 39. This driver tube 28 may also be a pentode or a multiplier type tube in order to provide a cathode current which may be made quite independent of plate circuit conditions. When the peaking component of the sawtooth voltage appears on the control grid 26 of vacuum tube 28 (at the beginning of the retrace interval) the transformer in the plate circuit of vacuum tube 28 will undergo one or more cycles of free oscillations (ring) due to the sudden increase in impedance or blocking of tube 28. This action will set up high peak voltages across the series primary and secondary windings of auto-transformer 50, which the high voltage rectifier 56 will subsequently rectify to produce a high D. C. potential across its cathode 58 and ground. This high D. C. potential may be in the order of several thousand volts or more and may be suitable (after filtering) for application to the cathode ray tube accelerating anode 60.

In one experimental set-up using a one-eighth inch square open ferrite core transformer with 100 primary turns and 2000 secondary turns and driven by a commercial power type pentode (6F6) operating from a low voltage power supply potential (at terminals 42 and 78) in the order of 300 volts, a high voltage of 12 kv. was

5

available for accelerating anode 60 while approximately 60 volts peak-to-peak sawtooth drive was provided for the output amplifier 72 at a driving impedance of 300 ohms. It is, therefore, apparent that for television and like applications the present invention affords a convenient, effective and economical arrangement for generating high potentials for cathode ray beam acceleration.

What is claimed is:

1. A combination electronic deflection system and high voltage power supply including a first vacuum tube producing a deflectable electron beam therein, a high impedance source of deflection signal, a second vacuum tube having an anode, means including said second vacuum tube adapted to convert said high impedance source of deflection signal to a low impedance source of deflection signal, an electromagnetic voltage step-up device included in the anode circuit of said second vacuum tube, said voltage step-up device being operative to produce high voltage transients when under the influence of said deflection signal, a third vacuum tube having at least a cathode and an anode, means including said third vacuum tube disposed to accept high voltage transients produced by said voltage step-up device and convert said transients to a source of D. C. potential adaptable for connective operation of said first vacuum tube, excitable means for deflecting said electron stream within said first vacuum tube, a fourth vacuum tube for exciting said electron stream deflecting means, said tube having a control grid adapted for excitation from said low impedance source.

2. In a cathode ray deflection system, a cathode ray tube having excitable means associated therewith for deflecting an accelerated electron beam adapted to be produced therein, vacuum tube means for exciting said electron beam deflection means, said vacuum tube means requiring a low impedance source of driving signal energy for optimum deflection of said electron beam, a second vacuum tube means providing a low impedance source of signal energy, means for connecting said low impedance source for driving said first mentioned vacuum tube means, and means included in said second vacuum tube means for converting a portion of said signal energy to a source of high D. C. potential suitable for the acceleration of said electron beam in said cathode ray tube.

3. In a cathode ray tube deflection system a cathode ray type electronic discharge tube having an anode, a high impedance source of deflection signal, a first vacuum tube having at least a cathode, an anode and a control grid, means connecting said high impedance source of deflection signal to said control grid, an auto-transformer having a portion thereof included in the anode circuit of said vacuum tube, an impedance included in the cathode circuit of said vacuum tube for driving a low impedance source of deflection signal from said high impedance source of deflection signal, a second vacuum tube having at least an anode and a cathode having said anode connected to said auto-transformer, and having said cathode connected with said anode of said cathode ray tube, a third vacuum tube having at least a control grid and an output electrode, means connecting said third tube control grid with said cathode impedance of said first vacuum tube, and deflection means for said cathode ray tube, said deflection means being coupled to the output electrode of said third

6

vacuum tube so as to provide deflection energy to said deflection means.

4. In a cathode ray tube deflection system a cathode ray electronic discharge tube having an anode, a high impedance source of deflection signal, a first vacuum tube having at least a cathode, an anode, and a control grid, means connecting said high impedance source of deflection signal to said control grid, an auto-transformer having a portion thereof included in the anode circuit of said vacuum tube, an impedance included in the cathode circuit of said vacuum tube for deriving a low impedance source of deflection signal from said high impedance source of deflection signal, a second vacuum tube having at least an anode and a cathode having said anode connected to said auto-transformer, and having said cathode connected with said anode of said cathode ray tube, a third vacuum tube having at least an anode, and a control grid, said third tube control grid being connected with said cathode impedance of said first vacuum tube to receive a low impedance deflection driving signal therefrom of sufficient amplitude to cause operation of said third tube control grid well into grid current regions, deflection means for said cathode ray tube and means coupling said deflection means with said third tube anode to receive excitation therefrom in accordance with said deflection signal appearing on said third tube control grid.

5. In a television apparatus or the like a cathode ray electron discharge device having an anode, means excitable for deflecting an electron beam produced within said discharge device, a primary source of deflection signal, a first vacuum tube having a cathode, an anode and a control electrode, means connecting said signal source to said control electrode, an impedance included in the cathode circuit of said tube, said impedance providing a source of deflection signal having a lower impedance than said primary source, an auto-transformer having its primary winding included in the anode circuit of said vacuum tube, said auto-transformer being adapted to produce high voltage impulses as a result of anode current variations caused by said deflection signal influence, a second vacuum tube having an anode and a cathode, means connecting the secondary winding of said auto-transformer to said second vacuum tube anode, means connecting said second vacuum tube cathode to said cathode ray electron discharge device anode, whereby unidirectional potential is applied to said last named anode, a third vacuum tube having an anode and a control electrode, means for connecting said electron beam deflecting means to the anode circuit of said third vacuum tube and means connecting said third vacuum tube control electrode to said impedance element in order to afford a greater magnitude of electron beam deflection in accordance with said deflection signal than would obtain if said last named controlled electrode were connected with said primary deflection signal.

6. In a television apparatus or the like a cathode ray electron discharge device having an anode, an electromagnetic yoke for said discharge device having a deflection winding adapted to cause electron beam deflection upon excitation of said winding, a primary source of deflection signal, a first vacuum tube having a cathode, an anode and a control electrode, means connecting said signal source to said control electrode, an impedance element included in the cathode circuit of said tube, said impedance providing a

7

source of deflection signal having a lower impedance than said primary source, an auto-transformer having its primary winding included in the anode circuit of said vacuum tube, said auto-transformer being adapted to produce high voltage impulses as a result of anode current variations caused by said deflection signal influence, a second vacuum tube having an anode and a cathode, means connecting the secondary winding of said auto-transformer to said second vacuum tube anode, means connecting said second vacuum tube cathode to said cathode ray electron discharge device anode, whereby unidirectional potential is applied to said last named anode, a third vacuum tube having an anode and a control electrode, means connecting said yoke winding between said anode of said third tube and a source of energy for said anode circuit whereby said deflection yoke will effect beam deflection in accordance with anode current variations, and means connecting said third vacuum tube control electrode to said impedance element in order to afford a greater magnitude of electron beam deflection in accordance with said deflection signal than would obtain if said last named controlled electrode were connected with said primary deflection signal.

7. In a television apparatus or the like a cathode ray electron discharge device having an anode, means excitable for deflecting an electron beam adapted to be produced within said discharge device, a primary source of deflection signal, a first vacuum tube having a cathode, an anode and a control electrode, means connecting said signal source to said control electrode, an impedance element included in the cathode circuit of said tube, said impedance element providing a source of deflection signal having a lower impedance than said primary source, a voltage step-up device adapted to be energized from said first tube anode circuit, a second vacuum tube having an anode and a cathode, means applying the output voltage of said voltage step-up device to said second tube anode, means connecting said second vacuum tube cathode to said cathode ray electron discharge device anode, whereby unidirectional potential is applied to said last named anode, a third vacuum tube having an anode and a control electrode, means for coupling said electron beam deflecting means to the anode circuit of said third vacuum tube and means connecting said third vacuum tube control electrode to said impedance element for excitation thereby.

8. In a television apparatus or the like a cath-

8

ode ray electron discharge device having an anode, means excitable for deflecting an electron beam produced within said discharge device, a primary source of deflection signal, a first vacuum tube having a cathode, an anode and a control electrode, means connecting said signal source to said control electrode, an impedance included in the cathode circuit of said tube, said impedance providing a source of deflection signal having a lower impedance than said primary source, an auto-transformer having its primary winding included in the anode circuit of said vacuum tube, said auto-transformer being adapted to produce high voltage impulses as a result of anode current variations caused by said deflection signal influence, means for converting an A. C. voltage to a unidirectional source of potential, said means having an input and an output, means connecting the secondary winding of said auto-transformer to the input of said last named means, means connecting said output of said unidirectional source of potential to said cathode ray discharge device, a second vacuum tube having an anode and a control electrode, means for connecting said electron beam deflecting means to the anode circuit of said second vacuum tube and means connecting said second vacuum tube control electrode to said impedance element.

9. In a television apparatus or the like a cathode ray electron discharge device, means excitable for deflecting an electron beam produced within said discharge device, a primary source of deflection signal, a first vacuum tube having a cathode, an anode and a control electrode, means connecting said signal source to said control electrode, an impedance included in the cathode circuit of said tube, said impedance providing a source of deflection signal having a low impedance, a voltage step-up device adapted to be actuated from said first tube anode circuit, means for converting an A. C. voltage to a unidirectional potential, said means having an input and an output, means applying the output voltage of said voltage step-up device to the input of said last named means, means for connecting said output of said unidirectional source of potential to said cathode ray discharge device, and means including a second vacuum tube responsive to the low impedance source of deflection signal for energizing the electron beam deflecting means.

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No references cited.