

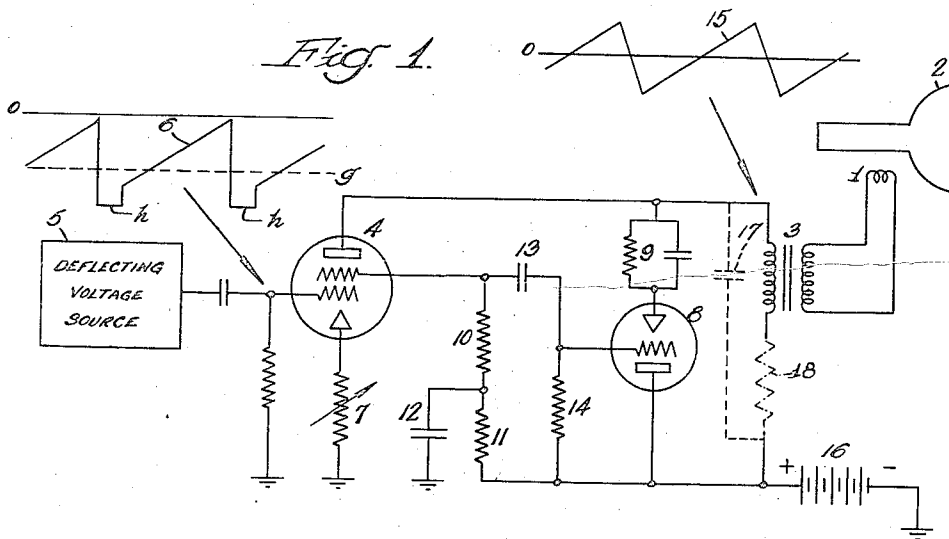
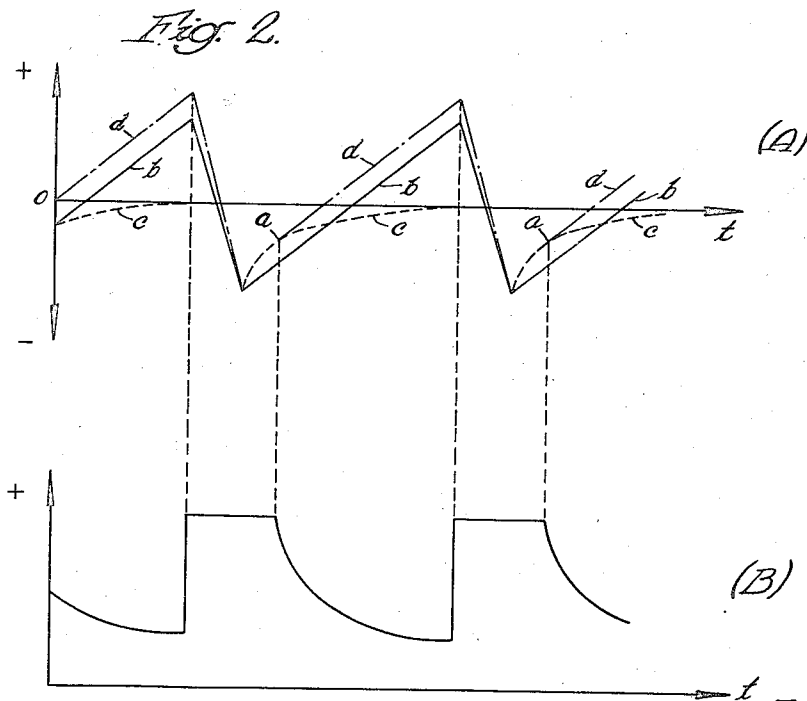
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DEFLECTING OUTPUT CIRCUITS FOR CATHODE RAY TUBES

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DEFLECTING OUTPUT CIRCUITS FOR
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This invention relates to electron beam deflecting systems for use with cathode ray tubes and is particularly adapted for use in cathode ray television systems. More specifically the invention is directed to an improved magnetic deflecting output system which is principally characterized by greater linearity of deflection and higher efficiency than are obtainable with prior systems of the same class.

As is well known in the television art, it is customary to scan the picture to be transmitted in a series of vertically spaced substantially horizontal lines. In many of the well known devices used both in generating the video signal and in reconstituting the picture therefrom, this entails the deflection of a beam of electrons from a thermionic or other suitable source in such a manner that the trace of the beam on a plane perpendicular to the axis of the undeflected beam is a spot which moves with substantially uniform velocity in a rectilinear path. The quality of the reproduced television picture is directly dependent upon the uniformity of the velocity of this spot.

One method of deflecting the electron beam is by means of a varying magnetic field set up in the vicinity of a plurality of coils located in the region of the normal and unmodified path of the beam. In order that the beam may be deflected in the desired manner, it is generally required that the current in the deflecting coils should change at a substantially constant rate during the greater part of each scanning cycle and that it should suddenly be returned to a predetermined value within a time relatively small by comparison with the duration of the scan.

The present invention is particularly applicable to a deflecting system of the type employing a driver tube for controlling, in response to a voltage wave of predetermined shape, the flow of energy from a D. C. source into the deflecting coil, and in which the coil has distributed capacity and is permitted to oscillate freely at its natural frequency, which is much higher than the scanning frequency, in order to effect a reversal of the coil current. There is also provided an inverted space discharge device, which may be a triode, connected in shunt with the coil and adapted to absorb energy from the coil during part of each scanning cycle. The inverted space discharge device is controlled by means of a suitably formed control voltage wave. In operation, energy is supplied from the D. C. source to the coil during only a part of each cycle and the

energy thus stored in the field about the coil is absorbed by the inverted space discharge device during another part of the scanning cycle. Thus a sort of "class B" operation obtains which is accompanied by an increase in efficiency of the system. In prior systems of this type difficulty was experienced in obtaining a sufficiently linear current in the deflecting coil for satisfactory scanning.

The present invention has, as its broad object, to provide means for remedying this difficulty. More specifically, the invention contemplates deriving a voltage from the screen grid circuit of the driver tube by means of which power is supplied to the deflecting coil and applying this voltage to control the inverted triode. This has been found to give the desired waveform in the deflecting coil.

Accordingly, by the invention, there is provided in a cathode ray tube beam deflecting system, in which a magnetic field is periodically varied so as to deflect a beam of electrons, an output circuit comprising a coil having some distributed shunt capacity and some series resistance and adapted to produce a varying magnetic field in response to energy supplied thereto, a space discharge device having at least an anode, a cathode, a control grid, and a screen grid for controllably supplying energy to said coil, a second space discharge device having at least an anode, a cathode, and a control grid, and having its anode and its cathode connected to opposite terminals of said coil, a load impedance in the screen grid circuit of said first-mentioned space discharge device, means for applying the voltage developed across said load impedance to the grid of said second space discharge device, and means coupled to the control grid of said first space discharge device for supplying thereto a signal of such a nature as to cause said space discharge device periodically to supply energy to said output circuit. The detailed operation of one embodiment of the invention may most conveniently be explained by reference to the accompanying drawing wherein:

Fig. 1 is a circuit diagram of an embodiment of the invention, and

Fig. 2 illustrates current and voltage waveforms in various parts of the circuit of Fig. 1.

In Fig. 1, a deflecting coil 1 is associated with a cathode ray tube 2 and is coupled by means of a transformer 3 to the output circuit of a screen grid space discharge device 4. A suitable voltage 6 is supplied from any convenient source 5 to the grid of the space discharge device 4 to control the

supply of energy to the deflecting system output circuit which includes the deflecting coil 1. In the embodiment shown, a variable resistor 7 is included in the cathode circuit of the space discharge 4 for controlling, by virtue of its degenerative action, the amplitude of the current in the deflecting coil. The triode space discharge device 8 has its anode and cathode connected to opposite terminals of the primary of the transformer 3, the inherent resistance and distributed capacity of which are represented by the resistor 18 and the condenser 17. A resistor-condenser biasing combination 9 is included in the cathode connection. The screen circuit of the tube 4 may include the load resistor 10 and filter comprising the resistor 11 and the condenser 12. The voltage developed across the load resistor 10 is supplied through a coupling condenser 13 to a resistor 14 connected between the grid and anode of the tube 8 to control its resistance. The sawtooth voltage 15 is formed by the aforementioned elements acting in combination.

The general operation of this circuit is, in some respects, similar to that of the prior art circuit hereinbefore discussed. Considering this operation briefly with reference to the circuit shown in Fig. 1, the driver tube 4, by reason of the waveform of the voltage 6 applied to its grid, permits energy to flow from the D. C. source 16 into the primary coil of the transformer 3 only during the latter portion of each scanning cycle when the voltage 6 exceeds the cut-off level *g* of the tube. The negative peaks *h* of the wave 6 are to insure cut-off of the tube during the part of the scanning cycle when the primary coil of the transformer 3 with its distributed shunt capacity 17 is oscillating freely so as to create a large positive voltage on the plate of the tube 4. The inverted triode 8 connected in shunt with the primary coil of the transformer 3 acts, following this cut-off period during which the current in the coil is reversed, to control the dissipation in its own internal resistance of the energy stored in the coil during the time that the tube 4 is conducting.

Theoretical considerations indicate that in order to obtain a strictly linear current in the deflecting coil, it would be necessary to increase the effective resistance provided by the tube 8 continuously from the start of the scan. However, once the current in the deflecting coil has been reduced to zero, it is necessary to supply power to the output circuit from the driver tube 4. Hence, the more rapidly the voltage on the grid of the tube 8 is decreased the sooner it becomes necessary to supply power to the output circuit from the tube 4. By delaying the reduction in voltage on the grid of tube 8 until some later time in the scan, the efficiency of the system may be improved and, as a result, the linearity of the output current in the early part of the scan will suffer only slightly. A certain amount of non-linearity is usually tolerable so that, for the sake of increased efficiency, it may be desirable to so delay the reduction in the voltage applied to the grid of tube 8. This is very readily done in the embodiment of Fig. 1 where the screen voltage plotted against time *t*, may be substantially of the form shown in Fig. 2B. It will be noted that the screen voltage remains substantially constant while the driver tube is cut-off, beginning to fall only when the driver begins to conduct.

The nature and extent of the distortion in the output current wave as well as the manner of compensating therefor by the method of the in-

vention will more readily be understood by reference to Fig. 2A. In this figure the solid line *b* denotes the ideal sawtooth current wave form to which it is desired that the current in the output circuit of the tube 8 and also that in the deflecting coil 1 should conform as nearly as possible. As aforementioned the effect of resistance, a certain amount of which must unavoidably be present in the output circuit, is to cause the current in the output circuit to decay exponentially as represented by the dotted line *c* in Fig. 2A so that the said current wave form departs considerably from the ideal sawtooth represented by the line *b*. Although it is theoretically possible to cause the output current wave-form to conform to that represented by the line *b* by increasing the output circuit resistance progressively throughout the scan, as above mentioned, it has been found impractical to do so because of the great reduction in the efficiency of the system which results.

It will be noted from Fig. 2A that the departure of the output current from the ideal represented by the line *b* is not as great during the early part of the scan as during the latter part thereof. Hence it is proposed, in accordance with the invention to delay increasing the output circuit resistance until the time in the scan when the departure of the output current from the ideal becomes sufficient to be objectionable. The means provided in the circuit of Fig. 1 for increasing the output circuit resistance is the tube 8, the internal resistance of which increases as the potential of its grid decreases with respect to the potential of its cathode. In accordance with the invention, it is desired to supply to the grid of the tube 8 a voltage which, during the first part of the scan, is positive with respect to the voltages of the cathode and substantially constant in magnitude but which, during the latter part of the scan, becomes gradually less positive. When such a voltage is applied to the grid of the tube 8, the internal resistance of the latter will, at first, continue rather low in value until such time as the voltage of the grid begins to decrease, at which time the internal resistance will gradually rise. The result of so controlling the resistance of the output circuit is to modify the output circuit current so that, during the latter half of the scan, it changes in the manner indicated by the line *d* in Fig. 2A. Thus it will be seen that during the first part of the scan the current in the output circuit decays exponentially along the curve *c*. Then at some point *a*, at which the resistance of the tube 8 begins to increase, the current departs from the exponential curve *c* and follows the line *d*. As a result the current is much more nearly of sawtooth waveform than it would otherwise be.

It has been found that a voltage of suitable waveform for controlling the resistance of the tube 8 in Fig. 1 may be obtained from a load impedance connected in the screen grid circuit of the tube 4 which supplies power to the output circuit. In the embodiment of Fig. 1 this load impedance takes the form of the resistor 10. Further in accordance with the invention the tube 4 may be controlled by a voltage of suitable wave form, as shown at 6 consisting of a combination of sawtooth and impulse components, so that more current flows in the plate circuit thereof during the latter part of the scan than at its beginning. Such a voltage will necessarily be one which increases throughout the scan as shown at 6. It is a significant feature of the invention that when the tube 4 is thus controlled to cause its plate current to increase throughout the scan, the

current in the screen grid will increase in like manner. This will be accompanied by a decrease in the screen grid potential. Thus, as current, the voltage applied to the grid of the tube 8 is automatically reduced, thereby reducing the current flowing in the plate circuit of the tube 8. These two effects cooperate to yield linearity of output current waveform.

It will be apparent to those skilled in the art that the magnitudes of the various circuit elements, and in particular the magnitude of the load impedance in the screen grid circuit of the tube 4, may be varied in order to obtain the desired results in respect of linearity of the output circuit current waveform in any specific instance. The proper value of the resistor 10, for example, in the embodiment of Fig. 1 may best be determined by adjusting it until substantially linear scanning obtains as evidenced by the appearance of the image produced upon the luminescent screen of the cathode ray tube 2. Furthermore the exact form of the voltage wave 6 which should be applied to the grid of the tube 4 may be determined in like manner and such voltage wave may be obtained from any suitable circuit, many forms of which are well known in the art, for producing such voltage waves. Hence it will be understood that the following values of the circuit elements used in the embodiment of Fig. 1 are merely exemplary and not intended to restrict the scope of the invention which is not limited to this specific embodiment but is capable of physical expression in other specific forms which will occur to those reading this specification:

Tube 4=type 6L6

Tube 8=type 6V6

Resistor 10=15,000 ohms

Resistor 11=10,000 ohms

Condenser 12=.5 microfarad

Condenser 13=.01 microfarad

Resistor 14=220,000 ohms

Resistor in biasing combination 9=2200 ohms

Condenser in biasing combination 9=.1 microfarad

Voltage of plate and screen supply battery 16=330 volts.

I claim:

1. In a cathode ray tube beam deflecting system in which a magnetic field is periodically varied so as to deflect a beam of electrons, an output circuit including a coil having some distributed shunt capacity and some series resistance, and means for producing in said coil a periodically recurrent wave of substantially sawtooth waveform consisting of alternately occurring portions of respectively steep and gradual slope, said means comprising a first series circuit including said coil, a second series circuit including said coil, means connected in said first series circuit for periodically supplying energy to said coil only during the latter portion of each of said portions of gradual slope of said sawtooth current wave, and means responsive to the loop current flowing in said first series circuit for increasing the effective resistance of said second series circuit during the time that energy is supplied to said coil.

2. In a cathode ray tube beam deflecting system in which a magnetic field is periodically varied so as to deflect a beam of electrons, an output circuit including a coil having some distributed shunt capacity and some series resistance, and means for producing in said coil a

periodically recurrent current wave of substantially sawtooth waveform consisting of alternately occurring portions of respectively steep and gradual slope; said means comprising a first series circuit including said coil, a source of electrical energy and a space discharge device having at least an anode, a cathode, and a control grid; means for applying to the grid of said space discharge device a periodically recurrent voltage wave form adapted to render said space discharge device non-conducting during the first part of each of said portions of gradual slope of said sawtooth current wave and to render said space discharge device increasingly more conducting during the latter part of each of said portions of gradual slope; a second series circuit including said coil; and means comprising a unilateral conducting device included in said second series circuit and responsive to the loop current in said first series circuit for increasing the effective resistance of said second series circuit during the time that said space discharge device is conducting, said unilateral conducting device being connected so as to prevent current flow in said second series circuit in the same sense as the current flow in said first series circuit.

3. In a cathode ray tube beam deflecting system, a coil having some distributed shunt capacity and some series resistance, a first circuit including said coil and a source of direct current electrical energy, means included in said first circuit for periodically effectively disconnecting said coil from said energy source, a second series circuit including said coil, and means included in said second circuit and responsive to the loop current flowing in said first circuit for progressively increasing the effective resistance of said second circuit during the time said coil is effectively connected to said energy source, and for reducing said effective resistance to and for maintaining said effective resistance at a substantially constant value during the time said coil is effectively disconnected from said source.

4. In a cathode ray tube beam deflecting system, a space discharge device having at least an anode, a cathode, a control grid, and an additional electrode disposed between said cathode and said anode, a coil having some inherent series resistance and shunt capacity, a source of electrical energy, both said coil and said source being connected in the anode-cathode circuit of said space discharge device, means for applying a controlling signal of predetermined form to the grid of said space discharge device, a second space discharge device having at least an anode, a cathode, and a control grid, and having its anode and cathode connected to opposite terminals of said coil, means for deriving a signal from the additional electrode of said first space discharge device, and means for applying said last-named signal to the grid of said second space discharge device.

5. In a cathode ray tube beam deflecting system, a space discharge device having at least an anode, a cathode, a control grid, and a screen grid, a coil having some inherent series resistance and shunt capacity, a source of electrical energy, both said coil and said source being connected in the anode-cathode circuit of said space discharge device, means for applying a controlling signal of predetermined form to the grid of said space discharge device, a second space discharge device having at least an anode, a cathode, and a control grid, and having its anode and cathode connected to opposite terminals of said coil, means for deriving a signal from the screen grid of said

first space discharge device, and means for applying said last-named signal to the grid of said second space discharge device.

6. In a cathode ray tube beam deflecting system, a space discharge device having at least an anode, a cathode, a control grid, and an additional electrode disposed between said cathode and said anode, a coil having some inherent series resistance and shunt capacity, a source of electrical energy, both said coil and said source being connected in the anode-cathode circuit of said space discharge device, means for applying a controlling signal of predetermined form to the grid of said space discharge device, a second space discharge device having at least an anode, a cathode, and a control grid, and having its anode and cathode connected to opposite terminals of said coil, the cathode of said second space discharge device being connected to the same terminal of said coil as the anode of said first space discharge device, means for deriving a signal from the additional electrode of said first space discharge device, and means for applying said last-named signal to the grid of said second space discharge device.

7. In a cathode ray tube beam deflecting system, a space discharge device having at least an anode, a cathode, a control grid, and an additional electrode disposed between said cathode and said anode, a coil having some inherent series resistance and shunt capacity, a source of electrical energy, both said coil and said source being connected in the anode-cathode circuit of said space discharge device, means for applying to the grid of said space discharge device a controlling signal comprising saw-tooth and impulse components, a second space discharge device having at least an anode, a cathode, and a control grid, and having its anode and cathode connected to opposite terminals of said coil, means for deriving a signal from the additional electrode of said first space discharge device, and means for applying said last-named signal to the grid of said second space discharge device.

8. In a cathode ray tube beam deflecting system, a space discharge device having at least an anode, a cathode, a control grid, and an additional electrode disposed between said cathode and said anode, a transformer having some inherent series resistance and shunt capacity associated with its primary winding, the primary winding of said transformer being connected in the anode-cathode circuit of said space discharge device, means connected to the secondary winding of said transformer for effecting deflection of a cathode ray beam, a source of electrical energy connected in the anode-cathode circuit of said space discharge device, means for applying a controlling signal of predetermined form to the grid of said space discharge device, a second space discharge device having at least an anode, a cathode, and a control grid, and having its anode and cathode connected to opposite terminals of the primary winding of said transformer, means for deriving a signal from the additional electrode of said first space discharge device, and means for applying said last-named signal to the grid of said second space discharge device.

9. In a cathode ray tube beam deflecting system,

an output circuit including a coil having some inherent series resistance and shunt capacity, a space discharge device having at least an anode, a cathode, a control grid and a screen grid, a connection between said cathode and a point of fixed potential, a connection between said anode and one terminal of said coil, a connection between the other terminal of said coil and a point of relatively higher potential, means comprising a resistor connecting said screen grid to said point of relatively high potential, a second space discharge device having at least an anode, a cathode, and a control grid, and having its anode and cathode connected to opposite terminals of said coil, a connection from said screen grid to the grid of said second space discharge device, and means for applying a controlling signal of predetermined form to the control grid of said first space discharge device.

10. In a cathode ray tube beam deflecting system in which a magnetic field is periodically varied so as to deflect a beam of electrons, an output circuit including a coil having some distributed shunt capacity and some series resistance, and means for producing in said coil a periodically recurrent wave of substantially sawtooth waveform consisting of alternately occurring portions of respectively steep and gradual slope, said means comprising a first series circuit including said coil, a second series circuit including said coil, means connected in said first series circuit for periodically supplying energy to said coil only during the latter portion of each of said portions of gradual slope of said sawtooth current wave, and means responsive to current flow in a portion of said first series circuit external to said second series circuit for increasing the effective resistance of said second series circuit during the time that energy is supplied to said coil.

11. In a cathode ray tube beam deflecting system in which a magnetic field is periodically varied so as to deflect a beam of electrons, an output circuit including a coil having some distributed shunt capacity and some series resistance, and means for producing in said coil a periodically recurrent current wave of substantially sawtooth waveform consisting of alternately occurring portions of respectively steep and gradual slope; said means comprising a first series circuit including said coil, a source of electrical energy and a space discharge device having at least an anode, a cathode, and a control grid; means for applying to the grid of said space discharge device a periodically recurrent voltage waveform adapted to render said space discharge device non-conducting during the first part of each of said portions of gradual slope of said sawtooth current wave and to render said space discharge device increasingly more conducting during the latter part of each of said portions of gradual slope; a second series circuit including said coil; and means included in said second series circuit and responsive to the current in said space discharge device for increasing the effective resistance of said second series circuit during the time that said space discharge device is conducting.

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