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INVENTOR.
Kurt Schlesinger
BY
H. S. Groen.
ATTORNEY.

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ELECTRON TUBE CIRCUITS

Kurt Schlesinger, West Lafayette, Ind., assignor
to Radio Corporation of America, a corporation
of Delaware

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The present invention relates generally to devices for developing linear voltage waves and is particularly applicable for developing the energy for deflecting an electron beam generated within a cathode ray tube.

Such circuit arrangements are directly and particularly applicable to television receivers and to other forms of electronic circuits wherein provision is to be made for causing an electron beam to be deflected relatively slowly and strictly linearly in one direction of its traverse and to be returned very rapidly to a starting point after reaching a predetermined point in its deflection. In one of the best-known forms of such arrangements as applied to a cathode ray tube device for television the cathode ray beam is deflected across a target in each of two mutually perpendicular directions, of which the movements in the two directions of deflection are harmonically related and in which each initial portion of the movement takes place much slower than the latter portion. Also the invention is particularly applicable to use with oscillograph apparatus where it is desired that wave trace investigations be made and where it is particularly desired that the traced phenomena shall be maintained substantially stationary during the investigation.

In the prior art circuits are known by which it is possible to produce linear voltage waves of saw-tooth form which may serve as the energy for the driving stage for deflection in connection with electrostatic or electromagnetic deflection of a cathode ray beam developed within a cathode ray tube. In such conventional deflection circuits three stages are usually provided, of which the first consists of an impulse generator connected as a blocking oscillator tube of well-known form and illustrated, for example, by the Tolson Reissue Patent #20,338. The second stage consists, for instance, of a discharge tube which derives its positive control electrode impulse from the blocking oscillator. The final stage usually consists of the final amplifier.

One of the objects of the present invention is to accomplish results commensurate with the circuits of the prior art and at the same time to provide simplifications in the circuit design and arrangement by which it will be possible to reduce the number of tubes required to accomplish the desired results. In one of the preferred forms of the invention the actions of the first two circuit elements above named, namely the blocking oscillator tube and the discharge tube, are combined into a single instrumentality.

A further object of the invention is to provide

a circuit arrangement wherein it is possible to generate and deliver directly to an output circuit energy of saw-tooth wave form and without addition of further coupling elements which could introduce distortion, and especially distortion at the lower frequencies.

A further object of the invention is to provide further simplification and to arrange at the same time so that the blocking stage develops sufficient power to deliver a sufficient charge to an oscillatory circuit comprising briefly a condenser and resistor, so that high voltage energy of saw-tooth wave form may be developed and used for deflection without further amplification.

A further object of the invention is to develop an oscillatory circuit arrangement for developing saw-tooth wave energy in which the saw-tooth shall be of substantially linear configuration.

A further object is to develop a circuit in which provision may readily be made for changing the frequency at which the saw-tooth wave energy is developed and to maintain at the same time a substantially constant amplitude where desired for all frequencies at which the saw-tooth wave energy is developed.

Still a further object of the invention is that of developing a saw-tooth wave oscillator and generator system in which the saw-tooth frequency is made independent of fluctuations in the voltage supplied to the system.

Other objects are to provide a system by which the amplitude of the output energy can be regulated readily merely by varying suitable parameters of the system without otherwise affecting the reliability of the system.

Still another object of the invention is to provide a system in which amplification of the output energy from the oscillator and discharge tube combination may readily be had without introducing any new distortion into the system.

Still other objects of the invention are to provide a system by which saw-tooth wave energy may be developed with a minimum number of tubes and component parts by which the costs of such systems may be reduced and in which the efficiency of operation may be increased.

Other objects and advantages of the invention will become apparent from considering the following specification and the claims hereinafter appended in connection with the accompanying drawing, in which:

Figure 1 is a simplified diagram of one form of circuit; and,

Figure 2 is a modification of the arrangement

of Figure 1 providing for obtaining a wide range of sweep or deflection frequencies.

Referring now to the drawing for a further understanding of the invention, in the arrangement of Figure 1 there is disclosed a form of deflection circuit in which an inductively coupled triode oscillator is used to produce a sawtooth voltage wave directly. In the arrangement, there is a triode tube 10 comprising the anode 11, the control electrode 14 and the cathode 17. A suitable source of voltage (not shown) is provided with its positive terminal connected to the terminal 12 which, in turn, supplies positive voltage to the anode 11 of the tube 10 by way of the transformer winding 13. The cathode 17 is connected to ground 19 through the cathode resistor 21. In a path parallel to the path between the transformer winding 13 and ground 19 there is provided a variable resistor 52 which is connected to the terminal 12, whereat positive voltage appears, and, in series with the resistor 52 and ground 19, there is connected a condenser 25 which is arranged to be charged to a maximum potential e_k by way of the resistor 52. Feedback between the plate or anode 11 and the control electrode 14 of tube 10 is provided by way of the second transformer winding 16, which connects at one terminal thereof to the tube control electrode 14 and, at the other terminal thereof, to the junction of the resistor 52 and the condenser 25. In this arrangement, a synchronizing impulse of any desired frequency, depending upon the operating parameters, is applied in a negative sense at the terminal 20 so as to be fed into the cathode circuit of the tube 10 by way of the cathode resistor through a connection made available at the point 22, for instance. The curve adjacent Figure 1 indicates, generally, the voltage across the condenser. In this arrangement it will be seen that positive plate voltage applied to the tube at the terminal 12 co-operates in the charge of the condenser 25 through the charging resistor 52, which may be made variable, as indicated. In this way it is evident that the voltage across condenser 25 is always negative and its highest peaks only in a positive direction are touching the zero grid line (as shown) whereby tube 10 is unblocked and performs the flyback cycle, the negative amplitude of which is determined by the limiting resistor 21.

In the arrangement of Figure 2 there is included an arrangement for providing a wide range of variances of sweep frequencies which shall be stable and linear, as well as fixed amplitude for all ranges, and not subject to change with change in voltage over a wide range of frequencies. Referring now to the circuit of Figure 2 there is shown by the tube sections 71 and 72 two separate half sections of a double triode tube, for instance, a tube known in the art as the 6F8, which is illustrated in half sections for simplicity of diagram. In the tube section 71 there is provided the usual cathode 73, the control electrode 74 and the plate or anode 75. The cathode connects to ground 19 by way of a plurality of separate resistor elements 76, 77, 78, 79 and 80, of which the resistors 78 and 79 are respectively shunted by capacity elements 81 and 82. Synchronizing impulses are supplied to the tube from the terminal connection 83 by way of the condenser 84 and resistor 85, and the amplitude of the synchronizing impulse as it is applied is controlled by variation of the tapping point 86 on the resistor 80. Connections are made from the point 87 adjacent the cathode to a terminal 88

of a switching instrumentality. At the junction point 89 between resistors 76 and 77 there is a connection made to a second terminal point 90 of the switching instrumentality. Also from junction point 91 of the resistors 77 and 78 and one terminal of the condenser 81, a connection is made to a further terminal 92 of the same switching instrumentality. From the junction point 93 of the resistor 78 and 79, as well as the lower side of condenser 81, and the upper terminal of condenser 82 a connection is made to the terminal point 94 of the same switching instrumentality, and likewise to the junction point 95 of resistors 79 and 80 and the lower side of condenser 82 a connection is made to the last tapping point 96 on the switching instrumentality. The switch is provided with the switch arm 97 having one terminal thereof connected to the tapping point 96 and also to ground at 19 through the resistor 80. This switch is in uni-control arrangement with a second switch arm later to be described. The anode or plate member 75 of the tube section 71 is connected by way of the transformer winding 101 to a terminal 102 to which anode voltage is applied to both halves of the tubes 71, 72. The control electrode 74 is connected by way of the transformer winding 103 and the resistors 104 and 105 to the same terminal point 102. The control electrode 74 also connects through the transformer winding 103 and the potentiometer 106 to ground at 19 and to the upper side of the various condenser elements 107, 108, 109, 110 and 111, later to be described. Adjustment of the tapping point 112 on the potentiometer is made as desired through the resistor 113. The control electrode 114 of the tube section 72 connects to the junction point 115 intermediate the resistors 104 and 105. Likewise plate or anode voltage is supplied from the terminal 102 through the resistor 116 to the anode or plate element 117 of the tube section 72, and output energy from the tube may be derived from the terminal 118, as indicated.

The cathode 119 of the tube section 72 is connected through the bias resistor 120 shunted by the condenser 121 to ground at 19. As was above noted, the upper terminals of all of the condensers 107 through 111, inclusive, connect to the control electrode 74 of the tube section 71. The lower terminals of these condensers connect respectively with the terminal points 123, 124, 125, 126 and 127 so that they may be individually connected to ground at 19 by way of the switch arm 128. The switch arms 97 and 128 are uncontrolled as conventionally shown by the connections 129 between the two switch arms.

It is, of course, to be understood that various values of condenser and resistor elements are capable of being used, and it is accordingly apparent that wide variation may be made for the desired frequency range. Likewise the type of tube shown may be varied. For the purpose of indicating a suitable range of frequency with respect to condenser and resistor elements, the following schedule is given as illustrated:

Switch arm 97	Switch arm 128	Frequency ranges
		<i>Cycles per second</i>
On contact 88.....	On contact 127.....	30 to 140.
On contact 90.....	On contact 126.....	100 to 440.
On contact 92.....	On contact 125.....	350 to 1,400.
On contact 94.....	On contact 124.....	1,000 to 4,000.
On contact 96.....	On contact 123.....	3,500 to 14,000.

For any change in the type of timing circuit a corresponding change in the over-all resistor of the grid cathode particularly should be provided. Thus it happens that the tube delivers a reduced number of ampere seconds to a reduced capacity, resulting in obtaining substantially the same amplitude of the output for all ranges of frequency. The variation of the leak resistor 113 does not affect the amplitude when once the system is adjusted. As shown by the diagram of Figure 2 it will be seen that direct coupling has been introduced between the tube section 71 and the succeeding amplifier section 72. At this point it might be remembered that, while the tube sections 71 and 72 are shown as halves of the same tube, it is, of course, apparent that two completely separate tubes may be used where desired. It is apparent also that if the oscillations take place in the negative portion of the grid bias the point 115 along the leakage resistors 104 and 105 may readily be determined so as to make the connection for the next succeeding stage without any coupling condenser. This point of connection is determined, for instance, by assuming the condenser 107 to charge to a value of approximately 30 volts, and then when potential is applied at the terminal 102 at a time when the charge is acquired by the condenser 107 there is a voltage of 330 volts between the control electrode and the positive terminal at the designated point. Furthermore, it is to be seen that the point 115 is taken such that it is a point of 0 volts D.-C. so that the A.-C. transmission is approximately 90% of the total voltage and still the control electrode 114 of the amplifier 72 is maintained at 0 volts D.-C. and no new or additional distortion can be introduced in that section of the amplifier. This is particularly useful and ample for very low sweep frequencies where with the conventional resistance capacity coupling difficulties arise due to limited size of the time constant provided by the coupling. Frequency variation is carried out by a change of the accelerated voltage bias rather than changes in the leakage resistance 113 which may be set once and for all and fixes the variation range. By making the value of the resistor 113 of proper order frequency variations of greater than one to twelve may be obtained where the resistor is of the order of 0.2×10^6 ohms and of the order of about 1 to 5 with the resistor 113 of a smaller value, e. g., about 60,000 ohms, whereas the change in frequency will be only of the order of about 1 to 3 with a simple variation of the leakage resistance without a change in the bias.

Having described my invention, what I claim is:

1. An oscillator for developing substantially non-distorted linear voltage waves of sawtooth form comprising a thermionic element including at least a cathode, a control electrode and an anode, a limiting impedance element connected between the cathode and a point of fixed potential, terminal means for connecting to a positive terminal of a source of voltage, and a transformer winding connected intermediate the said terminal means and the anode of said thermionic device so that positive voltage is fed to the said thermionic device through said transformer winding, a series combination comprising a resistor and a capacitor connected in parallel with all of said transformer winding, said thermionic device and said cathode impedance and having one terminal of the said capacitor connected to the said point of fixed potential, and a feedback connection including a transformer winding coupled to said

first named transformer winding connected between the control electrode of said thermionic device and the junction of said serially connected resistor and condenser.

2. An oscillator for developing substantially non-distorted linear voltage waves of sawtooth form comprising a thermionic element including at least a cathode, a control electrode and an anode, a limiting resistor element connected between the cathode and a point of fixed potential, terminal means for connecting to a positive terminal of a source of voltage, and a transformer winding connected intermediate the said terminal means and the anode of said thermionic device so that positive voltage is fed to the said thermionic device through said transformer winding, a series combination comprising a resistor and a capacitor connected in parallel with all of said transformer winding, said thermionic device and said cathode resistor and having one terminal of the said capacitor connected to the said point of fixed potential, and a feedback connection including a transformer winding coupled to said first named transformer winding connected between the control electrode of said thermionic device and the junction of said serially connected resistor and condenser.

3. The oscillator claimed in claim 1 comprising, in addition, means for supplying synchronizing impulses to the triode input circuit to control the cycle of oscillation.

4. An oscillator for developing substantially non-distorted linear voltage waves of sawtooth form comprising a thermionic element including at least a cathode, a control electrode and an anode, a limiting resistor element connected between the cathode and a point of fixed potential, terminal means for connecting to a positive terminal of a source of voltage, and a transformer winding connected intermediate the said terminal means and the anode of said thermionic device so that positive voltage is fed to the said thermionic device through said transformer winding, a series combination comprising a variable resistor and a capacitor connected in parallel with all of said first named transformer winding, said thermionic device and said cathode resistor and having the said capacitor connected with one terminal thereof to the said point of fixed potential, and a feedback connection including a transformer winding coupled to said first named transformer winding connected between the control electrode of said thermionic device and the junction of said series connected variable resistor and condenser.

5. The oscillator claimed in claim 4 comprising, in addition, means connected to the said limiting resistor for applying synchronizing impulses to said oscillator to control the period of oscillation thereof.

6. The oscillator claimed in claim 1 comprising, in addition, means connected to the said cathode impedance for applying synchronizing impulses to said oscillator to control the period of oscillation thereof.

7. An oscillator for developing substantially non-distorted linear voltage waves of sawtooth form comprising a first thermionic element including at least a cathode, a control electrode and an anode, a limiting impedance element connected between the cathode and ground, terminal means for supplying positive voltages to the anode of said tube, and a transformer winding connected in the anode supply and intermediate the said terminal and the said anode, a plurality of con-

denser elements of predetermined graduated sizes, resistance means connected to the said terminal means for supplying charging current to said condensers, switching means for connecting said condensers individually serially between said charging resistance means and ground, a second transformer winding having one end thereof connected to the control electrode of said tube and the other end connected intermediate the said charging resistance and said condensers and coupled to the first named transformer winding to provide feedback between the anode circuit and the control electrode, a second switching means connected to operate jointly with said first named switching means for varying the effective cathode connected limiting impedance of said tube with changes in the connection of the said condensers connected to be charged through said resistor means, an amplifying tube comprising at least a cathode, a control electrode and an anode with the said anode connected to said terminal means and the said cathode connected to ground, and a galvanic connection from an intermediate point on said charging resistor to said control electrode for supplying control voltages of a wave form corresponding to the voltages across said connected condenser to said amplifying tube.

8. The oscillator claimed in claim 7 comprising, in addition, means for supplying control voltages to said cathode impedance of said first named tube for controlling the period of charge and discharge of said condensers whereby the frequency of the developed sawtooth waves is controlled.

9. An oscillator for developing substantially non-distorted linear voltage waves of sawtooth form comprising a pair of terminal points across which a source of voltage is adapted to be connected, a first series circuit including a transformer primary winding, a limiting impedance and a thermionic tube having a cathode, a control electrode and an anode connected between said terminal points, a second series circuit comprising a resistor and a condenser connected between said terminal points, and a bridging connection including the secondary winding of a transformer coupled to the said primary winding connected between the control electrode of said thermionic tube and the junction point of the condenser and resistor of the second named series circuit.

10. An oscillator for developing substantially

non-distorted linear voltage waves of sawtooth form comprising a pair of terminal points across which a source of voltage is adapted to be connected, a first series circuit including a transformer primary winding, a limiting impedance and a thermionic tube having a cathode, a control electrode and an anode connected between said terminal points, a second series circuit comprising a resistor and a condenser connected between said terminal points, and a bridging connection including the secondary winding of a transformer coupled to the said primary winding connected between the control electrode of said thermionic tube and the junction point of the condenser and resistor of the second named series circuit, and means for supplying control impulses upon the impedance element included in the first named series circuit to control the oscillation cycle of charge and discharge of said condenser element of the second series circuit.

11. An oscillator for developing substantially non-distorted linear voltage waves of sawtooth form comprising a first thermionic element including at least a cathode, a control electrode and an anode, a limiting impedance element connected between the cathode and ground, terminal means for supplying positive voltages to the anode of said tube, and a transformer winding connected in the anode supply and intermediate the said terminal and the said anode, a plurality of condenser elements of predetermined graduated sizes, resistance means connected to the said terminal means for supplying charging current to said condensers, switching means for connecting said condensers individually serially between said charging resistance means and ground, a second transformer winding having one end thereof connected to the control electrode of said tube and the other end connected intermediate the said charging resistance and said condensers and coupled to the first named transformer winding to provide feedback between the anode circuit and the control electrode, and a second switching means connected to operate jointly with said first named switching means for varying the effective cathode connected limiting impedance of said tube with changes in the connection of the said condensers connected to be charged through said resistor means.

KURT SCHLESINGER.