Aug. 20, 1940. E. L. C. WHITE ET AL 2,212,217

OSCILLATORY ELECTRIC CIRCUITS

Filed Aug. 21, 1937 2 Sheets-Sheet 1

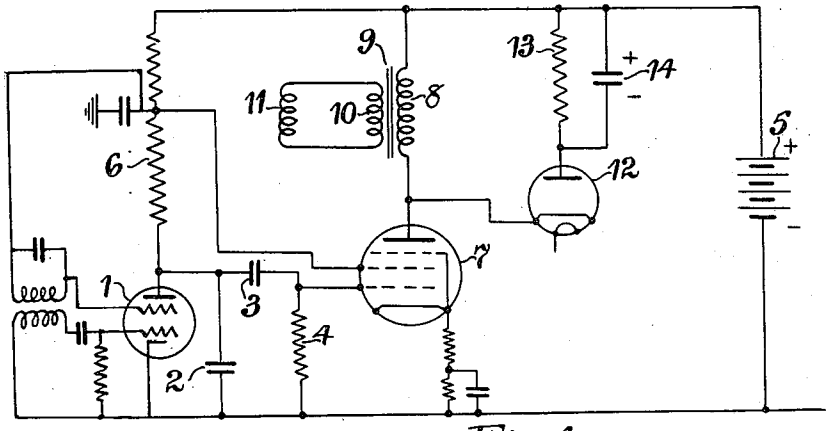

Fig. 1.

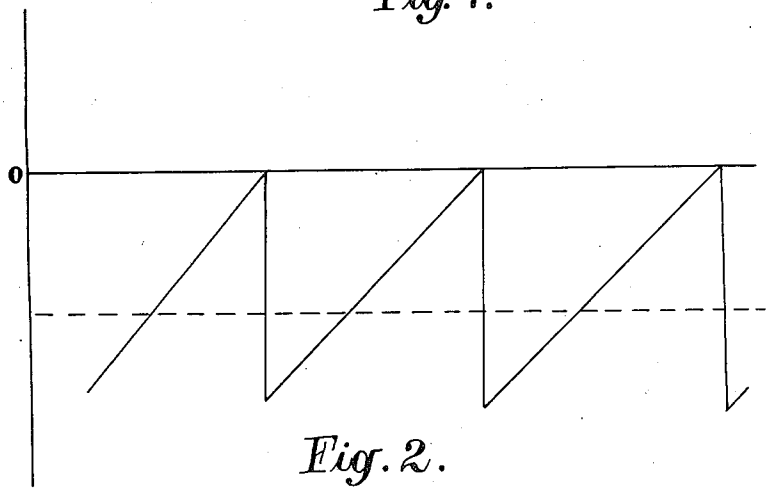

Fig. 2.

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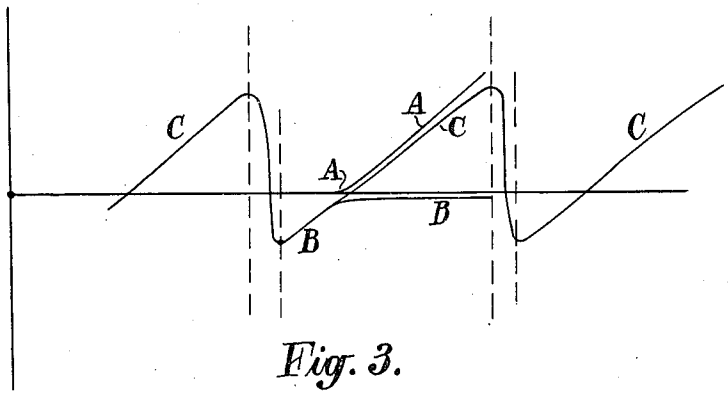

Fig. 3.

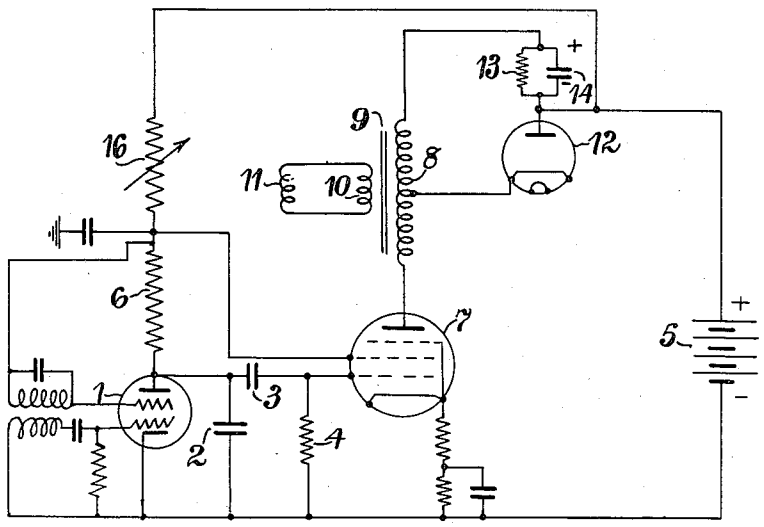

Fig. 4.

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OSCILLATORY ELECTRIC CIRCUITS

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Application August 21, 1937, Serial No. 160,258
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7 Claims. (Cl. 250—27)

This invention relates to electric oscillatory circuits of the type employed for providing a time base in connection with cathode ray tubes for the purpose of deflecting the electron beam.

Many forms of circuit for generating voltages of saw tooth wave form for deflecting the electron beam in a cathode ray tube have been proposed and in some forms of such circuit a diode valve is operatively associated with deflecting coils and with an oscillator valve controlled by synchronising signals. An example of such a proposed circuit will be described more in detail hereinafter.

The object of the present invention is to effect economy in the power consumed in oscillatory circuits of the type to which the invention relates and to prevent waste of power.

According to the present invention an oscillatory circuit for supplying deflecting wave forms for a cathode ray tube includes a valve to the output circuit of which is coupled a winding itself coupled to deflecting means, a diode valve being connected across a portion of said winding or another winding coupled thereto and serving to control the passage of current through said winding. In a particular circuit arrangement embodying the invention the grid of a valve is fed with potentials of saw-tooth wave-form by a blocking oscillator circuit and a winding in its anode lead forms the primary winding of a transformer, the secondary winding of which is constituted by the scanning coils of a cathode ray tube. The diode valve is connected in series with a parallel connected resistance and condenser combination across a portion of the said primary winding. The valve employed may be a pentode valve and in order to maintain the shape of the output current wave similar for all amplitudes, the amplitude of the voltage fed to the control grid of the pentode may be varied simultaneously with the voltage applied to the screening grid. A convenient means for effecting such simultaneous variation consists of a variable resistance connected in the common supply to the anode circuit of a blocking oscillator valve feeding the pentode valve, and to the screen grid of the pentode.

In order that the invention may be more clearly understood and readily carried into effect, a form of circuit embodying previous proposals will now be described in greater detail, together with an example of a circuit embodying the invention and reference will be made to the accompanying drawings in which:

Fig. 1 is an oscillatory circuit showing a diode valve, part of a blocking oscillator circuit and scanning coils of a cathode ray tube arranged in a manner previously proposed.

Fig. 2 shows a voltage wave-form generated by the blocking oscillator circuit in Fig. 1.

Fig. 3 shows current wave-forms generated by the circuit of Fig. 1 and

Fig. 4 is an oscillatory circuit embodying the invention.

Referring to Fig. 1 of the drawings, the valve 1 of which only the envelope and anode are shown diagrammatically, forms part of a blocking oscillator circuit including condenser 2 and a resistance 6. While the valve 1 is non-conducting, the condenser 2 is being charged from a source of high tension voltage 5 through the resistance 6, in the anode lead of the valve 1. The control grid of a valve 7 is connected to the junction between the resistance 4 and condenser 3 and the anode circuit of the valve 7 includes the primary winding 8 of a transformer 9. Scanning coils 11 of a cathode ray tube (not shown in the drawings) are connected to the secondary winding 10 of the transformer 8. The anode of the valve 7 is connected directly with the cathode of a diode valve 12, the anode of which is connected through a resistance 13, shunted by a condenser 14 to the positive terminal of the H. T. source 5.

In the operation of this circuit, the blocking oscillator valve 1 generates a voltage wave form as shown in Fig. 2, the potential of the grid of valve 7 following this wave form. In Fig. 3 the curve A represents the wave form of the current passing through the valve 7, the curve B represents the current through the diode valve 12, and the curve C, the current through the primary winding 8. From the curve C it will be seen that the current through the primary winding builds up to practically the peak value of the current passing through the valve 7 as shown in curve A, and then reverses in a half cycle of the natural frequency of the stray capacities from anode of 7 to earth with the inductance of the scanning coils 11 stepped-up by the transformer 8. The current reversal is, however, not complete owing to various losses, and as shown in the drawings the actual reversal may be only of the order of 50%.

During the slow part of the voltage rise there is a constant rate of change of current in the scanning coils 11 which represents a constant voltage difference across the primary winding 8. This voltage difference must be supplied from the H. T. battery 5 which must be great enough to provide the necessary H. T. potential on the anode of 7 as well as the steady voltage difference.

During the latter part of the slow scanning stroke, energy from the H. T. battery 5 via valve 7 is stored through the transformer in the scanning coils. During the early part of the stroke when the diode is conductive, this energy in the form of the product of the diode current, and the above mentioned potential across the winding 8, is dissipated in the resistance 13, that is, all the energy from the H. T. battery 5 which is stored in the coils is lost in the resistance 13, except for such energy as is lost in resistance, eddy current losses and dielectric losses of the coils and transformer. It is the object of this invention to reduce the power required for operating this circuit by reducing the loss in resistance 13.

In Fig. 4 the invention is shown applied to a circuit of the general form of Fig. 1, but with additional improvements. Thus, the cathode of the diode 12 is connected to a tapping point in the primary winding 8 of the transformer 9 and the upper end of this primary winding, instead of being connected directly to the H. T. source, is connected to the parallel resistance and condenser combination 13 and 14 which are connected in the anode lead to the diode valve 12 as in Fig. 1. A further alteration is in the connection of the positive terminal of the H. T. source directly to the anode of the diode 12 instead of to the upper end of the resistance and condenser combination.

It will be seen that the diode and resistance/condenser combination are connected across only a portion of the primary winding 8 and the tapping point on the transformer is so chosen that the diode current is at least equal to or is increased compared with the anode current of the valve 7 so that the average diode current is slightly in excess of the average anode current.

Owing to the current in the diode 12 being equal to or slightly greater than the current in the valve 7, very little energy is dissipated in resistance 13 and this resistance, instead of carrying the whole diode current now carries the difference between the diode current and the valve current. As the terminal of the battery 5 is connected directly to the anode of the diode 12, fewer H. T. volts are required, since the condenser 14 stores energy which in the arrangement of Fig. 1 is dissipated in the resistance 13, the condenser 14 in Fig. 4 using the energy stored in it to provide power for overcoming the back E. M. F. of part of the winding 8.

The leakage inductance between that portion of the winding 8 across which the diode 12 is connected and the whole of the winding 8, should be kept as low as practicable so that during the forward strokes of the saw-tooth, when the valve 7 is beginning to take current in place of the diode 12, the transition from one to the other shall be smooth and free from discontinuity due to the leakage inductance referred to.

It is desirable to maintain the shape of the pentode current curve A similar for all amplitudes and accordingly amplitude control is effected by simultaneously varying the potential applied to the screening grid of the pentode valve and the amplitude of the saw tooth potential applied to the control grid of that valve.

This may be done by connecting a variable resistance 16 in series with the resistance 6 and the positive terminal of the H. T. source 5, the screening grid of the pentode valve 7 being connected to the junction between the fixed resistance 6 and variable resistance 16. It will be understood that other methods of effecting simultaneous variation of the values mentioned may be adopted.

While in the arrangement described with reference to Figure 4 the diode 12 is shown connected to a tapping point in the winding 8, the diode may be connected with a separate winding coupled with the winding 8.

We claim:

1. In combination, a blocking grid oscillator for producing saw-tooth wave energy, a thermionic amplifier tube, said thermionic amplifier tube having an anode, a source of electrical energy, a transformer having a primary and secondary winding, said primary winding being connected in series with the source of energy and the anode of the thermionic tube, a deflecting coil connected to the secondary winding of the transformer, a thermionic rectifier connected across the primary of the transformer and current initiating connections from said blocking oscillator to said amplifier for regulating current flow through said thermionic tube.

2. In combination, a blocking grid oscillator for producing saw-tooth wave energy, a thermionic amplifier tube, said thermionic amplifier tube having an anode, a source of electrical energy, a transformer having a primary and secondary winding, said primary winding being connected in series with the source of energy and the anode of the thermionic tube, a defleeting coil connected to the secondary winding of the transformer, a thermionic diode connected across the primary of the transformer and current initiating connections from said blocking oscillator to said amplifier for regulating current flow through said thermionic tube.

3. In combination, a blocking grid oscillator for producing saw-tooth wave energy, a thermionic amplifier tube, said thermionic amplifier tube having an anode, a source of electrical energy, a transformer having a primary and secondary winding, said primary winding being connected in series with the source of energy and the anode of the thermionic tube, a deflecting coil connected to the secondary winding of the transformer, a rectifier connected across the primary of the transformer and current initiating connections from said blocking oscillator to said amplifier for regulating current flow through said thermionic tube.

4. In combination, a blocking grid oscillator for producing saw-tooth wave energy, a thermionic amplifier tube, said thermionic amplifier tube having an anode, a source of electrical energy, a transformer having a primary and secondary winding, said primary winding being connected in series with the source of energy and the anode of the thermionic tube, a deflecting coil connected to the secondary winding of the transformer, a rectifier, a parallelly connected resistance and condenser connected in series with the rectifier, connections across the primary of the transformer to the serially connected rectifier and resistance and condenser and current initiating connections from said blocking oscillator to said amplifier for regulating current flow through said thermionic tube.

5. In combination, a blocking grid oscillator, a thermionic tube having a cathode, a control electrode, a screen electrode and an anode, means to supply energy from the blocking grid oscillator to the control electrode, a transformer having a primary and secondary winding, a source of electrical energy, a parallelly connected resistance and condenser connected in series between the

source of energy and the primary of the transformer, a connection from the primary of the transformer to the anode of the thermionic tube, a deflecting coil connected to the secondary of the transformer, a rectifier connected to the primary of the transformer and the parallelly connected resistance and condenser, and means to vary the potential of the screen electrode in accordance with the variation of the potential of the control electrode.

6. In combination, a source of electrical energy, a blocking grid oscillator, means to energize the blocking grid oscillator from the source of energy through a serially connected resistance, an amplifier having an input and output circuit, means to supply energy from the blocking grid oscillator to the input circuit of the amplifier, a transformer having a primary and a secondary winding, said primary winding being connected in the output circuit of the amplifier, a rectifier connected in series with a parallelly connected resistance and condenser connected across the primary of the transformer, and means to supply energy to the rectifier and the amplifier from the source of energy.

7. In combination, a source of electrical energy, a blocking grid oscillator, means to energize the blocking grid oscillator from the source of energy through a serially connected resistance, an amplifier having an input and output circuit, means to supply energy from the blocking grid oscillator to the input circuit of the amplifier, a transformer having a primary and a secondary winding, said primary winding being connected in the output circuit of the amplifier, a thermionic diode connected in series with a parallelly connected resistor and condenser connected across the primary of the transformer, and means to supply energy to the thermionic diode and the amplifier from the source of energy to maintain the average current flowing through the diode at least equal to the average current flowing to the amplifier.

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