

UNITED STATES PATENT OFFICE

2,494,865

TRIGGERED ELECTRONIC SWEEP
GENERATOR

Brian Clifford Fleming-Williams and Alaric Allen, London, England, assignors to A. C. Cossor Limited, London, England, a British company

Application April 27, 1945, Serial No. 590,694
In Great Britain May 4, 1944

8 Claims. (Cl. 250—27)

1

This invention relates to thermionic valve circuits serving for the generation of linear potential sweeps and/or abrupt potential steps, and being of the kind comprising a valve amplifier having a point in its anode circuit connected through a differentiating network to a point of constant potential, and having its input voltage derived from the output of this differentiating network, so that a substantially linear potential sweep of the valve anode is obtained.

A feature of the invention is the application of the output from the differentiating network through a resistance to the input grid of the valve amplifier; and the provision of means to maintain a voltage drop across this resistance, so as to bias the valve to cut-off while awaiting a firing pulse which will initiate a potential sweep of the valve anode.

In the accompanying drawing, Figure 1 shows a circuit diagram of an arrangement embodying the invention, which, in response to the application of a firing pulse, produces at one output terminal a single linear voltage sweep, followed by automatic return, and at another output terminal an abrupt voltage step at the end of said voltage sweep; and Figure 2 shows a modified arrangement for the application of a firing pulse to the circuit shown in Figure 1.

In Figure 1, the valve V is a pentode which may be of the Mullard Radio Valve Company's EF50 type.

Examples of component values will be given for use in conjunction with this valve to produce a circuit suitable for generating voltage sweeps having duration of the order of 100 micro-seconds. These values are as follows:

R1	----- kilohms	25
R2	----- do	20
R3	----- do	100
R4	----- do	500
R5	----- do	250
R6	----- do	50
R7	----- do	5
C1	----- picofarads	200
C2	----- microfarads	0.1
C3	----- do	0.005

A positive line voltage of 280 volts is assumed and a negative line voltage of 150 volts.

In the stable condition of the circuit the valve

2

V is cut off. Diode D1 is conducting and holds the potential of the anode of valve V at a value selected by the slider of potentiometer R1. Diodes D2, D3 and D4 are also conducting. Diode D2 completes a path from positive line through resistor R3 to earth; diode D4 completes a path from negative line to earth through resistors R5, R6, and diode D3 completes a path from positive line to negative line through resistors R3, R2 and R5.

The currents will be approximately as follows:

	Milliamps
Current through R3	2.8
Current through R2	0.4
Current through R6	0.16

The potential of the anode of diode D2 will be near to earth potential, and therefore above the range of operating potentials of the control grid of valve V which are reached during the potential sweep of the anode. The potential of the anode of diode D3 will be about 8 volts negative, and the valve V will therefore be biased beyond cut-off by the voltage drop maintained across resistor R2.

As the valve V is not passing current, its screen will be at positive line potential.

The stable condition is disturbed by the application of a positive firing pulse to terminal T1. This pulse may have a duration of about one microsecond, and must have sufficient power to charge condenser C3 rapidly. It will be assumed that the amplitude and duration of the firing pulse are sufficient to charge condenser C3, by way of condenser C2 and diode D4, to a potential of 12 volts positive instead of about 8 volts negative, to which it was charged in the stable condition. Diode D3 is thereby cut off, and diode D4 is also cut off as soon as the firing pulse has ceased.

When diode D3 is cut off, the potential of the control grid of valve V jumps to a less negative value owing to the collapse of the voltage drop across resistance R2, and anode current begins to flow. At the same time the potential of the anode of diode D2 falls to the new value of the control grid potential, because the current through resistance R2 has now ceased. Diode D2 is therefore cut off. Owing to the coupling through condenser C1, the potential of the anode

3

of valve V jumps down by the same amount as that of the anode of diode D2. Diode D1 is therefore cut off.

The initial value of the anode current of valve V is approximately the sum of the current which has been flowing through resistor R3 (2.8 milliamps) and the current which has been flowing through resistor R4 and diode D1 (say, 0.1 milliamp). The anode and control grid potentials automatically assume appropriate values to give this anode current.

A period now follows during which the anode potential makes a linear sweep downwards. Meanwhile the control grid potential rises slightly so as to increase the anode current continuously by the small amount necessary to maintain a constant current of 2.8 milliamps through condenser C1, in addition to the small but steadily increasing current which flows through resistor R4 as the anode potential falls. During this period the screen current will be fairly steady at about 1 milliamp, producing an initial fall of screen potential of about 5 volts.

Condenser C1 and resistor R3 form a differentiating network connected from the anode of valve V to the positive line, and the control grid potential, now that diodes D2 and D3 are cut off, is derived from the output of this differentiating network, i. e. the voltage across resistor R3.

The charging rate of condenser C1 will approximately correspond with the charging rate which it would have if it were connected in series with a resistance of value G times R3 across a direct voltage source of value G times the voltage of the positive line, G being the gain of the valve V as an amplifier in the present circuit. The sweep of anode potential will therefore be very nearly linear.

When the anode potential has fallen to about 1 volt positive, the valve V becomes unable to maintain the charging current for condenser C1. The potential of the control grid therefore rises abruptly to earth potential and diode D2 again passes current. The screen current of valve V rises rapidly to about 20 milliamps, causing a sharp fall of screen potential of about 100 volts.

The potentials of all the electrodes of valve V now remain constant until current again begins to flow through diode D3. The period which elapses before this happens is controlled solely by the charging circuit of condenser C3 through resistor R5. From the time when diode D4 was cut off at the end of the firing pulse, condenser C3 will have been discharging, through resistor R5, exponentially from 12 volts positive towards 150 volts negative. When its charge passes zero, diode D3 again becomes conductive and current in valve V is relatively gradually cut off. The potential of the anode of valve V then returns exponentially towards that of the positive line until it reaches the value set by the slider on potentiometer R1. As current in valve V is cut off, the potential of the screen returns to that of the positive line. The circuit thus returns to the stable condition.

It will be seen that the potential of terminal T2 has a slight abrupt fall at the commencement of the firing pulse applied to terminal T1, and thereafter falls linearly almost to earth potential. The potential of terminal T3 undergoes a fall of about 5 volts at the commencement of the firing pulse and then remains nearly steady until that of terminal T2 has nearly reached earth potential; thereupon the potential of terminal T3 falls abruptly about 100 volts and then re-

4

mains steady for a period determined by the discharging conditions of condenser C3. The return strokes of the potentials of terminals T2 and T3 towards the initial conditions are, however, neither abrupt nor linear.

If the gradual commencement of the voltage step at terminal T3 is objectionable, the output at this terminal may be passed through a limiter so that only the latter part of the voltage step is employed.

Figure 2 shows an alternative arrangement for substitution in place of the elements D4 and R6 of Figure 1. The purpose of this arrangement is to limit the demand for power from the firing source which is connected to terminal T1. In this arrangement resistor R5 and condenser C3 are arranged to form a cathode load for a triode valve V2, and the firing pulses are applied from terminal T1 through condenser C2 to the grid of this valve.

The valve V2 is biased to cut-off when the circuit is in its stable condition, just as valve V of Figure 1 is biased to cut-off. The bias is provided by resistor R8, which will have approximately the same value as resistor R2; and it is applied to the grid through grid leak R9.

The firing pulses should be positive-going. When a firing pulse is applied, valve V2 is rendered conducting and its anode current charges condenser C3. When condenser C3 is sufficiently charged for diode D3 to be cut off, the circuit will operate in the same manner as has already been described with reference to Figure 1.

We claim:

1. A thermionic valve circuit for the generation of potential sweeps consisting of linear sweeps and abrupt steps, comprising a valve amplifier having a cathode, an anode and a control grid, an output circuit including a source of current and a load impedance connected between the cathode and the anode of said valve, a negative feedback path from the output to the input of the valve comprising a differentiating network having its input side connected between a point of constant potential and the anode of said valve and its output side connected between the cathode and the control grid of the valve, a resistor included in the connection between said differentiating network and said control grid of the said valve, means to maintain a voltage drop across said resistor so as to bias the valve to cut-off in the absence of a firing pulse to initiate a potential sweep of the valve anode, and means responsive to a firing pulse to overcome said bias to such a degree that valve current begins to flow and a potential sweep of the anode is initiated.

2. A circuit according to claim 1 wherein a rectifier is connected from the differentiating-network end of said resistance to a source of potential slightly above the range of operating potentials of the input grid of the valve which are reached during a potential sweep of the valve anode.

3. A circuit according to claim 1, wherein a rectifier is connected from the input-grid end of said resistance to a source of potential below the cut-off potential of the grid.

4. A circuit according to claim 1 wherein a rectifier is connected from the input-grid end of said resistance to a source of potential below the cut-off potential of the grid, and including an impedance connected in series with said rectifier, and means controlled by a firing pulse for

5

establishing a voltage across said impedance of a value to overcome the bias of said valve.

5. A circuit according to claim 1 wherein a rectifier is connected from the input-grid end of said resistance to a source of potential below the cut-off potential of the grid, and including an impedance connected in series with said rectifier, and means responsive to a firing pulse for establishing a voltage across said impedance to overcome the bias of said valve, said last-named means including a second thermionic valve having cathode and grid elements, said firing pulses being applied to the grid of said second valve, and said impedance is connected in the cathode lead of said second valve.

6. A circuit according to claim 1 wherein a rectifier is connected from the input-grid end of said resistance to a source of potential below the cut-off potential of the grid, and including an impedance connected in series with said rectifier, and means responsive to a firing pulse for establishing a voltage across said impedance to overcome the bias of said valve, said last-named means including a second thermionic valve having cathode and grid elements, said firing pulses being applied to the grid of said second valve, and said impedance is connected in the cathode lead of said second valve, and a connection from said impedance to the grid of said second valve for normally biasing said second valve to cut-off when the circuit is in its stable condition.

7. A thermionic valve circuit for the generation of potential sweeps comprising a valve am-

6

plifier having a cathode, an anode and a control grid, a condenser having one terminal connected to said anode, a series resistance connecting the other terminal of said condenser to a point of constant potential, a second resistance connecting said other terminal of said condenser to the grid of said valve, a rectifier having a cathode, a connection including said rectifier and a series resistance for establishing a conducting path from said grid to a negative source of potential, a condenser connected between the cathode of said valve and the cathode of said rectifier, and means controlled by firing pulses for charging said second condenser to impress a positive potential on the cathode of said rectifier with respect to the cathode of said valve.

8. A circuit according to claim 7 and including a second rectifier for establishing a conducting path between the junction of said first-mentioned series resistor and said first-mentioned condenser to the cathode of said valve.

BRIAN CLIFFORD FLEMING-WILLIAMS.
ALARIC ALLEN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,266,668	Tubbs	Dec. 16, 1941
2,367,116	Goldsmith	Jan. 9, 1945
2,412,485	Whiteley	Dec. 10, 1946