Aug. 19, 1952 T. E. FAIRBAIRN 2,607,897

OSCILLATOR

Filed June 13, 1946 2 SHEETS—SHEET 1

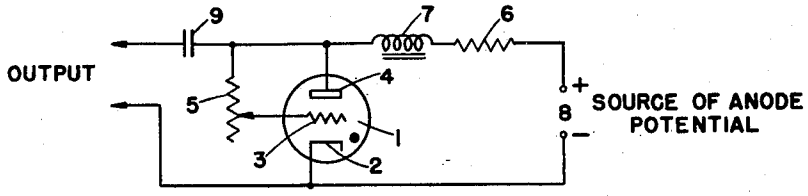

FIG. 1

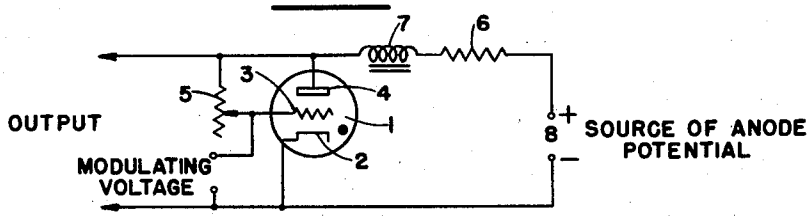

FIG. 2

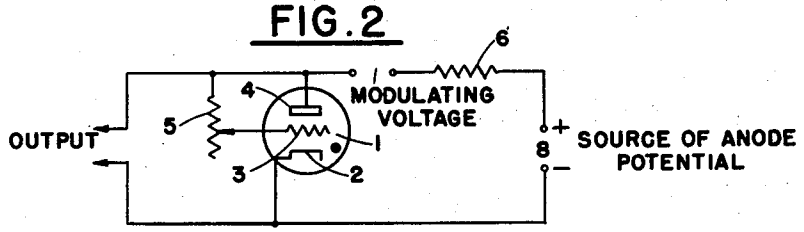

FIG. 3

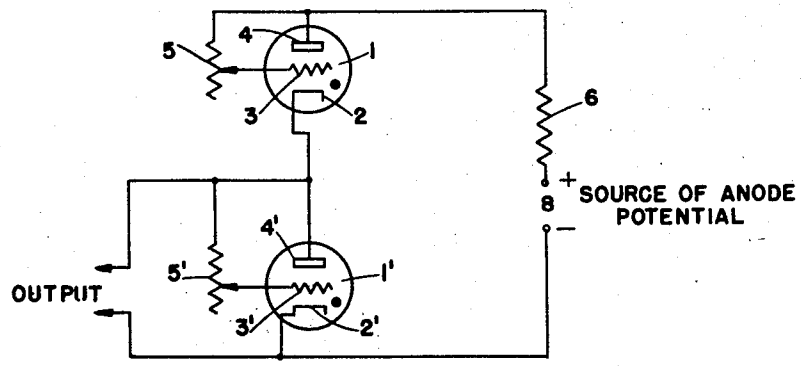

FIG. 4

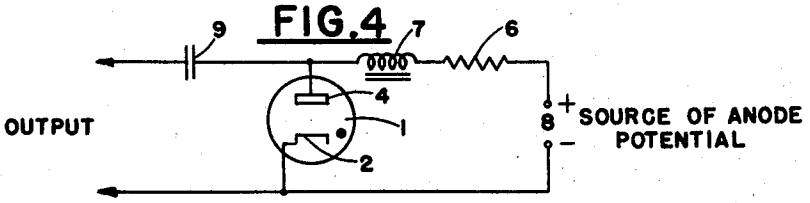

FIG. 5

INVENTOR.
THOMAS E. FAIRBAIRN

BY M. A. Hayes

Attorney

Aug. 19, 1952 T. E. FAIRBAIRN 2,607,897

OSCILLATOR

Filed June 13, 1946 2 SHEETS—SHEET 2

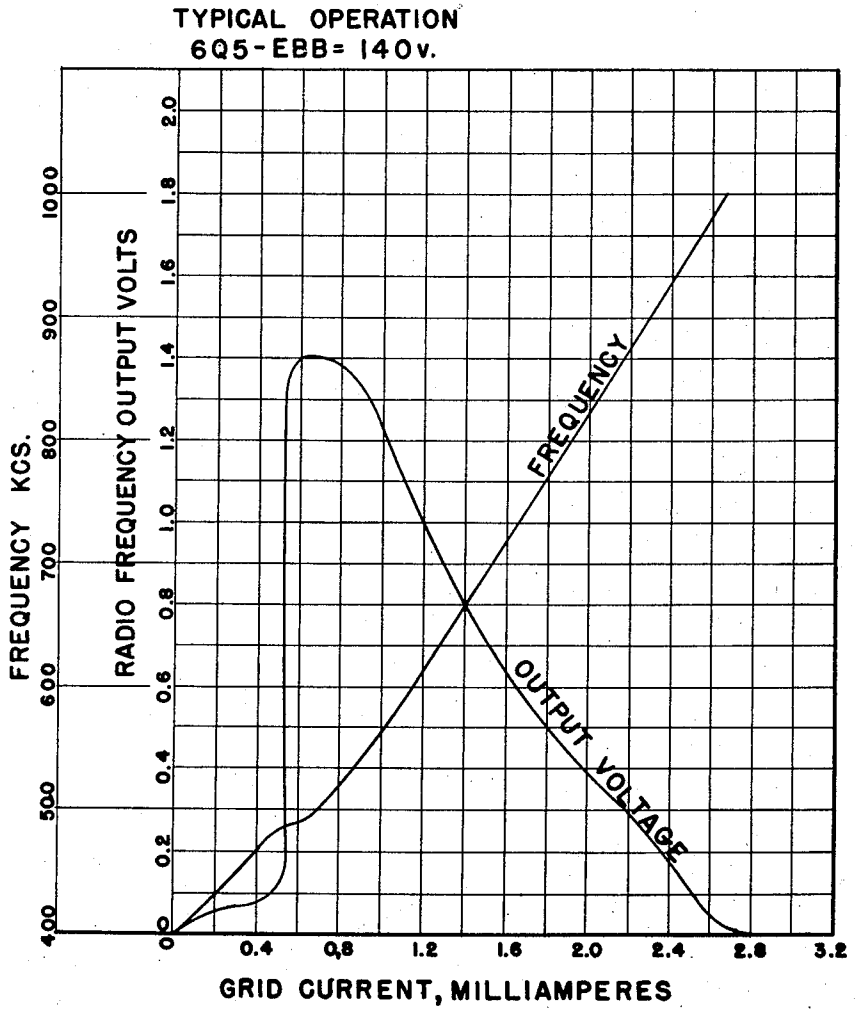

FIG. 6

INVENTOR.
THOMAS E. FAIRBAIRN
BY M. A. Hayes
Attorney

Patented Aug. 19, 1952 2,607,897

UNITED STATES PATENT OFFICE

2,607,897

OSCILLATOR

Thomas E. Fairbairn, Toledo, Ohio

Application June 13, 1946, Serial No. 676,390

13 Claims. (Cl. 250—36)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

1

This invention relates to improvements in high frequency oscillators, and has special reference to gaseous tube oscillators.

One of the objects of this invention is to provide a stable high frequency oscillator, the frequency and voltage output of which are constant for wide variations in load impedance.

Another object of the invention is to provide an oscillator with the characteristics mentioned above which in addition is capable of being modulated by any alternating voltage.

A feature of my invention is extreme simplicity of construction.

In prior art devices employing gaseous discharge tubes, it has been customary to produce oscillations therein which are evolved by ionization and deionization of the gas, the frequency of the output of the tube being determined by a tuned tank circuit connected to the output of the tube or by the charging time of an external condenser as in a relaxation oscillator. The upper limit of frequency which can be produced by a gaseous tube oscillator generally does not exceed 50 kilocycles as the ionization and deionization of the gas is an off-on process which has a definite minimum time limit and cannot be reduced because of the presence of stray electrons even during the period of deionization.

I have found that the ionized gas in a discharge tube normally oscillates within the tube at a frequency between 500 and 1,500 kilocycles at low orders of ionization, the frequency being dependent on certain of the external circuit constants. This effect is somewhat akin to the inherent oscillations in a resonating crystal but with the added advantage of a much higher output. I employ this effect to produce a novel high frequency gaseous discharge oscillator which has a selective frequency output of high magnitude as will be disclosed hereinafter.

The novel features which I believe to be characteristic of my invention are set forth in the appended claims; the invention itself, however, will best be understood by reference to the following description taken in connection with the drawings in which I have indicated diagrammatically several circuit organizations whereby the various objects of my invention may be carried into effect. In the drawings:

Figure 1 shows the basic circuit for producing unmodulated high frequency alternating voltages.

Figure 2 shows a means for obtaining modulation of the generated high frequency alternating voltages by the application of a low frequency modulating voltage.

Figure 3 shows another circuit for obtaining low frequency amplitude modulation of a high frequency alternating voltage generated by a gaseous tube oscillator, by applying in series with

2

the anode voltage supply a low frequency modulating voltage.

Figure 4 shows a special case of the circuit of Figure 3 wherein the modulating voltage is supplied by a second oscillator of the same type as the high frequency oscillator.

Figure 5 shows the circuit applied to a diode type of gaseous discharge device.

Figure 6 is a graph showing the operation of the basic circuit of Figure 1 using the type 6Q5 tube as a typical gaseous triode.

Referring now to the accompanying drawings wherein like reference characters in the various figures designate similar circuit elements, there is shown in Figure 1 the basic circuit of my invention intended to supply unmodulated high frequency alternating voltages.

Referring specifically to this figure, there is shown a gaseous discharge device 1 containing a cathode 2, a control electrode 3, and an anode 4. There is also shown a resistance 5 for limiting the current drawn by the control electrode 3, a second resistance 6 for limiting the anode current, an inductance 7 for isolating the source of potential 8 from the high frequency voltages and an output circuit including a capacitance 9 in series for isolating the load from the direct anode potential. It should be noted that the inductance 7 and the condenser 9 perform no function towards tuning the output of the gaseous discharge device 1 as the initiation of oscillations is inherent in the ionized gas within the device 1 and the control of the frequency thereof is a function of the resistance 5 as will appear hereinafter.

The operation of the circuit is as follows:

The value of the anode current limiting resistance 6 is such that a small anode current is permitted to flow. If relatively large anode currents are permitted to flow, the oscillations in the ionized gas are thrown into erratic random currents at all frequencies thereby preventing oscillation of the ionized gas at a single frequency determined by the external control circuit and the physical constants of the tube. The value of this current for best operation is a function of the type of gas tube used.

When the circuit is connected as shown in Figure 1, a high frequency alternating voltage is developed at the terminals marked output by reason of the natural high frequency oscillations occurring in the ionized gas of the tube. The magnitude and frequency of this voltage is determined by the choice of the value of the grid current limiting resistance 5.

It has been found that the magnitude and frequency of this voltage are substantially constant for wide variations in load impedance.

As a concrete example, consider the circuit of Figure 1 applied to a type 6Q5, tube, one of the types which readily lend themselves to use in

this circuit. In this case, the value of anode current for production of sustained oscillation has been found to fall in the region between 3 and 30 milliamperes, with the greatest output occurring at approximately 9.2 milliamperes. In this example, the value of the anode current limiting resistance is 10,000 ohms and the grid resistance is a 500,000 ohm variable resistance, for an anode supply voltage of 140 volts. The actual results of operation of the circuit with this type tube are shown in the graph, Fig. 6. Reference to this graph will show the proper operating points for amplitude and frequency modulation.

The circuit arrangement of Fig. 2 shows a modification of the arrangement of Fig. 1 designed to produce modulated output voltage. By the application of a low frequency alternating voltage to the terminals marked modulating voltage any desired perentage of modulation may be obtained.

The circuit of Fig. 3 shows means for modulating the output of the oscillator by the insertion of a modulating voltage in series with the anode supply voltage source.

The circuit arrangement of Fig. 4 shows another embodiment wherein one tube aranged in my basic circuit is used to modulate a second tube similarly arranged but oscillating at a higher frequency. Each oscillator operates in a manner similar to that explained in connection with Fig. 1. The voltage appearing from anode to cathode of the low frequency oscillator tube 1 is the modulating voltage and corresponds to the voltage appearing across the output terminals of Fig. 1. The voltage appearing from anode to cathode of tube 1' is the useful output voltage and is modulated at the frequency generated by tube 1.

Figure 5 shows a circuit very similar to Figure 1 except that the tube is a diode and no control means other than anode current is provided.

While I have limited myself to description of my invention in certain preferred embodiments, I desire that it be understood that modifications may be made and that no limitations are intended other than those imposed by the scope of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America without the payment of any royalties thereon or therefor.

Having described my invention, I claim:

1. A generator of substantially sinusoidal high frequency alternating voltage comprising a continuously conducting gaseous discharge device having a cathode electrode and an anode electrode, a direct current source across said electrodes, and resistance means arranged between said source and said anode electrode for limiting the anode current to a value ranging from 3 to 30 milliamperes, and an output connection between said cathode and anode electrodes, whereby a high frequency alternating voltage is developed across the cathode electrode and the anode electrode of said discharge device without the aid of any tuned tank circuit or external condenser.

2. A generator of substantially sinusoidal high frequency alternating voltages comprising a continuously conducting gaseous discharge device having a control grid and a cathode electrode and an anode electrode, a direct current source across said electrodes, a first means arranged between said source and said anode electrode for limiting the anode current to a value ranging from 3 to 30 milliamperes a second means in series with said first means, anode, electrode and source for isolating the high frequency voltages from said direct current source, said second means including an inductance connected to said anode electrode, and a modulating voltage connected to said control grid and cathode electrode, whereby a modulated high frequency alternating voltage is developed across the cathode electrode and the anode electrode of said discharge device without the aid of any tuned tank circuit or external condenser.

3. A generator of substantially sinusoidal high frequency alternating voltage without the aid of a tank circuit or condenser, comprising a continuously conducting gaseous discharge device having at least a cathode electrode and an anode electrode, a source of potential across said cathode and anode, a current limiting resistor between said anode and said source of potential, means for isolating the high frequency alternating voltage from the source of anode potential, said means including an inductance connected between the anode electrode and the source of anode potential, whereby a high frequency alternating voltage is developed between the cathode electrode and the anode electrode of said discharge device, and an output circuit connected between said cathode electrode and said anode electrode having in series a capacitor for isolating the direct anode potential from the load circuit.

4. A generator of sinusoidal high frequency alternating voltage comprising a continuously conducting gaseous discharge device having a cathode, an anode and a control electrode, a direct current potential across said cathode and said anode with the positive terminal of the potential connected to said anode and the negative terminal connected to said cathode of the discharge device, a current limiting resistance in series with and between said anode and said positive terminal and a variable resistance connected between said anode and said control electrode of the discharge device, and a modulating voltage connected to said control electrode and cathode whereby a modulator high frequency alternating voltage is generated across said anode and cathode of the device without the aid of any tuned tank circuit or external condenser.

5. A generator of sinusoidal high frequency alternating voltages comprising a continuously conducting gaseous discharge device having a cathode, an anode and a control electrode, means across said cathode and said control element for applying a modulation signal across said cathode and said control electrode, voltage and frequency control means comprising a variable resistance connected across the anode and said control electrode, a source of potential across said cathode and said anode and means between said anode and said source for limiting the anode current of the discharge device, and an output circuit across the anode and cathode whereby a high frequency alternating voltage is generated across said cathode and said anode.

6. A generator of modulated high frequency alternating voltages without the aid of a tank circuit or condenser, comprising a continuously conducting gaseous discharge device having a cathode electrode and other electrodes, including an anode and at least one control electrode, a source of anode potential, a current limiting resistance, a connection between the positive terminal of the source of anode potential and one

end of said current limiting resistance, a connection between the other end of said resistance and the anode of the discharge device, a connection between the negative terminal of the source of anode potential and the cathode of the discharge device, a source of low frequency alternating voltage connected in series with the anode supply circuit, a variable resistance connected between the anode and the control electrode of the discharge device, whereby a modulated high frequency alternating voltage is generated between the cathode and the anode of the discharge device, and an output circuit connected between said anode and cathode.

7. A generator for producing modulated high frequency alternating voltages without the aid of a tank circuit or condenser, comprising a first continuously conducting gaseous discharge device having at least a cathode, control electrode and anode, a second continuously conducting gaseous discharge device having at least a cathode, control electrode and anode, a source of anode potential, a current limiting resistance connected between the positive terminal of the source of potential and the anode of the first discharge device, a connection between the cathode of the first discharge device and the anode of the second discharge device, a connection between the cathode of the second discharge device and the negative terminal of the source of anode potential, variable resistances connected between the control electrode of each discharge device and the associated anode, whereby a high frequency alternating voltage, modulated at a low frequency, is generated between the cathode and the anode of the second discharge device, and an output circuit connected between the anode and cathode of the second discharge device.

8. A generator of alternating voltages comprising a continuously conducting gaseous discharge device having a cathode, an anode and a control electrode, a source of potential across said cathode and said anode, means between said anode and said source for limiting and controlling the anode current, and means across said anode and said control electrode for controlling the current drawn by the control electrode, said last mentioned means including a limiting resistance connected between said control electrode and the anode of the discharge device for determining the frequency of the alternating voltage.

9. An electronic device for generating sinusoidal high frequency alternating voltages without the aid of a tank circuit or condenser, comprising a continuously conducting gaseous discharge device having a cathode electrode and other electrodes including an anode and at least one control electrode, a source of anode potential having positive and negative terminals, a current limiting resistance connected between the anode of the discharge device and the positive terminal of the source of potential, a connection between the negative terminal of the source of potential and the cathode of the discharge device, a connection between the anode of the discharge device and one end of a variable resistance, a connection between the other end of said variable resistance and the primary control electrode of the discharge device, whereby a high frequency alternating voltage is generated between the anode and the cathode of the device, and an output circuit connected between said anode and said cathode including a capacitor isolating the direct potential of the anode from said output circuit.

10. A generator of sinusoidal high frequency alternating voltages comprising a continuously conducting gaseous discharge device having a cathode electrode and other electrodes including an anode and at least one control electrode, a source of anode potential, a current limiting resistance, one end of which is connected to the positive terminal of the source of potential, an inductance connected between the other end of the current limiting resistance and the anode of the discharge device, a connection between the negative terminal of the source of potential and the cathode of the discharge device, a connection between the anode of the discharge device and one end of a variable resistance, a connection between the other end of said variable resistance and the primary control electrode of the discharge device, mean for inserting a modulating voltage, and an output circuit whereby a high frequency alternating voltage is generated between the anode and the cathode of the device.

11. An electronic device for generating alternating voltages without the aid of a tank circuit or condenser, comprising a continuously conducting gaseous discharge device having electrodes including at least a cathode and anode, a source of anode potential, a current limiting resistor between said anode and said source of potential, and an output circuit connected between anode and cathode, said output circuit including a capacitor in series with the output lead connected to the anode.

12. An electronic device for generating alternating voltages without the aid of a tank circuit or condenser comprising a continuously conducting gaseous discharge device, said discharge device having at least a cathode and anode, a source of potential across said cathode and anode, a current limiting resistor between said anode and said source of potential, and an output circuit connected between said anode and cathode.

13. An electronic device for generating alternating voltages without the aid of a tank circuit or external condenser comprising a continuously conducting gaseous discharge device in which the ionized gas oscillates within the discharge device at low orders of ionization, said discharge device having at least an anode and cathode, a source of potential across said anode and cathode, a current limiting resistor between said anode and said source of potential, and an output circuit connected between said anode and cathode.

THOMAS E. FAIRBAIRN.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,802,183	Park	Apr. 21, 1931
2,025,911	Stansburg	Dec. 31, 1935
2,094,677	Schlesinger	Oct. 5 ,1937
2,097,066	Hoover	Oct. 26, 1937
2,100,700	Schlesinger	Nov. 30, 1937
2,165,509	Ring et al.	July 11, 1939
2,172,050	Mayberry	Sept. 5, 1939
2,253,975	Guanella	Aug. 26, 1941
2,416,307	Grieg	Feb. 25, 1947

FOREIGN PATENTS

Number	Country	Date
145,963	Australia	May 25, 1936