

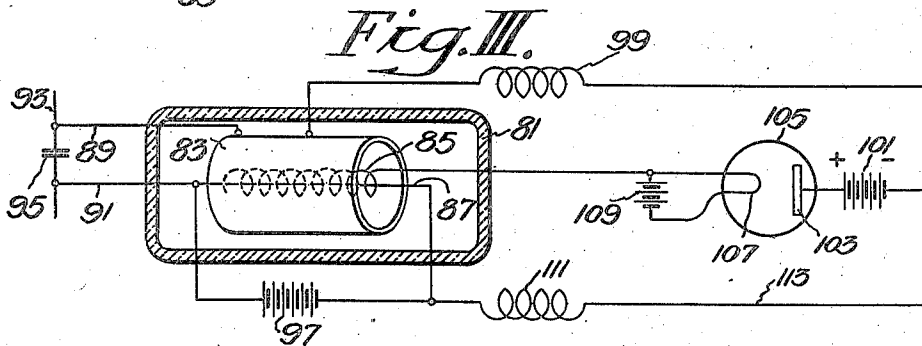
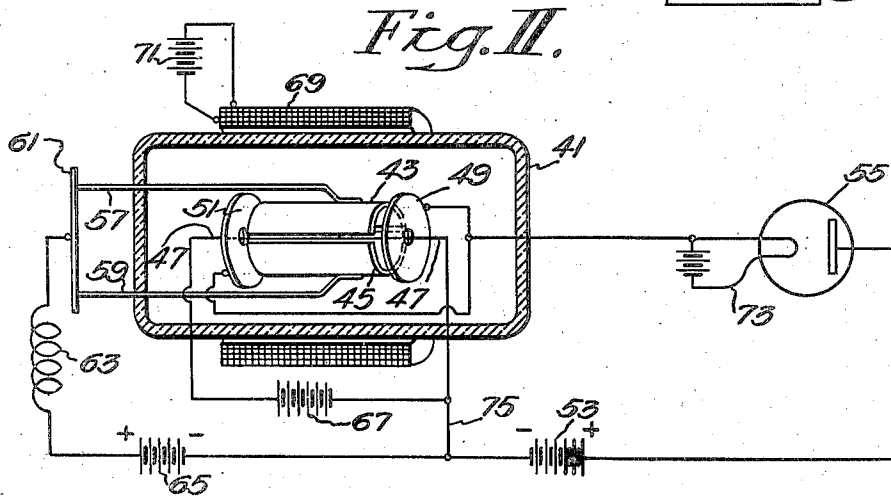
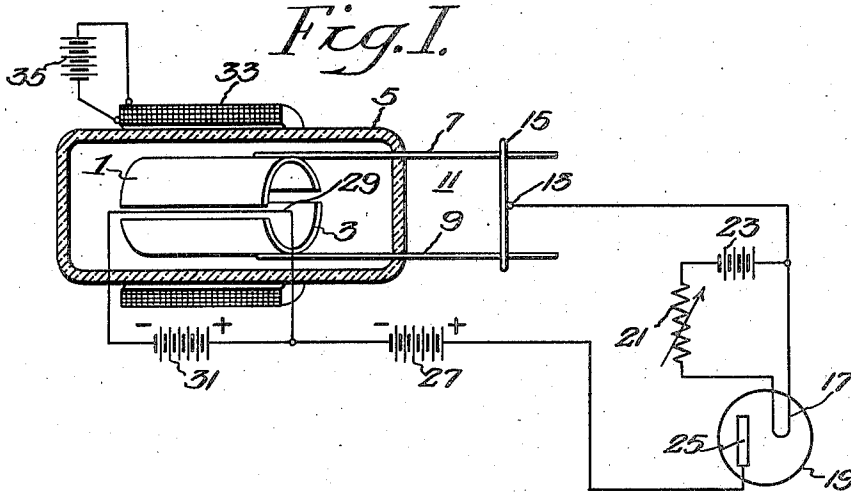
Jan. 31, 1939.

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2,145,361

ELECTRONIC DISCHARGE DEVICE

Filed Feb. 28, 1936



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UNITED STATES PATENT OFFICE

2,145,361

ELECTRONIC DISCHARGE DEVICE

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Application February 28, 1936, Serial No. 66,163

9 Claims. (Cl. 250—36)

My invention relates to electronic discharge devices for use at ultra high frequencies. More specifically my invention consists of an electronic oscillator of the Barkhausen-Kurz or magnetron type having anode current limiting means for stabilizing the operation.

Ultra high frequency oscillators of the magnetron or Barkhausen-Kurz type have been termed electronic oscillators. Electronic oscillators have electron transit times which are of appreciable duration with respect to their period of oscillation. In particular cases, the period of oscillation is determined by the electron transit time.

In general, electronic oscillators, detectors or amplifiers lack stability of operation. The lack of stability, and particularly frequency stability, has been attributed to variations of anode current, anode heating, electronic bombardment of the cathode, and effects caused by the relative phasing of the electron movements with respect to the alternating electrostatic field.

I have found that limiting or stabilizing the anode current is one method of stabilizing the operation of such electron discharge devices. One of the objects of my invention is to stabilize the operation of an electronic oscillator or amplifier. Another object is to stabilize the operation of an electronic oscillator, or the like, by limiting the anode current by suitable saturation means. A further object is to include an electron discharge tube, operating at saturation levels, in the anode circuit of a magnetron or Barkhausen-Kurz oscillator.

While the novel features of my invention are set forth in the appended claims, my invention may be best understood by reference to the accompanying drawing and specification.

Fig. I is a schematic circuit diagram of a magnetron oscillator including current limiting means in the anode circuit,

Fig. II illustrates a modified form of magnetron in which the current limiter is included in the end plate circuit, and

Fig. III is a schematic diagram of a Barkhausen-Kurz oscillator in which a current limiting tube is used in the grid circuit.

In Fig. I, a pair of anode electrodes 1, 3 are suitably mounted with an evacuated envelope 5. The anode leads 7, 9 are extended to form an oscillatory circuit 11. The mid-point 13 of a bridging member 15 is connected to the cathode 17 of a limiting tube 19. The cathode circuit includes a rheostat 21 and a battery 23. The anode 25 is connected to the positive terminal of the anode battery 27. The negative terminal of the anode battery is joined to the cathode circuit.

The cathode circuit is comprised of the cathode 29 which is suitably supported within the envelope 5 and the cathode heating battery 31. A magnetic field is established by an electromag-

net 33. The power for the magnet may be supplied by a battery 35, or other current source. A permanent magnet may be substituted for the electromagnet. The lines of magnetic force are substantially parallel to the cathode 29.

The magnetron is adjusted to detect, amplify or oscillate by an appropriate adjustment of magnetic field and oscillatory circuit. The anode current passes through the current limiter tube 19. The cathode heating current of this tube is adjusted by the rheostat 21, or equivalent means, to a value which insures limitation of current flowing from its cathode to anode. This limitation is established by saturation effects caused by the space charge, and limited electron emission of the cathode.

Inasmuch as the anode current cannot increase beyond the limits set by limiter tube 19, it will be apparent that instability of operation cannot be caused by excessive anode currents. Furthermore, the saturation current of the limiter tube may be determined at a value which will act as a regulator to automatically maintain constant anode currents in the magnetron anode circuit.

In Fig. II the magnetron comprises an envelope 41 within which are arranged a pair of anodes 43, 45, a cathode 47, and a pair of end plates 49, 51. These end plates are made of a non-magnetic material. Their function is to increase the efficiency of the magnetron by causing the electrons to follow a spiral helical path from the cathode towards the anodes, and end plates. The end plates are maintained at a positive bias with respect to cathode by a battery 53. Since the operation of an end plate magnetron will depend in part upon the electrons flowing from cathode to the end plates, the operation may be stabilized by including a current limiter tube 55 in the end plate circuit.

The anode circuit includes a transmission line 57, 59 which terminates in the anodes 43, 45 and a dipole antenna 61. The midpoint of the dipole antenna may be connected through a radio frequency choke coil 63 to the positive terminal of an anode battery 65 whose negative terminal is joined to the cathode circuit. The cathode 47 may be heated by a battery 67. The magnetic field is established by a suitable coil 69 and energizing battery 71. Although not shown, a cathode circuit rheostat may be included in the cathode circuit 73 of the limiter tube 55.

It should be understood that batteries 53, 65 connected to the anode and end plate electrodes may be combined. The operation of the circuits of Fig. II are substantially the same as those of Fig. I. The essential difference is that the stabilization of the magnetron of Fig. I is by anode current limitation, while the circuit of Fig. II operates by limitation of end plate current. The anode current limiter of Fig. I may

be used in Fig. II or both effects combined by including the limiter tube in the common lead 75.

In Fig. III the schematic circuit diagram of a Barkhausen-Kurz oscillator or amplifier is shown. In this figure, within an envelope 81 are included an anode 83, a grid 85, and a cathode 87. Each of these electrodes is positioned by appropriate supporting elements. The anode and cathode are connected to leads 89, 91 which form an oscillatory circuit and transmission line which may terminate in a dipole antenna 93. The blocking capacitor 95 is included in the dipole antenna 93 to prevent short circuiting of the battery 97 which heats the cathode 87.

The anode 83 is connected to a radio frequency choke coil 99 which in turn is connected to the negative terminal of the grid biasing battery 101, although it may be made slightly positive with respect to cathode. The positive terminal of this battery is connected to the anode 103 of the current limiter tube 105. The cathode 107 of this tube is heated by a battery 109. The current in the cathode 107 may be adjusted to obtain the limiting or saturation effects previously described in connection with the limiter tube 19 of Fig. I. The cathode circuit is connected to the grid 85. This grid is positively biased by the potential of battery 101 less the voltage drop across the cathode-anode path of the limiter tube 105. The grid-cathode circuit is completed by the radio frequency choke coil 111 which is connected between cathode and the negative terminal of the biasing battery 101.

The operation of the Barkhausen-Kurz oscillator illustrated in Fig. III is dependent upon the electron transit time from the cathode to the anode and return. The stability of operation of this type oscillator is affected by the same circumstances as the magnetron oscillator. The electronic path most affected by variations of current is that between cathode and the positively biased grid electrode. The current in this path is regulated by the saturation or limiting tube, and thus stabilized.

Although the limiting tube is shown in the grid-cathode circuit, it may be located in the common connection 113 between the choke coil 111 and the negative terminal of the battery 101.

In Figs. I and II, a split anode type of magnetron has been illustrated. It should be understood that my invention is not limited to magnetrons having two semi-cylindrical anodes but may be applied to magnetrons having one, or any number of anodes. Likewise, in Fig. III, the oscillatory circuit is shown between the outer electrode and cathode, but it is not essential that the tune circuit be connected in the illustrated manner, as the circuit may be connected to any two electrodes.

I claim as my invention:

1. A magnetron oscillator having a thermionic cathode electrode and an electrode positively biased with respect to said cathode, the oscillatory period of said tube being a function of the electron transit time, an oscillating circuit connected to said electrodes, a source of voltage for said electrodes, and means connected between said source of voltage and one of said electrodes for limiting the electronic current during operation to a predetermined maximum.

2. A magnetron oscillator having a thermionic cathode and electrodes positively biased with respect to said cathode, the electron transit period determining the oscillatory period of said tube, an oscillating circuit connected to said cathode

and at least one of said other electrodes, a source of voltage for said oscillator, and means connected between said source of voltage and at least one of said electrodes for limiting the electronic current during operation to a predetermined maximum.

3. A magnetron oscillator having a thermionic cathode and positively biased electrodes and an oscillatory period which is a function of the electron transit time, an oscillating circuit connected between said cathode and at least one of said electrodes, a source of voltage for said electrodes, and an electron discharge device having a current saturation characteristic connected between the source of voltage and one of said electrodes for limiting the electronic current during operation of the device to a predetermined maximum.

4. A magnetron oscillator having a thermionic cathode and a plurality of positively biased electrodes and an oscillatory period which is a function of the electron transit time, an oscillating circuit connected between said cathode and at least some of said electrodes, a voltage source, and an electron discharge device having a current saturation characteristic connected between the source of voltage and at least some of said positively biased electrodes for limiting the electronic current during operation of the device to a predetermined maximum.

5. A magnetron having a thermionic cathode and a plurality of anodes, an oscillating circuit connected to said anodes, a source of voltage for said anodes and means connected between said source of voltage and said anodes for limiting the anode current during operation to a predetermined maximum.

6. A magnetron having a thermionic cathode and a plurality of anodes, an oscillating circuit connected to said anodes, a source of voltage for said anodes and an electron discharge device having a current saturation characteristic connected between the source of voltage and said anodes for limiting the anode current during operation of the magnetron to a predetermined maximum.

7. A magnetron having a thermionic cathode, end plates, and a plurality of anodes, an oscillating circuit connected to said anodes, sources of voltage for positively biasing said anodes and said end plates with respect to said cathode, and means connected between said sources of voltage and said end plates for limiting the anode current during operation to a predetermined maximum.

8. A magnetron having a thermionic cathode, end plate electrodes, and a plurality of anodes, a source of voltage, an oscillating circuit, and a connection from said oscillating circuit to said voltage source and to said anodes, a voltage source for said end plates, and means connected between the last mentioned voltage source and said end plates for limiting the anode current during operation to a predetermined maximum.

9. A magnetron having a thermionic cathode, end plate electrodes and a plurality of anodes, a source of voltage, an oscillating circuit, and a connection from said oscillating current to said voltage source, a voltage source for said end plates, and an electron discharge device having a current saturation characteristic connected between the source of voltage and said end plates for limiting the anode current during operation to a predetermined maximum.