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MAGNETRON HAVING MODULATING MEANS

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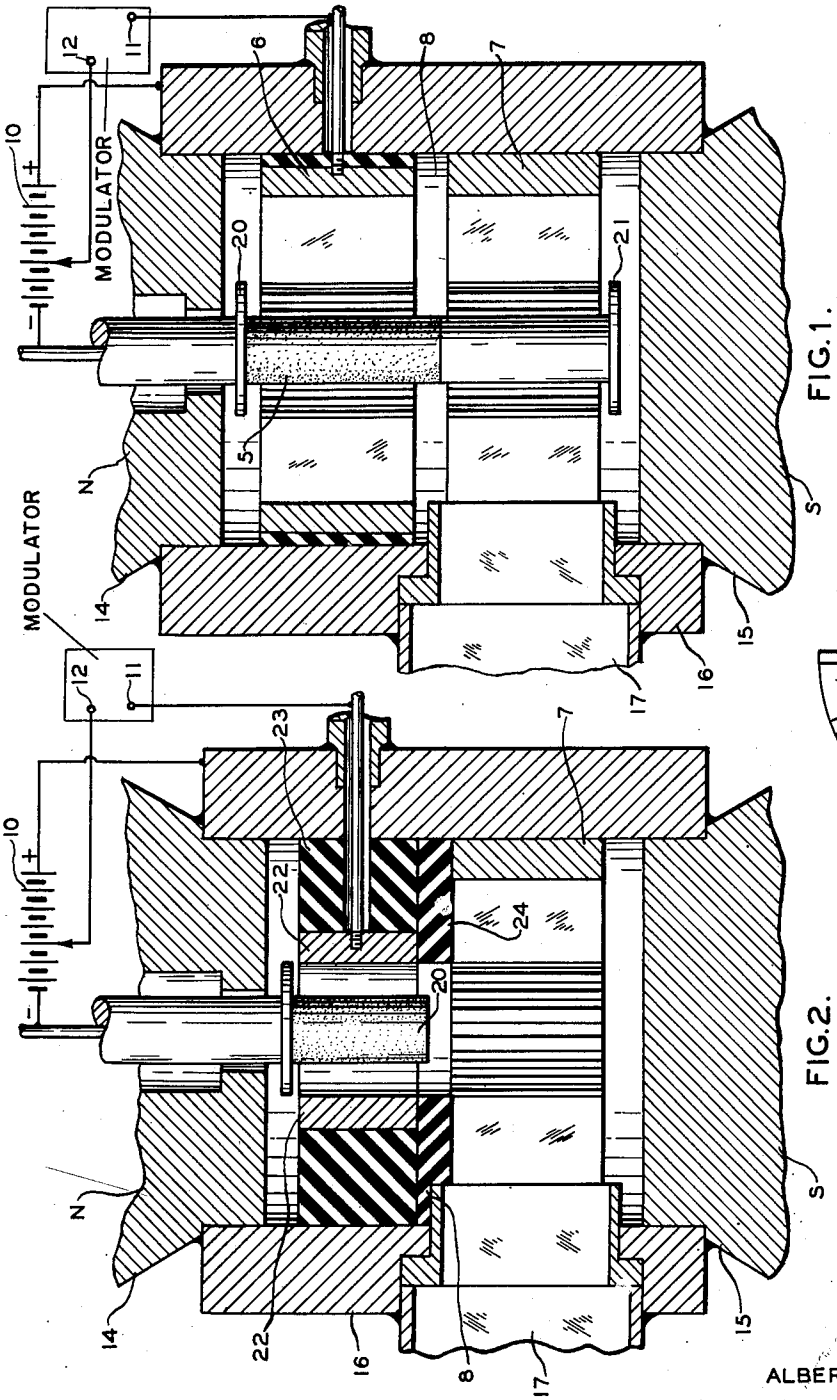


FIG. 1.

FIG. 2.

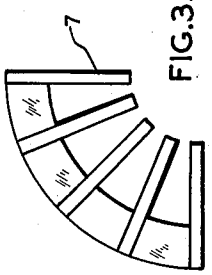


FIG. 3.

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MAGNETRON HAVING MODULATING MEANS

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6 Claims. (Cl. 315—40)

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My invention relates in general to electron discharge devices and more particularly to the class of such devices that includes the so-called magnetron tubes.

The magnetron radio frequency generator as known in the prior art consists of an anode electrode and a cathode electrode placed concentrically therewith, both electrodes being situated in a strong unidirectional magnetic field. Electrons emitted from the cathode electrode are acted upon simultaneously by the electrostatic field between anode and cathode and the previously mentioned magnetic field in such a fashion as to cause oscillations to be set up in the resonant chambers of the anode.

Since the conventional magnetron is a two element electron discharge device it is difficult to vary the operation of the tube by altering the electrode potentials or by changing the strength of the magnetic field, the anode being maintained at a quite high voltage and the magnetic field being extremely strong. Therefore, it is clearly advantageous to add a third electrode analogous in function to a control grid in a vacuum tube.

Accordingly it is one object of my invention to provide an improved magnetron oscillator provided with a control electrode.

Another object of my invention is to provide a three electrode magnetron tube.

Still another object is to provide a magnetron in which the operating conditions may be governed by a control electrode.

These and further objects of my invention will be apparent to those skilled in the art upon reference to the following specification, claims, and to the drawings in which:

Fig. 1 represents a vertical cross-sectional view of one embodiment of a three electrode magnetron constructed according to the principles of my invention; and

Fig. 2 represents a vertical cross-sectional view of another embodiment of my invention.

Fig. 3 is a plan view of an anode segment.

Briefly, my invention comprises a magnetron structure consisting of an emitting cathode surrounded concentrically by a control electrode, the combination being maintained coaxially with a conventional magnetron anode.

Referring now to Fig. 1, one embodiment of the invention is shown. A cylindrical cathode 5 is coated over its upper half with an electron emissive material. The ends of cathode 5 are enlarged so as to have two hats or shields to prevent electrons from escaping from the anode-cathode region. The emissive portion of cathode 5 is surrounded by a control electrode 6, which

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in this case is a conventional magnetron anode block. Any type of multiresonator type of block may be used, such as hole-and-slot, vane, or "Rising Sun" anode, etc. The anodes of this type are well known in the magnetron art, and are described and illustrated, for example, in The Bell System Technical Journal vol. XXV #2, April 1946. Control electrode 6 and a magnetron anode 7 are mounted coaxially and may be precisely similar in construction. By the way of illustration a segment of a vane anode is illustrated in Fig. 3, which is, as mentioned previously, one type of suitable anode structure 7. Since different biasing potentials are present on control electrode 6 and magnetron anode 7, they are separated by an insulating ring which may be the vacuum in the envelope surrounding the cathode and anode, or a solid non-conductor. In Fig. 1, the control electrode 6 is insulated from anode 7 by means of a gap 8 and an insulating ring 9, while in Fig. 2 the control electrode 22 is insulated by means of rings 23 and 24. A power supply 10 furnishes potentials, and terminals 11 and 12 permit a modulating voltage to be impressed upon control electrode 6. The entire cathode-anode structure is placed between poles 14 and 15 of a powerful magnet so that the magnetic field will be parallel to the cathode axis. The unit is normally enclosed in a hermetically sealed and evacuated envelope 16.

A wave guide output circuit 17 is illustrated in the figures. However, any other type of output circuit can be used, such as a loop and a concentric line. The circuits of this type are well known in the art, and do not constitute a part of this invention.

In the operation of the tube, electrons are drawn from the emitting surface of cathode 5 by the potential difference between it and control electrode 6. The electrons enter the space immediately surrounding the cathode where the relationship between the magnetic field therein and the electrostatic potential is such that the electrons describe a spiral path around cathode 5 toward anode 6. The circumferential velocity of the electrons is largely determined by the voltage applied to control electrode 6. When the electrons pass into the region between the non-emitting portion of the cathode and anode 7, oscillations are set up in the resonant chambers of anode 7 and radio frequency power is generated therein. Oscillations also occur in the resonant chambers of electrode 6, but this oscillator absorbs power from supply 10 and is not a power generator. The peak power output from anode 7 varies with the voltage on control electrode 6 and hence amplitude modulation of the

output signal may be brought about by impressing an alternating voltage on electrode 6.

The embodiment shown in Fig. 2 differs from that of Fig. 1 in that only an emissive portion 20 of the cathode is employed. Also control electrode 22 is a simple ring rather than a complete anode block. Anode 7 is a conventional magnetron anode in Fig. 1, and may be of any desirable type identical to that illustrated, such as a vane anode illustrated in Fig. 3. The cathode in Fig. 2 may be of the type illustrated in Fig. 1, or may consist of two axially separated cylinders only the upper one being the electron-emitting cathode, as shown in Fig. 1. Since the nonemitting cathode is not essential to the operation of the device it may be omitted, as illustrated in Fig. 2.

While there has been described hereinabove what is at present considered to be a preferred embodiment of the present invention, it will be obvious to those skilled in the art that changes and modifications may be made therein without exercise of inventive ingenuity. Hence, I claim all such modifications and adaptations as may fall fairly within the spirit and scope of the hereinafter appended claims.

What I claim is:

1. A magnetron comprising a cylindrical cathode with an electron-emitting coating on the outer surface of said cathode, a control element surrounding said cathode, said control element being coaxially mounted with respect to said cathode and forming an interaction space between said cathode and said control element, and a multiresonator anode coaxially mounted with the continuation of the axis of said cathode and axially displaced from said cathode and said control element, so that said anode surrounds no portion of the cathode.

2. A magnetron circuit comprising a cylindrical cathode having an electron-emitting coating on the upper portion of said cathode and only a substantially non-emissive metallic surface on the remaining portion of said cathode, a control electrode coaxially mounted with the electron-emitting coating portion of said cathode, a multiresonator type of anode coaxially mounted with and surrounding only said remaining portion of said cathode, an insulating means between said control electrode and said anode, a source of direct potential connected across said cathode and said anode, a source of direct potential connected across said cathode and said control electrode, and a source of varying potential connected in series with the cathode-control electrode circuit.

3. A magnetron circuit including a cathode in the form of a cylinder having an electron-emitting coating on the upper portion of the outer surface of said cylinder, a control element in concentric relationship with respect to the coated electron-emitting portion of said cylinder, said control element being in spaced relationship with respect to said cylinder, a magnetron anode in coaxial relationship with respect to and surrounding only the remaining portion of said cylinder, said anode being spaced from said cylinder so as to form an interaction space between said cylinder and said anode, and said anode being also spaced from said control element along the axis of said cylinder, a source of cathode-anode potential connected across said cylinder and said anode, a source of direct potential connected across said cylinder and said control element, and a source of modulating voltage connected in series with said source of direct potential.

4. A magnetron circuit including a cathode in the form of a cylinder having an electron-emitting coating only on the upper portion of the outer surface of said cylinder, a control element in concentric relationship with respect to the electron-emitting portion of said cylinder, said control element comprising a hollow metallic cylinder surrounding said electron-emitting coated upper portion of said cylinder, the inner diameter of said hollow cylinder being larger than the outer diameter of said source of cathode cylinder, a multiresonator type of magnetron anode in coaxial relationship with respect to the remaining portion of said cathode cylinder, the inner diameter of said anode being greater than the outer diameter of the uncoated portion of said cathode cylinder, said anode being axially spaced from said control element, a source of cathode-anode potential connected across said cylinder and said anode, a source of direct potential connected across said cylinder and said control element, and a source of modulating voltage connected in series with said direct potential.

5. A magnetron comprising a single cylindrical cathode, an electron-emitting coating only along the upper portion of said cathode, the lower portion of said cathode being a non-emitter of electrons, a control electrode coaxial with and surrounding substantially the entire upper portion of said cathode, a multiresonator anode in spaced, coaxial relationship with the lower portion of said cathode, said anode being axially spaced from said electrode and surrounding only the lower portion of said cathode, and means for producing a magnetic field substantially parallel to the axis of said cathode.

6. A magnetron circuit comprising a single cylindrical cathode, a control electrode having a cylindrical inner surface surrounding said cathode, a multiresonator anode having a cylindrical inner surface having the same diameter as the cylindrical surface of the control electrode and in axially spaced relationship with respect to said control electrode, said cathode control electrode and anode having a common central axis, means for producing a magnetic field substantially parallel to said common axis, a source of direct potential connected between said anode and said cathode, a source of direct potential connected between said control electrode and said cathode, the potential between said control electrode and said cathode being lower than the potential between said cathode and said anode, and a source of modulating voltage connected in series with the cathode-control electrode circuit for modulating the output of said magnetron circuit.

ALBERT M. CLOGSTON.

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