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2,493,423

ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

Filed May 29, 1944

Fig. 1.

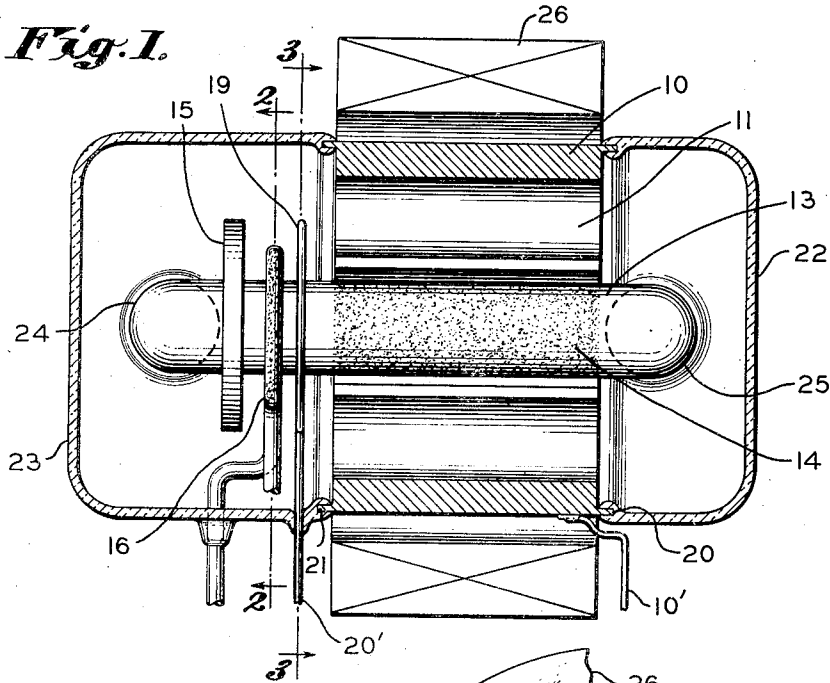


Fig. 3.

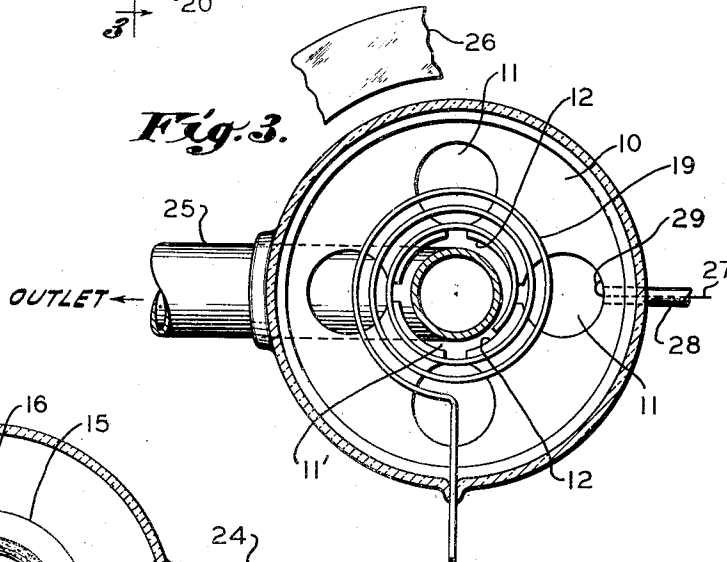
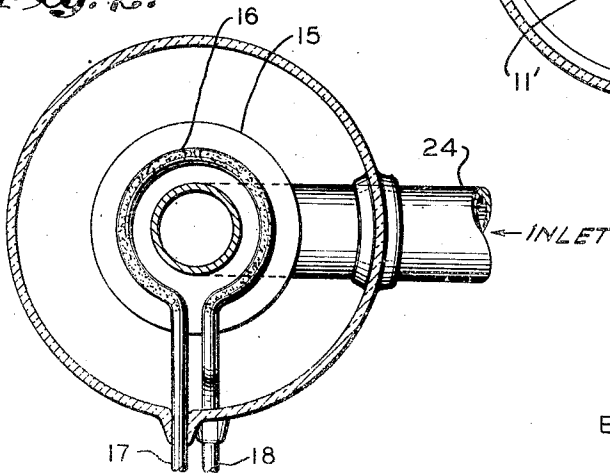


Fig. 2.



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ELECTRON DISCHARGE DEVICE OF THE
MAGNETRON TYPE

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10 Claims. (Cl. 250—27.5)

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Our invention relates to electron discharge devices, particularly to magnetrons in which the electrode system during operation of the device is subjected to a magnetic field.

Magnetrons dependent upon secondary emission have been recently developed. In this type of tube the main cathode may be of the cold type and coated with secondary emitting material. This cathode may be surrounded by the usual anode arrangement. To initiate emission from the main cathode, a second cathode, of the thermionic type and referred to as a pilot cathode and maintained at or near cathode potential, provides the electrons which are attracted to the main cathode for releasing secondaries. Due to the magnetic field, the path of the primary electrons is such that a considerable portion of them collide with the secondary emission surface of the cold cathode with sufficient velocity to release the secondary electrons. These secondary electrons then traverse a normal cyclic path common to the magnetron structure, a considerable number of which return to the cathode with sufficient energy to release still more secondary electrons. This process is repeated until an equilibrium condition is reached.

It is desirable in such types of magnetrons to be able to control the flow of primary electrons in accordance with predetermined conditions and thus the secondary electron current.

An object of our invention is to provide an electron discharge device of the magnetron type in which amplifier action can be produced.

Another object of our invention is to provide an electron discharge device of the magnetron type utilizing secondary emission and in which complete and desirable control according to predetermined conditions of the primary electrons can be assured.

A still further object of our invention is to provide a magnetron of the type described utilizing grid control and in which grid control is assured by using secondary cathodes operable at low temperatures.

These and other objects will appear hereinafter.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 is a longitudinal section of a magnetron made according to our invention, Figure 2 is a transverse section taken along the line 2—2 of

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Figure 1, and Figure 3 is a transverse section taken along the line 3—3 of Figure 1.

In accordance with our invention we provide a magnetron having an anode block 10 of the type now commonly used, which has a plurality of longitudinally extending tubular chambers or bores 11 parallel to and spaced around and communicating with a central cathode chamber 11' within which a tubular cathode 13 is coaxially positioned with respect to the anode block. The legs 12 formed intermediate the chambers 11 act as the anode segments whereas chambers 11' act as cavity resonators. An anode lead 10 is provided.

The portion of the cold cathode 13 within the cathode member 11' is coated with secondary emitting material 14 and the cathode 13 is provided at one end with a reflector 15 adjacent which is placed a coated thermionic or pilot cathode 16 having leads 17 and 18. The reflector 15 and thermionic cathode 16 are both positioned outside the cathode chamber.

Positioned between the cathode 16 and the cathode coating 14 is a control grid 19 for controlling the emission of primary electrons from the cathode 16. The grid is provided with a lead 20' and is preferably maintained at a lower potential than the cathode 13.

The anode block 10 is provided with lips 20 and 21 to which are sealed the cup-shaped ends 22 and 23 of insulating material, preferably glass or ceramic, and through which the ends 24 and 25 of the tubular cathode 13 are sealed. The purpose of the hollow tubular construction is to permit the flow of cooling fluid through the main cathode. The coil 26 is utilized for providing a magnetic field parallel to the cathode 13 and between the cathode 13 and the anode segments 12.

In order that the grid may maintain control of the cathode emission, it is necessary that there be no primary electrons emitted from it. Cathode material should, therefore, be such that effective secondary emission takes place at low temperatures. This may be done by using silver magnesium material for cathode 13, upon which secondary emitting material is disposed. Since returning secondary electrons bombard cathode 13, a large amount of energy must be removed from it by suitable means. Air cooling may be sufficient at low duty cycles and water cooling may be necessary if the device is utilized as a continuous oscillator. It may be desirable to isolate the pilot cathode 16 from the cathode 13 by operating the former at a lower potential with the grid 19 at a potential lower than that of either of

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the cathodes. The control voltage may be applied to the grid 19 to initiate operation of the magnetron. The usual output coupling loop 29 terminates in the coaxial line 27, 28.

While we have indicated the preferred embodiments of our invention of which we are now aware and have also indicated only one specific application for which our invention may be employed, it will be apparent that our invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of our invention as set forth in the appended claims.

What we claim as new is:

1. An electron discharge device having an anode provided with a central cathode chamber therein, a first cathode having an electron-emitting surface positioned within said chamber surrounded by the active surface of said anode, a second cathode positioned adjacent but outside of said anode for supplying primary electrons to said chamber, and a control electrode positioned between the emitting surfaces of the second cathode and said first cathode.

2. An electron discharge device having an anode provided with a central cathode chamber therein, a first cathode having an electron-emitting surface positioned within said chamber and surrounded by the active surface of said anode, a second cathode positioned adjacent but outside of said anode for supplying primary electrons to said chamber, a control electrode positioned between the emitting surfaces of the second cathode and said first cathode, and means adjacent said electron discharge device for providing a magnetic field between said anode and said first cathode.

3. An electron discharge device having an anode, a hollow cold cathode positioned axially of said anode and coated with secondary emitting material, a thermionic cathode for supplying electrons to the space between said anode and said hollow cathode and positioned outside but adjacent said space, a control electrode positioned between said thermionic cathode and the coated surface of said hollow cathode, and an electron reflecting electrode positioned on said cold cathode on the opposite side of said thermionic cathode from said control electrode, said cold cathode having tubular members extending from the ends of said cold cathode for directing a cooling medium through said cold cathode.

4. An electron discharge device having an anode block provided with a central cathode chamber extending therethrough and a plurality of tubular chambers parallel to said central chamber and opening into said chamber, a hollow cold cathode positioned within the cathode chamber and having a surface coated with secondary emitting material, a thermionic cathode for supplying primary electrons to said cathode chamber and positioned adjacent but outside said cathode chamber, a control electrode between said thermionic cathode and the coated surface of said cold cathode and an electron reflecting electrode positioned on the opposite side of said thermionic cathode from said control electrode, said anode block being provided with sealing lips and cup-shaped insulating members sealed to said lips and providing with said anode block an envelope for said cathodes, control electrode and reflecting electrode, said

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hollow cold cathode having tubular members communicating with the interior thereof and extending through said envelope.

5. An electron discharge device having an anode block provided with a central cathode chamber extending therethrough and a plurality of tubular chambers parallel to said central chamber and opening into said chamber, a cold cathode positioned within the cathode chamber and having a surface coated with secondary emitting material, a thermionic cathode adjacent but outside said cathode chamber for supplying primary electrons to said cathode chamber, a control electrode between said thermionic cold cathode and the coated surface of said cathode, and an electron reflecting electrode positioned on the opposite side of said thermionic cathode from said control electrode, said anode block being provided with sealing lips and cup-shaped insulating members sealed to said anode block and providing with said anode block an envelope for said cathodes, control electrode and reflecting electrode.

6. An electron discharge device having an anode block provided with a central cathode chamber extending therethrough and a plurality of tubular chambers parallel to said central chamber and opening into said central chamber, a hollow cold cathode positioned within the cathode chamber and having a surface coated with emitting material, a thermionic cathode adjacent but outside the cathode chamber for supplying primary electrons to said cathode chamber, and a control electrode for said thermionic cathode positioned between said thermionic cathode and the coated surface of said cold cathode, said hollow cold cathode having tubular members opening into the interior thereof and extending from the ends of said cold cathode.

7. An electron discharge device having an anode block provided with a central cathode chamber extending therethrough and a plurality of tubular chambers parallel to said central chamber and opening into said central chamber, a hollow cold cathode positioned within the cathode chamber and having a surface coated with secondary emitting material, a thermionic cathode adjacent but outside said cathode chamber for supplying primary electrons to said cathode chamber, a control electrode for said thermionic cathode positioned on one side of said thermionic cathode, a reflecting electrode positioned on the opposite side of said thermionic cathode from said control electrode, said hollow cold cathode having tubular members opening into the interior thereof and extending from the ends of the cold cathode, and means adjacent said electron discharge device providing a magnetic field within said cathode chamber and parallel to said cathode.

8. An electron discharge device having an anode provided with a central cathode chamber, a tubular cold cathode positioned within said chamber and axially of said anode and coated with secondary emitting material on its outer surface, a thermionic cathode for supplying electrons to said chamber and positioned adjacent but outside of said chamber and a control electrode positioned between said thermionic cathode and the coated surface of said tubular cathode, said cold cathode having tubular members extending from the ends of said cold cath-

ode for directing a cooling medium through said cold cathode.

9. An electron discharge device having an anode, a tubular cold cathode positioned axially of said anode and coated with secondary emitting material on its outer surface, a thermionic cathode for supplying electrons to the space between said anode and said tubular cathode adjacent but outside said space, a control electrode positioned between said thermionic cathode and the coated surface of said tubular cathode, and a reflecting electrode positioned on said cold cathode on the opposite side of said thermionic cathode from said control electrode.

10. An electron discharge device according to claim 1, wherein said first cathode is tubular and is provided with tubular members extending from the ends thereof for directing a cooling medium therethrough.

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Certificate of Correction

Patent No. 2,493,423

January 3, 1950

JOHN M. SPOONER ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 2, line 11, strike out the word "the", second occurrence; line 12, before "chambers" insert *the*; line 13, for "lead 10" read *lead 10'*; column 4, line 15, strike out "cold" and insert the same before "cathode," in line 16, same column;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 3rd day of October, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,

Assistant Commissioner of Patents.