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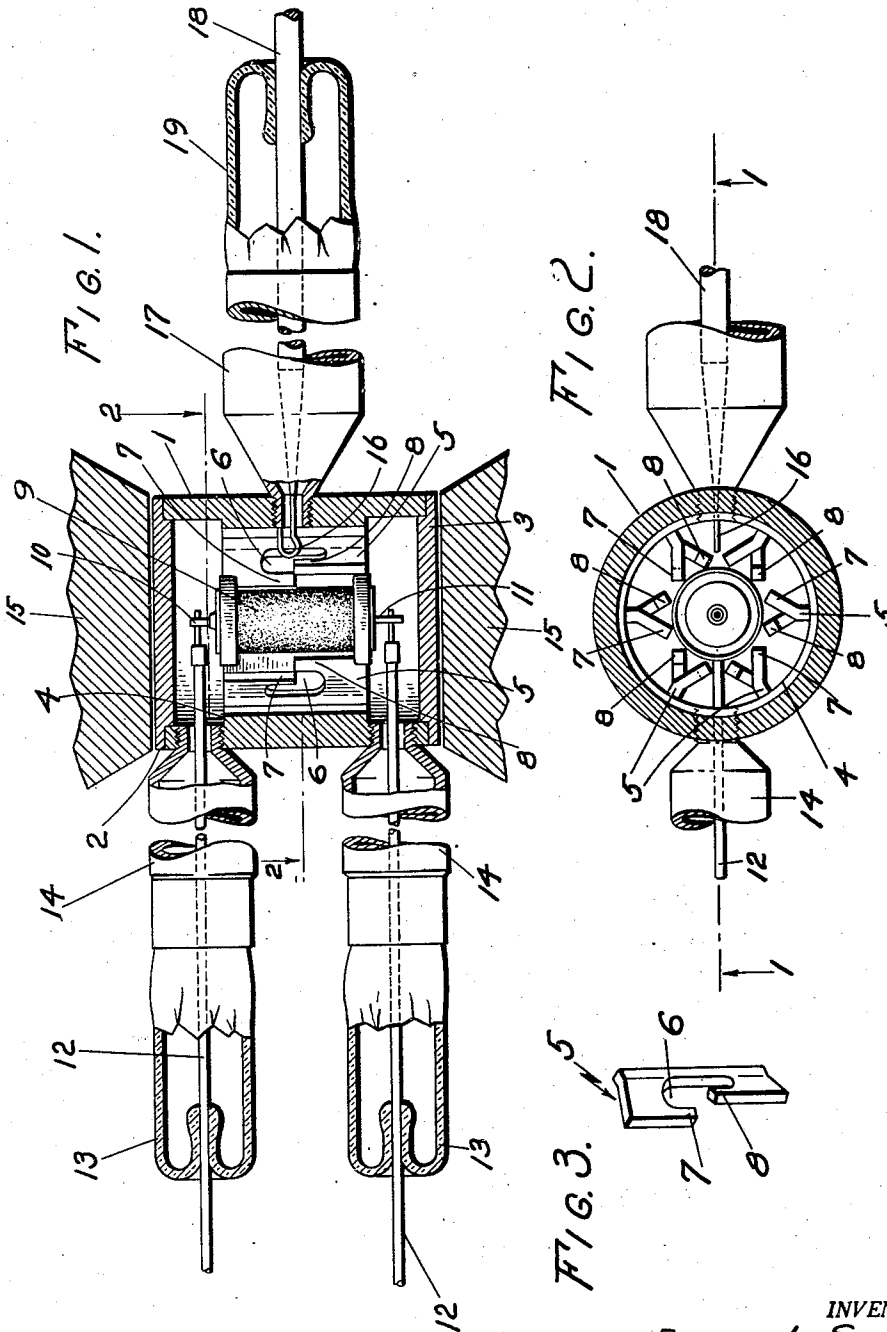
P. L. SPENCER

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ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

Filed Nov. 2, 1943

2 Sheets-Sheet 1



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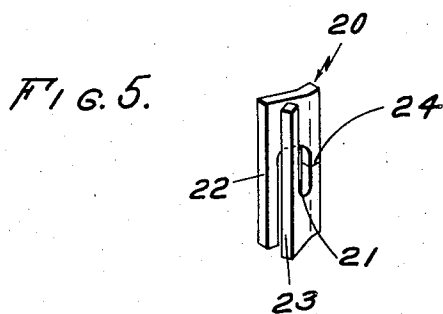
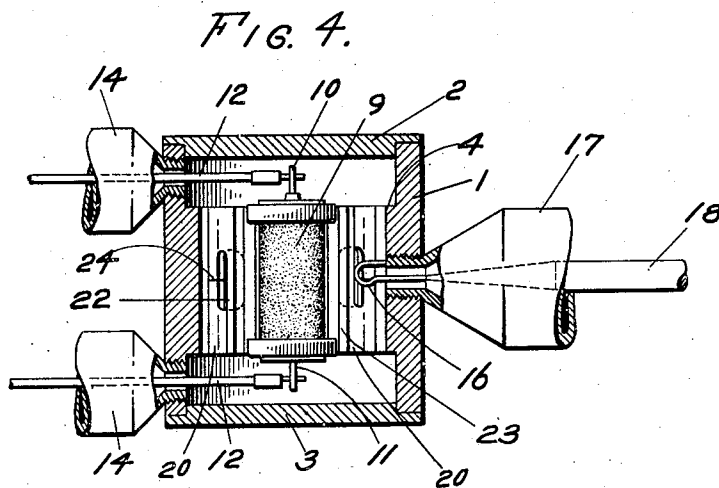
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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE OF THE
MAGNETRON TYPEPercy L. Spencer, West Newton, Mass., assignor
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Application November 2, 1943; Serial No. 508,709

8 Claims. (Cl. 315—39)

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This invention relates to a magnetron, and more particularly to one of the multiple anode type in which the internal structure provides a plurality of oscillating circuits, all of which are intended to oscillate at the same frequency and thus to contribute to the effective output of the magnetron. Heretofore difficulty has been encountered in coupling all of the oscillating circuits together, and propagating the oscillatory energy from circuit to circuit until it is picked up by the output connection. I believe this has been due to the fact that such coupling has heretofore been accomplished through a complex and elongated path.

An object of this invention is to devise a magnetron of the foregoing type in which the coupling between the oscillating circuits is accomplished by a simple path of shortened length.

Another object is to devise an arrangement in which the coupling between the oscillating portion of the device and the output means is substantially increased.

A further object is to devise an arrangement of the above type in which the efficiency thereof is substantially increased.

The foregoing and other objects of this invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying drawings, wherein:

Fig. 1 is a longitudinal cross-section of a magnetron embodying my invention taken along line 1—1 of Fig. 2;

Fig. 2 is a transverse cross-section taken along line 2—2 of Fig. 1;

Fig. 3 is a perspective view of one of the anode arm members of the arrangement shown in Figs. 1 and 2;

Fig. 4 is a longitudinal cross-section, similar to Fig. 1 of another embodiment of my invention; and

Fig. 5 is a perspective view of one of the anode arm members of the arrangement shown in Fig. 4.

The magnetron illustrated in Figs. 1 and 2 comprises a tubular envelope 1 made of a cylinder of conducting material, such as copper. The ends of the envelope are covered by caps 2 and 3 likewise formed of conducting material, such as copper, and hermetically soldered in place on the ends of envelope 1. The envelope 1 is formed with a central annular projection 4. A plurality of anode arm members 5 are secured to the inner face of the projection 4, as by soldering, and disposed substantially radially within the envelope

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1. The anode arm members 5 may be formed by being stamped from a sheet of highly conductive copper. Each of said anode arm members is formed with a central opening 6 and is divided along one side to provide upper and lower anode arms 7 and 8. Each anode arm member 5 is then bent so as to displace the arms 7 and 8 relatively to each other. The anode arm members 5 are so arranged within the envelope 1 that the upper and lower anode arms 7 and 8 are alternately disposed around the central region within the envelope 1. The outer edges of the arms 7 and 8 form electron receiving anode faces which cooperate with a cathode 9 supported substantially centrally of said anode faces. The cathode 9 is preferably of the indirectly-heated oxide-coated thermionic type having an outer conducting cylinder coated with electron emissive oxides and having an internal heater. The end conductors 10 and 11 of the heater project from the opposite ends of the cathode structure 9. One of the conductors 10 may be electrically connected to the external cathode sleeve, while another conductor 11 is insulated from said sleeve. The cathode 9 is supported by a pair of lead-in conductors 12 welded respectively to the end conductors 10 and 11. The lead-in conductors 12 pass through glass seals 13 mounted at the outer ends of conducting pipes 14 hermetically sealed through the wall of the envelope 1 adjacent the upper and lower ends thereof.

When such a magnetron is placed between suitable magnetic poles 15 to create a longitudinal magnetic field and the device is energized, oscillations are set up. These oscillations may be led out from the tube by means of a coupling loop 16 substantially aligned with the openings 6 in the anode arm members 5. One end of the coupling loop 16 is connected to the inner end of a conducting pipe 17 hermetically sealed through the wall of the envelope 1 substantially midway between the ends thereof. The other end of the coupling loop 16 is connected to a conductor 18 which passes through said pipe 17 and is sealed through a glass seal 19 mounted at the outer end of said pipe. An additional conducting pipe, not shown, may be electrically connected to the pipe 17 and form with the conductor 18 a concentric transmission line through which the high frequency oscillations generated by the magnetron may be led to a suitable utilization device.

In the above construction a capacitance exists between adjacent anode arms. Likewise a conducting path exists between each pair of alternate anode arms, extending, for example, from

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an upper anode arm 7, through its anode arm member 5, around the opening 6 to the lower anode arm 8. It will also be noted that a possible conducting path exists, for example, from one anode arm 7, through the upper portion of its anode arm member 5, through a portion of the wall of the projection 4 to the adjacent anode arm member 5, and thence through the lower portion of said adjacent arm member to the lower anode arm 8 thereof. Each of the above disposed paths contains a substantial amount of inductance. The above capacitances and inductances constitute a plurality of tuned circuits. It is desired that all of these circuits shall be resonant at a definite predetermined frequency at which the device is to be operated. When the magnetron is in its oscillating condition the anode arms 7 and 8 will be of opposite voltage phase, and thus oscillating currents will flow through each of the conducting paths above described. These oscillating currents will flow in a generally circular direction around each opening 6 and thus tend to create a magnetic field extending axially through each of said openings. It will be noted that the openings 6 collectively form a closed annular space within the envelope 1. Since the anode arms 7 and 8 are of opposite voltage phase all of the oscillating currents will be in phase so as to tend to create an annular magnetic field extending in one direction through said annular space during one half cycle and in the other direction through said annular space during the other half cycle. Thus all of the oscillating currents will contribute to the production of a strong resultant annular magnetic field in said annular space. The coupling loop 16 is interposed so that said resultant magnetic field passes through said coupling loop whereby said loop is closely coupled to all of the oscillating circuits. In this way the energy of each of said oscillating circuits is propagated through a simple annular path of shortened length directly to said coupling loop 16, which thus leads said oscillatory energy from the tube with a substantial maximum of efficiency.

The close coupling between all of the oscillating circuits tends to force all of said circuits to oscillate at exactly the same frequency even though slight differences in the natural frequencies of said circuits might otherwise tend to exist. Also such a construction has a strong tendency to eliminate the probability of the tube to oscillate in various spurious modes which in previous devices have substantially decreased the efficiency. Tubes constructed as above therefore tend to be of a substantially increased efficiency.

Instead of the arms 7 and 8 extending only to the central portion of the tube, the device could be made so that these arms would extend substantially the full length of the cathode, thus utilizing the cathode emission in a more completely effective manner. Such an alternative construction is shown, for example, in Figs. 4 and 5. In these figures the same reference numerals which are used in Figs. 1-3 are applied where the elements are identical. The anode arm members of Figs. 1-3 are replaced by the anode arm members 20 shown most clearly in Fig. 5. These members are likewise each formed with a central opening 24 and upper and lower anode arms 22 and 23 displaced from each other in the same manner as described in connection with anode arms 7 and 8. However, the anode arms 22 and 23 extend, respectively, substantially the full length of the anode arm member 20. A con-

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venient way of forming such an anode arm member is to make it in two halves, each stamped out of a sheet of copper, and after bending each half in the desired direction said halves may be joined by soldering along a joint indicated at 24 in Fig. 5.

The embodiment illustrated in Figs. 4 and 5 operates substantially identically with the operation as described in connection with Figs. 1-3.

Of course it is to be understood that this invention is not limited to the particular details as described above as many equivalents will suggest themselves to those skilled in the art.

What is claimed is:

1. An electron discharge device comprising a cathode, an anode structure, said anode structure comprising a plurality of anode arm members each having a pair of electron-receiving faces adjacent said cathode, each pair of said faces being interconnected through a path of conducting material in its arm member, said path surrounding an opening in said arm member, said arm members being disposed with said openings substantially in register and defining a resultant path in which a resultant magnetic field is adapted to be set up, and a coupling loop interposed in said resultant path.

2. An electron discharge device comprising an elongated cathode and an anode structure, said anode structure comprising a plurality of anode arm members each having a pair of elongated electron-receiving faces adjacent said cathode, said anode arm members being disposed substantially parallel with and around said cathode, each pair of said faces being interconnected through a path of conducting material in its arm member, said path surrounding an opening in said arm member, said arm members being disposed with said openings which substantially in register and defining a resultant annular path in which a resultant magnetic field is adapted to be set up.

3. An electron discharge device comprising an elongated cathode, an anode structure, said anode structure comprising a plurality of anode arm members each having a pair of elongated electron-receiving faces adjacent said cathode, said anode arm members being disposed substantially parallel with and around said cathode, each pair of said faces being interconnected through a path of conducting material in its arm member, said path surrounding an opening in said arm member, said arm members being disposed with said openings substantially in register and defining a resultant annular path in which a resultant magnetic field is adapted to be set up, and a coupling loop interposed in said annular path.

4. An electron discharge device comprising a cathode and a plurality of conducting plates mounted in generally radial directions around said cathode, each of said plates having an opening therein and having a pair of anode arms extending in opposite directions along one side of said opening, said arms being displaced from each other in a direction transverse to said plate.

5. An electron discharge device comprising a cathode and a plurality of conducting plates mounted in generally radial directions around said cathode, each of said plates having an opening therein and being divided at one side of said opening forming a pair of anode arms extending in opposite directions, said arms being displaced from each other in a direction transverse to said plate.

6. An electron discharge device comprising a cathode, a plurality of conducting plates mount-

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ed in generally radial directions around said cathode, each of said plates having an opening therein, and having a pair of anode arms extending in opposite directions along one side of said opening, said arms being displaced from each other in a direction transverse to said plate, said openings being registered and defining a resultant annular path, and a coupling loop interposed in said annular path.

7. An electron discharge device comprising a cathode, a plurality of conducting plates mounted in generally radial directions around said cathode, each of said plates having an opening therein, and having a pair of anode arms extending in opposite directions along one side of said opening, said arms being displaced from each other in a direction transverse to said plate, each of said arms being of substantially the length of said plate.

8. A magnetron comprising a cathode, a plurality of conducting plates mounted in generally radial directions around said cathode, each of

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said plates having an opening therein, and having a pair of anode arms extending in opposite directions at one side of said opening, said arms being displaced from each other in a direction transverse to said plate, said openings being registered and defining a resultant annular path, and means adjacent said cathode and anode structure for creating a magnetic field in the space therebetween.

PERCY L. SPENCER.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,123,728	Hollmann	July 12, 1938
2,250,698	Berline	July 29, 1941
2,199,177	Hollmann	Apr. 30, 1940
2,084,867	Prinz et al.	June 22, 1937
2,005,793	Lindenblad	June 25, 1935

Certificate of Correction

Patent No. 2,437,280.

March 9, 1948.

PERCY L. SPENCER

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 4, line 39, claim 2, strike out the word "which"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 4th day of May, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.