

June 21, 1949.

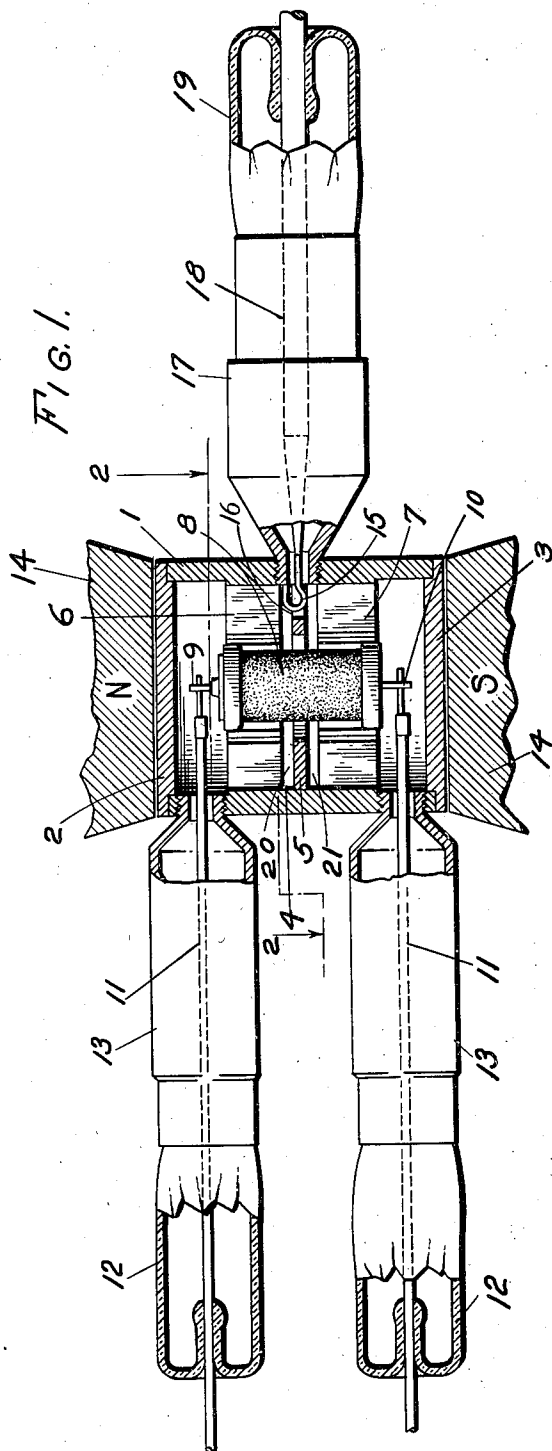
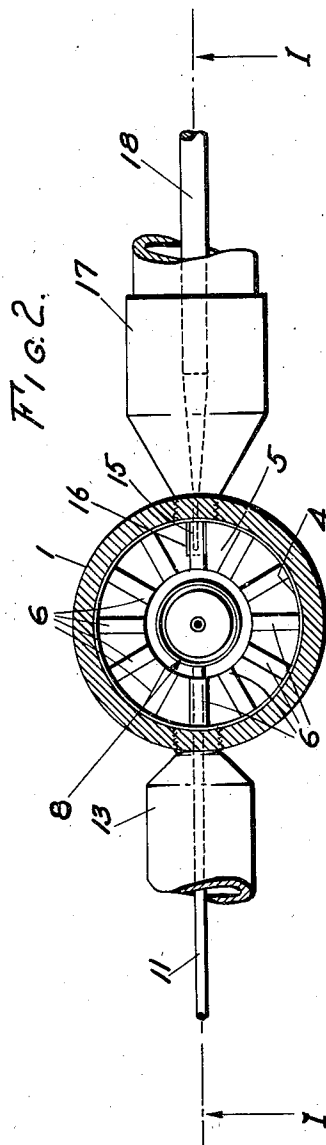
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ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

Filed Nov. 15, 1943

2 Sheets-Sheet 1



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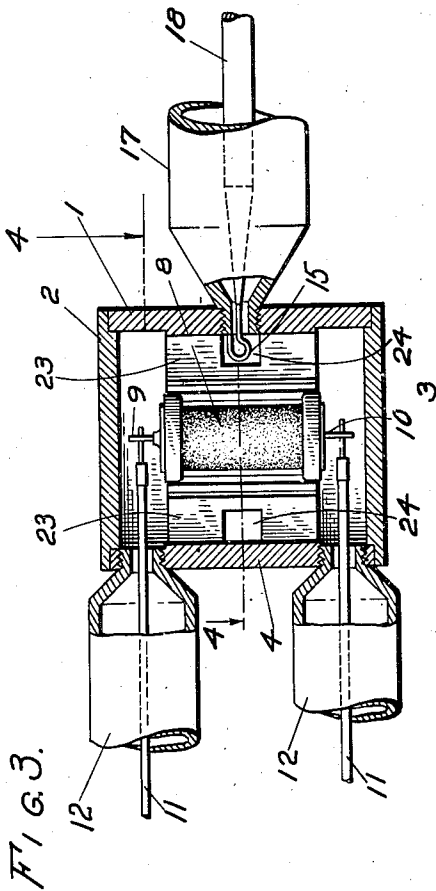
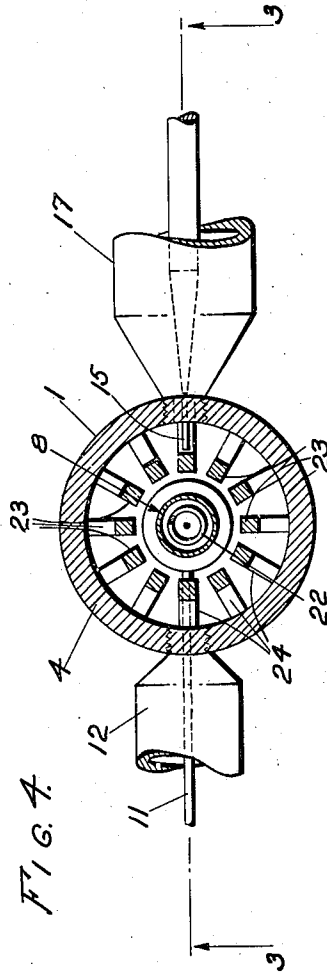
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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE OF THE
MAGNETRON TYPEPercy L. Spencer, West Newton, Mass., assignor
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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.

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

Another 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 longitudinal cross-section of another embodiment of my invention taken along line 3-3 of Fig. 4; and

Fig. 4 is a transverse cross-section taken along line 4-4 of Fig. 3.

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 the envelope 1. The envelope 1 is formed with a central annular projection 4. Extending from substantially the central portion of the projection 4 is a central ring-shaped plate 5 soldered along its outer edge to the inner face of the projection 4. A plurality of radial plates 6 are arranged above the plate 5 and soldered in place along the portion of the inner surface of the projection 4. A similar lower set of radial plates 7 is soldered in place along the lower portion of the inner surface of the projection 4 below the ring 5. The plates 6 and 7 are preferably aligned with each other, and may be stamped out of a sheet of highly-conductive copper. The inner end of the plate 5 and the inner ends of the plates 6

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and 7 form anode faces which cooperate with a cathode 8 supported substantially centrally of said anode faces. The cathode 8 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 9 and 10 of which project from the opposite ends of the cathode structure 8. One of the conductors 9 may be electrically connected to the external cathode sleeve while the other conductor 10 is insulated from said sleeve. The cathode 8 is supported by a pair of lead-in conductors 11 welded respectively to the end conductors 9 and 10. The lead-in conductors 11 pass through glass seals 12 mounted at the outer ends of conducting pipes 13 hermetically fastened through the wall of the envelope 1 adjacent the upper and lower ends thereof.

When such a magnetron is placed between suitable magnetic poles 14 to create a longitudinal magnetic field and the device is energized, oscillations are set up with the opening between each pair of plates 6 operating as a tuned oscillating cavity. These oscillations may be led out from the tube by means of a coupling loop 15 extending into an opening 16 formed in the ring 5. One end of the coupling loop 15 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 15 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 line through which the high frequency oscillations generated by the magnetron may be connected to a suitable utilization circuit.

Heretofore in magnetrons of the multiple anode type having radial arms, the coupling to the output loop has been relatively weak due to the fact that the oscillating energy had to be propagated throughout the length of each oscillating cavity or opening and from cavity to cavity until the coupling loop was reached. Shortening of the radial arms would shorten the path through which the oscillatory energy is transmitted to the coupling loop. However, such shortened arms would reduce the effective electron-receiving anode face length below that at which the emission from a sufficiently large cathode area was utilized to handle the amount

of power desired. By the present arrangement the advantage of a shortened coupling path is obtained without substantially decreasing the effective current-carrying capacity of the tube. It will be noted that in the above construction, the previous anode plates have been in effect divided into two halves 6 and 7, with the ring 5 interposed therebetween. It will be noted that an annular space 20 exists between the ring 5 and the plates 6, and a similar annular space 21 exists between the ring 5 and the plates 7. The coupling loop 15 is sufficiently large so that it is coupled to both of said annular spaces 20 and 21. The device in effect consists of two oscillating magnetron structures operating in parallel. Each of these structures possesses the desired shortened length of anode arm and both together operate to deliver substantially the same amount of power as in the previous construction. Since the loop 15 is coupled to each of the two structures, these structures are coupled together, thus tending to oscillate in synchronism and contribute to the output of the tube. The shortened coupling path increases the coupling which exists between the loop 15 and each of the oscillating cavities. Tubes constructed as above therefore tend to be of a substantially increased efficiency.

In some instances it may be desirable to increase the degree to which the two magnetron structures within the tube are coupled or tied together more strongly. An alternative construction in which such increased coupling occurs is shown, for example, in Figs. 3 and 4. In these figures the same reference numerals which are used in Figs. 1 and 2 are applied where the elements are identical. The cross-section taken in Fig. 4 being somewhat different from that of Fig. 2, the heater 22 of the cathode 3 appears in Fig. 4. The anode elements of Figs. 1 and 2 are replaced by radial plates 23 soldered in place along the inner surface of the projection 4. Each of the plates 23 is formed with a substantially central opening 24. These openings are preferably located at the rear of each of the plates 23, leaving a continuously-conducting anode face extending the total length of the plate 23 and presented to the cathode 3. It will be seen that in this arrangement two magnetron structures likewise exist as in Figs. 1 and 2. In Figs. 3 and 4, however, each anode arm of the upper structure is directly electrically connected to the corresponding anode arm of the lower structure by the continuously-conducting anode face of the plate 23. Such an arrangement has substantially all of the advantages of the embodiment shown in Figs. 1 and 2 with the added advantage of increased coupling between the upper and lower halves of the tube. Such an arrangement likewise tends to operate with increased efficiency.

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. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. An electron-discharge device comprising: a cathode; an anode structure spaced from and surrounding said cathode; said anode structure including a plurality of anode arms having electron-receiving faces adjacent said cathode; each of said anode arms being divided into upper and lower sections by a slot passing through its elec-

tron-receiving face, along an axis perpendicular to said face; the slots of all of said anode arms being circularly aligned; and a conducting member supported intermediate said upper and lower anode arm sections; said conducting member traversing all of said slots.

2. An electron-discharge device comprising: a cathode; an anode structure spaced from and surrounding said cathode; said anode structure including a plurality of anode arms having electron-receiving faces adjacent said cathode; each of said anode arms being divided into upper and lower sections by a slot passing through its electron-receiving face, along an axis perpendicular to said face; the slots of all of said anode arms being circularly aligned; a conducting member supported intermediate said upper and lower anode arm sections; said conducting member traversing all of said slots; and a coupling device, adapted to be connected to an external circuit, extending into one of said slots adjacent said conducting member.

3. An electron-discharge device comprising: a cathode; an anode structure spaced from and surrounding said cathode; said anode structure including a plurality of anode arms having electron-receiving faces adjacent said cathode; each of said anode arms being divided into upper and lower sections by a slot passing through its electron-receiving face, along an axis perpendicular to said face; the slots of all of said anode arms being circularly aligned; a conducting member supported intermediate said upper and lower anode arm sections; said conducting member traversing all of said slots and dividing each of the same into two smaller slots; and a coupling device, adapted to be connected to an external circuit, extending into both of the smaller slots of at least one of said anode arms.

4. A magnetron comprising: a cathode; an anode structure spaced from and surrounding said cathode; means for establishing a magnetic field in the space between said cathode and said anode structure, in a direction perpendicular to the electron path between said cathode and said anode structure; said anode structure including a plurality of anode arms having electron-receiving faces adjacent said cathode; each of said anode arms being divided into upper and lower sections; the upper and lower sections of all of said anode arms being spaced by circularly aligned slots; a conducting member supported intermediate said upper and lower sections, and traversing all of said slots; and a coupling device, adapted to be connected to an external circuit, extending into one of said slots adjacent said conducting member.

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