July 5, 1949. P. L. SPENCER 2,475,526

ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

Filed Sept. 26, 1947

FIG. 1.

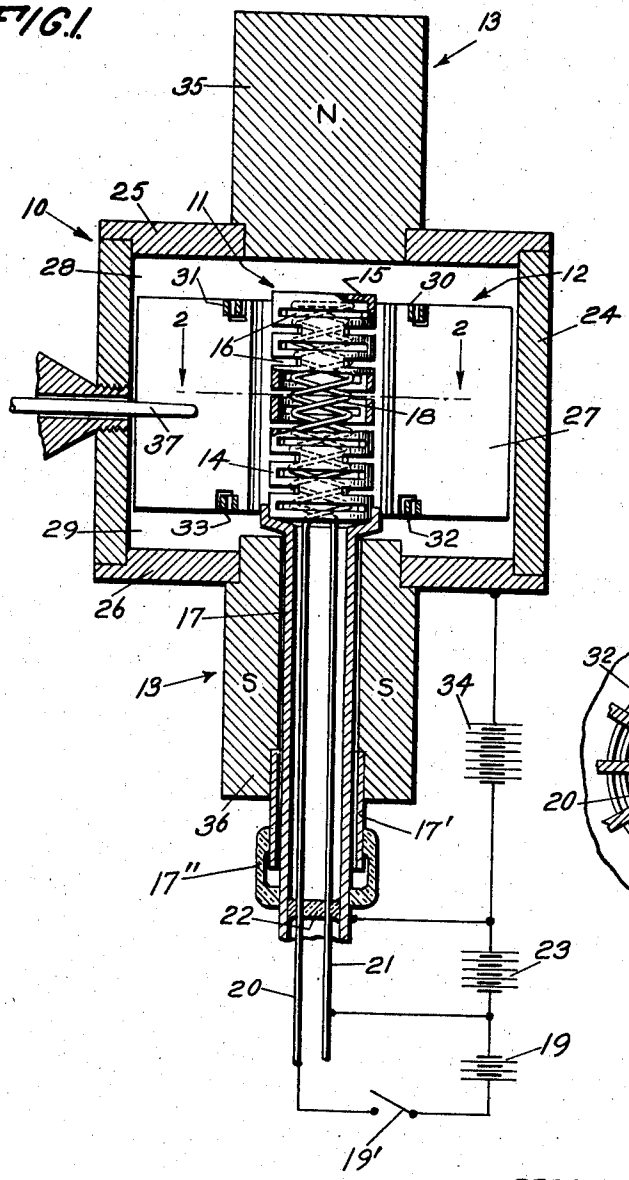
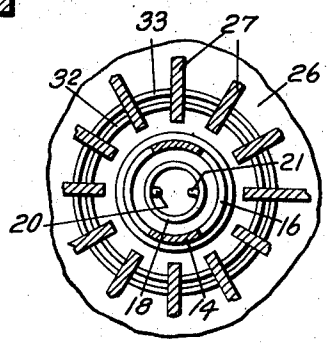


FIG. 2.



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ELECTRON-DISCHARGE DEVICE OF THE MAGNETRON TYPE

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2 Claims. (Cl. 250—27.5)

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This invention relates to electron-discharge devices of the magnetron type, and more particularly to a cathode structure for such devices and an electrical circuit therefor.

One of the objects of the present invention is to provide a cathode structure, especially suitable for use in a magnetron tube, which requires less power input thereto than has heretofore been necessary to obtain corresponding power outputs.

Another object of the present invention is to provide a cathode structure for a magnetron oscillator which, when once oscillation has commenced, relies for its electron emission, mainly, upon cathode bombardment by charged particles which have absorbed energy from the radio-frequency field developed in the oscillator, said bombardment resulting either in aiding the heating of said cathode to a temperature of thermionic primary emission or the knocking out therefrom of secondary electrons, or both.

A further object of the present invention is to provide an electrical circuit enabling operation, as aforesaid, of a magnetron tube provided with a novel cathode structure such as that above referred to.

In the accompanying specification there shall be described, and in the annexed drawing shown, an illustrative embodiment of the electron-discharge devices of the present invention. It is, however, to be clearly understood that the present invention is not to be limited to the details herein shown and described for purposes of illustration only, inasmuch as changes therein may be made without the exercise of invention, and within the true spirit and scope of the claims hereto appended.

In said drawing, Fig. 1 is a longitudinal sectional view taken substantially through the center of a magnetron tube made and connected in circuit in accordance with the principles of the present invention, the cathode structure of said tube being partially broken away to show the internal construction; and

Fig. 2 is a fragmentary, transverse sectional view taken along line 2—2 of Fig. 1.

Referring now more in detail to the aforesaid illustrative embodiment of the present invention, the numeral 10 generally designates a magnetron tube consisting, broadly, of a cathode structure 11, an anode structure 12 spaced from and surrounding said cathode structure, and magnetic means 13 for establishing a magnetic field in the discharge space between said cathode and anode structures.

The cathode structure 11 comprises, preferably,

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a hollow cylindrical member 14 closed at one end, as at 15, and made of a conductive material which is especially suitable both for primary and secondary electron emission, such as tantalum. The member 14 is provided with a plurality of staggered transverse slots 16 affording communication between the interior and exterior thereof, and may be supported at the upper end of a conductive tubular member 17 in any desired appropriate manner.

Disposed in the interior of the member 14 is a filamentary member 18 made, preferably, of tungsten, said member being adapted to serve, as will hereinafter be fully explained, as a primary electron emitter, and as a heater for aiding in raising the temperature of the member 14 to a temperature of thermionic emission. Heating current may be conveyed to the filamentary member 18 from a suitable source of voltage 19, controlled by a switch 19', through lead-in conductors 20 and 21 which may enter the device 10 through the tubular member 17, said conductors being supported in said tubular member as by being embedded in a vitreous seal 22 carried in said tubular member. The cylindrical member 14 is maintained at a positive potential with respect to the filamentary member 18 by appropriately connecting a suitable source of voltage 23 between one of the lead-in conductors 20—21 and the tubular supporting member 17.

The anode structure 12 comprises, preferably, a hollow cylindrical body 24 made of highly conductive material, such as copper, said body being closed at its ends by end plates 25 and 26, the junctions between said body and said end plates being hermetically sealed. Extending radially inward from the interior surface of the body 24 is a plurality of anode vanes 27, also made of copper, said vanes being longitudinally substantially coextensive with the cathode member 14, and terminating, radially, a sufficient distance from the surface of the cathode member 14 to provide an appropriate discharge space therebetween. Each pair of adjacent anode vanes 27 defines, together with that portion of the cylindrical body 24 lying therebetween, an open-ended cavity resonator, all of said cavity resonators communicating, at their open ends, with end spaces 28 and 29 presented, respectively, between the upper ends of the vanes 27 and the plate 25, and the lower ends of said vanes and the plate 26.

Preferably, the vanes 27 are double strapped, for undesired mode suppression, at both ends, as by conductive rings 30 to 33, inclusive, the upper,

inner strap 30 and the lower, outer strap 33 electrically connecting together the alternate vanes, and the upper, outer strap 31 and the lower, inner strap 32 electrically connecting together the intermediate vanes. The anode structure 12 is maintained at a positive potential with respect to the cathode structure 11 by appropriately connecting a suitable source of voltage 34 therebetween.

A solid pole piece 35 may project into the device through the end plate 25, and a hollow pole piece 36, surrounding the tubular member 17 and sealed thereto by means of a second tubular member 17' and a vitreous seal 17'', may project into the device through the end plate 26, said pole pieces being hermetically sealed to the respective plates through which they project, and being associated with appropriate magnetic means, not shown, whereby a magnetic field may be established through the device in a direction transverse to the discharge path between the cathode structure 11 and the anode structure 12.

Power may be extracted from the device by any suitable means, for example, a conventional coupling loop 37 extending into any one of the cavity resonators defined by the vanes 27.

In operation, the switch 19' is initially closed and the filamentary member 18 is heated to a temperature of thermionic emission by the passage of current therethrough from the source of voltage 19, the emitted primary electrons traveling toward the cylindrical member 14 by reason of said cylindrical member being maintained at a positive potential with respect to said filamentary member by the source of voltage 23. While some of these electrons will be collected by the cylindrical member 14, an appreciable number thereof will pass through the slots 16 in said cylindrical member and move toward the anode vanes 27, the latter being maintained at a positive potential with respect to both the cylindrical member 14 and the filamentary member 18 by means of the source of voltage 34.

The device will be set into oscillation by the initial primary emission from the filamentary member 18. At the same time, the cylindrical member 14 will become heated by radiation from the filamentary member 18. Some of the energy generated in the oscillating cavity resonators by the action of the primary electrons initially emitted from the filamentary member 18 will be absorbed by some of said primary electrons, and some of the electrons which have absorbed such energy will be slammed back into the cylindrical member 14, additionally to heat the same so that it now becomes a source of primary electrons, or to knock out secondary electrons therefrom, or both, thus augmenting the space charge of the device. It has been found that once the space charge has been augmented as above, the power input to the device, particularly, the heating current supplied by the source of voltage 19, may be considerably reduced or even discontinued, and still enable the generation of

power comparable to that obtainable with the conventional, continually operating cathodes heretofore employed.

This completes the description of the aforesaid illustrative embodiment of the electron-discharge devices of the present invention, together with the mode of operation thereof. It will be noted from all of the foregoing that the device is simple and effects considerable economy of operation as compared with what has heretofore been the case in order to obtain corresponding power outputs.

Other objects and advantages of the present invention will readily occur to those skilled in the art to which the same relates.

What is claimed is:

1. An electron-discharge device comprising: a cathode structure; an anode structure, spaced from said cathode structure, and incorporating a cavity resonator; and means, adjacent said anode structure, for establishing a magnetic field in the discharge space between said cathode and anode structures; said cathode structure including a tungsten filament; and a tantalum cylinder, spaced from and enclosing said filament, and provided with an aperture therethrough affording spatial communication between said filament and said anode structure.

2. An electrical circuit comprising: an electron-discharge device including a cathode structure, an anode structure spaced from said cathode structure and incorporating a cavity resonator, means adjacent said anode structure for establishing a magnetic field in the discharge space between said cathode and anode structures, said cathode structure including a tungsten filament adapted to be heated to a temperature of thermionic emission by the passage of current therethrough, and a tantalum can spaced from and enclosing said tungsten filament, and provided with an aperture affording communication between said tungsten filament and the discharge space of said device; a first source of unidirectional voltage, connected between said cathode and anode structures, for maintaining the latter at a positive potential with respect to the former; and a second source of unidirectional voltage, connected between said tungsten filament and said tantalum can, for maintaining the latter at a positive potential with respect to the former.

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