March 28, 1950 W. C. BROWN 2,502,405

ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

Filed Dec. 20, 1948 2 Sheets-Sheet 1

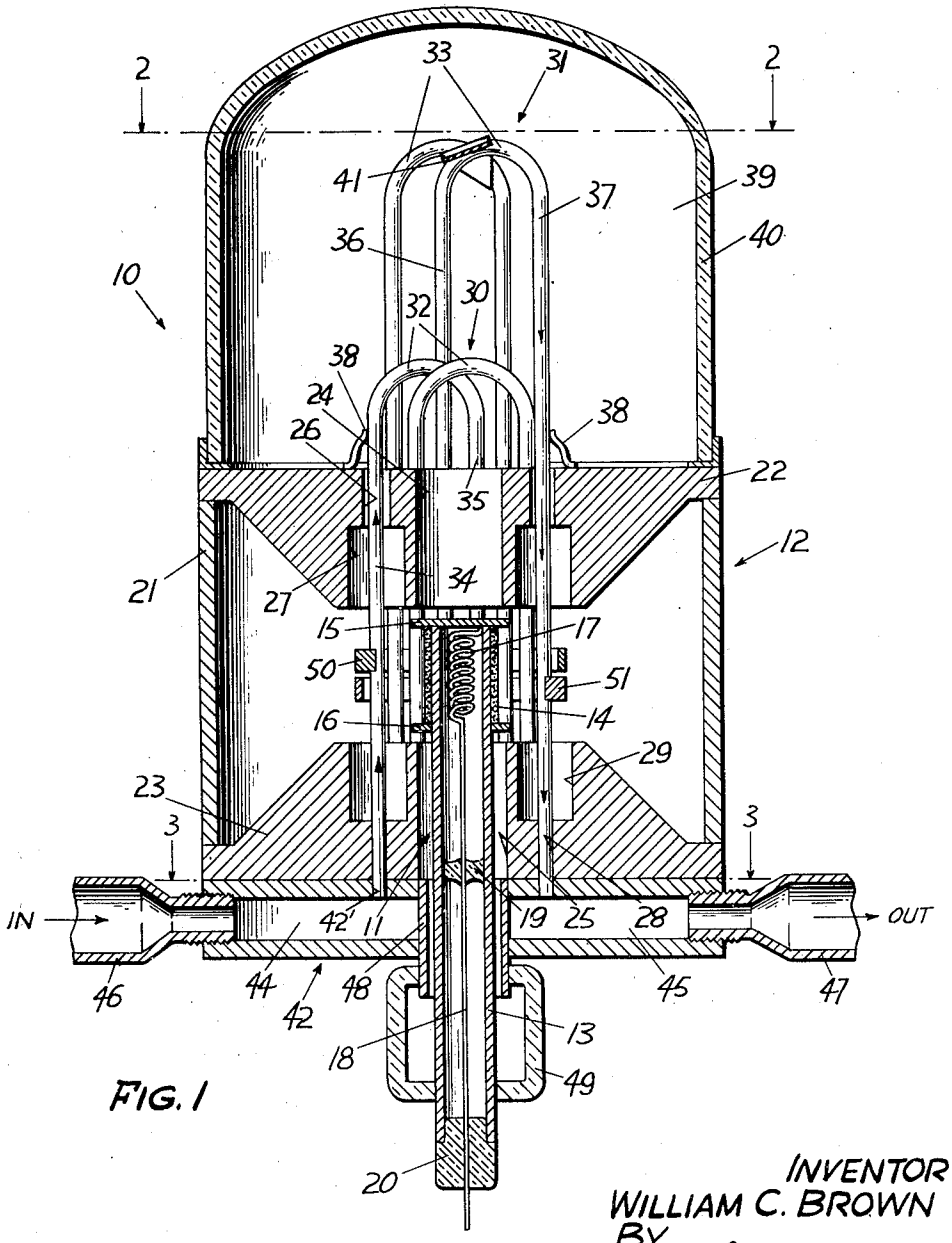


FIG. 1

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ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

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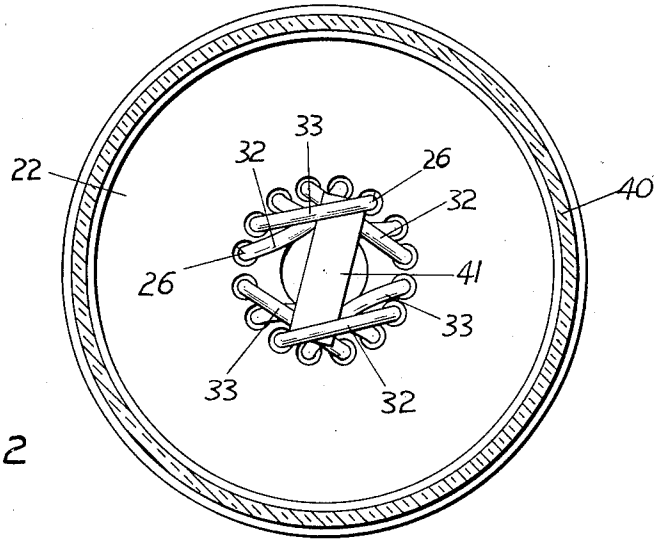


FIG. 2

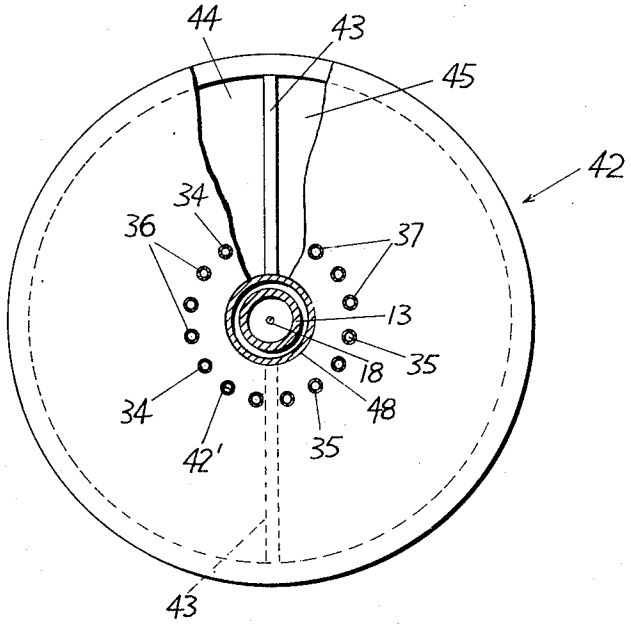


FIG. 3

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ELECTRON-DISCHARGE DEVICE OF THE MAGNETRON TYPE

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9 Claims. (Cl. 250—27.5)

1

This invention relates to electron-discharge devices, and more particularly to electron-discharge devices of the magnetron type.

It has heretofore been difficult to build a magnetron capable of delivering appreciable power under continuous-wave operating conditions unless the tube was of considerable size and weight. Furthermore, the structure of such a tube was rather complicated and the tube, therefore, was difficult and expensive to make.

Hence, it is one of the objects of the present invention to avoid the above difficulties by providing a magnetron which, while being of relatively small dimensions, is capable of generating appreciable radio-frequency power under continuous-wave operating conditions.

It is a further object of the present invention to provide a magnetron which accomplishes the foregoing object in a simple and economical manner.

In the accompanying specification there shall be described, and in the annexed drawings shown, an illustrative embodiment of the electron-discharge device 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 drawings,

Fig. 1 is a longitudinal sectional view taken substantially through the center of a magnetron made in accordance with the principles of the present invention;

Fig. 2 is a transverse sectional view taken along line 2—2 of Fig. 1; and

Fig. 3 is a similar view taken along line 3—3 of Fig. 1.

Referring now more in detail to the aforesaid illustrative embodiment of the present invention, with particular reference to the drawings illustrating the same, the numeral 10 generally designates an electron-discharge device of the magnetron type. Such a device includes a centrally disposed cathode structure 11 and an anode structure 12 spaced from and surrounding said cathode structure.

While not limited thereto, the cathode structure 11 may comprise a cathode sleeve 13, made, for example, of nickel, and provided, adjacent its upper end, with a coating 14 of any preferred electron-emissive coating, such as a combination of the oxides of the alkaline-earth metals. The

2

upper, open end of the sleeve 13 is preferably closed by a shield 15, and said sleeve preferably carries, immediately below the lower extremity of the coating 14, another shield 16. Mounted within the sleeve 13 is a heating coil 17, the upper end of said coil being electrically connected to said sleeve and the lower end thereof being electrically connected to a lead-in conductor 18. The latter passes downwardly out of the device through the sleeve 13 and is supported in spaced relationship to said sleeve by insulating members 19 and 20. Heating current may be supplied to the coil 17 by connecting the sleeve 13 and the lead-in conductor 18 to the terminals of any preferred voltage source, not shown. The manner of supporting the cathode structure 11 with respect to the anode structure 12 will be described at a later point in this specification.

The anode structure 12 preferably comprises a cylindrical envelope member 21, made of conductive material, and having its open ends closed by annular, conductive supporting members 22 and 23. While not limited thereto, these supporting members, are, preferably, the spaced opposed pole pieces with which devices of the type to which the present invention relates are generally provided for supplying the conventional longitudinal magnetic field in the interaction space between the cathode and anode structures of such devices.

The members 22 and 23 are provided with central openings 24 and 25. Surrounding the opening 24, the member 22 is provided with a multiplicity of bores 26 having portions 27 of enlarged diameter, and surrounding the opening 25, the member 23 is provided with a multiplicity of bores 28 having portions 29 of enlarged diameter. The bores 26 are of somewhat greater diameter than the bores 28 for a purpose which will later become apparent, and the enlarged bore portions 27 and 29 constitute, as will be understood to those skilled in the art, radio-frequency chokes.

Carried by the supporting members 22 and 23 is a plurality of U-shaped, relatively short and relatively long, electron-receiving members 30 and 31, these members being made of hollow, tubular, conductive material and including, respectively, yoke portions 32 and 33, and leg portions 34 and 35, and 36 and 37. The members 30 and 31 have their leg portions 34 and 35, and 36 and 37, passing through the bores 26 of the supporting member 22, in spaced relationship to the walls thereof, and anchored in the bores 28 of the supporting member 23. The arrangement

of the U-shaped members 30 and 31 is such that the shorter members alternate with the longer members, and the legs of each of such members are disposed, respectively, on opposite sides of registering predetermined diameters of the supporting members 22 and 23. Adjacent the upper surface of the supporting member 22, all of the legs 34 to 37, inclusive, of all of the U-shaped members 30 and 31 are securely connected to said supporting member 22 by inductive leads 38, and the electrical length of the members 30 and 31, between said inductive leads 38 and the lower ends of the legs 34 to 37, inclusive, is a half wave of the operating wave-length of the device, whereby each pair of adjacent legs 34 to 37, inclusive, together with those portions of the supporting members 22 and 23 lying therebetween, constitute a resonant transmission line, more particularly, a half wave line inductively closed at both ends.

The yokes 32 and 33 of the members 30 and 31 extend above the supporting member 22 into a space 39 which is enclosed by a dome 40 made, preferably, of insulating material. The yokes 33 of the longer members 31 are electrically interconnected by a conductive strap 41 whereby said longer members 31 jointly function as a single radiating element.

The purpose of making the members 30 and 31 of hollow, tubular material is to enable the circulation therethrough of a cooling fluid, thus enabling dissipation of anode heat. This cooling fluid is supplied to and withdrawn from an annular header 42 provided with a partition 43, see Fig. 3, disposed along a line lying in the plane of the above referred to predetermined diameters of the supporting members 22 and 23, the partition dividing the header into coolant-receiving and coolant-discharging chambers 44 and 45. The header 42 is also provided with openings 42' registering with the bores 26 of the supporting member 23. The receiving chamber is provided with an inlet port 46 and the discharging chamber is provided with an outlet port 47.

Thus, the legs 34 of the U-shaped members 30 and the legs 36 of the U-shaped members 31 communicate with the coolant-receiving chamber 44 of the header 42, while the legs 35 of the U-shaped members 30 and the legs 37 of the U-shaped members 31 communicate with the coolant-discharging chamber 45 of the header 42.

In order to support the cathode structure 11 with respect to the anode structure 12, an inner wall 48 of the header 42 is made longer than the depth of said header, and secured to said wall is an insulating ferrule 49 fastened at its other end to the cathode sleeve 13.

Substantially at the electrical centers of the resonant transmission lines defined by the legs 34 to 37, inclusive, and the intervening portions of the supporting members 22 and 23, alternate legs are electrically interconnected by a mode-locking conductive strap 50 and the intervening legs are similarly electrically interconnected by a mode-locking conductive strap 51.

When the cathode of a device such as has been described is provided with appropriate heating current, and a suitable potential difference is established between said cathode and anode, and a cooling fluid is circulated through the electron-receiving members of said anode, the device generates appreciable radio-frequency power under continuous-wave operating conditions without overheating.

This completes the description of the aforesaid illustrative embodiment of the present invention. It will be noted from all of the foregoing that the device not only functions to generate appreciable power under continuous-wave operating conditions, but it is simple in its design, is easy and economical to fabricate and assemble, and is of such construction as to permit its being built with relatively small dimensions.

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; and an anode structure spaced from said cathode; said anode structure including an envelope member; a pair of supporting members connected to said envelope member; a header having coolant-receiving and coolant-discharging chambers, and inlet and outlet ports communicating, respectively, with said chambers; and a plurality of hollow electron-receiving members carried by said supporting members and communicating at opposite ends, respectively, with said coolant-receiving and coolant-discharging chambers.

2. An electron-discharge device comprising: a cathode; and an anode structure spaced from said cathode; said anode structure including an envelope member; a pair of spaced, opposed, electrically-conductive pole pieces connected to said envelope member; a header having coolant-receiving and coolant-discharging chambers, and inlet and outlet ports communicating, respectively, with said chambers; and a plurality of hollow electron-receiving members carried by said pole pieces and communicating at opposite ends, respectively, with said coolant-receiving and coolant-discharging chambers.

3. An electron-discharge device comprising: a cathode; and an anode structure spaced from said cathode; said anode structure including an envelope member; a pair of supporting members connected to said envelope member; a header having coolant-receiving and coolant-discharging chambers, and inlet and outlet ports communicating, respectively, with said chambers; and a plurality of hollow, tubular, U-shaped members carried by said supporting members and communicating at opposite ends, respectively, with said coolant-receiving and coolant-discharging chambers; each pair of adjacent legs of said U-shaped members, together with those portions of said supporting members lying therebetween, constituting a resonant transmission line.

4. An electron-discharge device comprising: a cathode; and an anode structure spaced from said cathode; said anode structure including an envelope member, a pair of spaced, opposed, electrically-conductive pole pieces connected to said envelope member; a header having coolant-receiving and coolant-discharging chambers, and inlet and outlet ports communicating, respectively, with said chambers; and a plurality of hollow, tubular, U-shaped members carried by said pole pieces and communicating at opposite ends, respectively, with said coolant-receiving and coolant-discharging chambers; each pair of adjacent legs of said U-shaped members, together with those portions of said pole pieces lying therebetween, constituting a resonant transmission line.

5. An electron-discharge device comprising: a cathode; and an anode structure spaced from said cathode; said anode structure including an

envelope member; a pair of supporting members connected to said envelope member; a header having coolant-receiving and coolant-discharging chambers, and inlet and outlet ports communicating, respectively, with said chambers; a plurality of hollow electron-receiving members carried by said supporting members and communicating at opposite ends, respectively, with said coolant-receiving and coolant-discharging chambers; and a pair of conductive straps electrically connected, respectively, to alternate and intervening electron-receiving members.

6. An electron-discharge device comprising: a cathode; and an anode structure spaced from said cathode; said anode structure including an envelope member; a pair of spaced, opposed, electrically-conductive pole pieces connected to said envelope member; a header having coolant-receiving and coolant-discharging chambers, and inlet and outlet ports communicating, respectively, with said chambers; a plurality of hollow electron-receiving members carried by said pole pieces and communicating at opposite ends, respectively, with said coolant-receiving and coolant-discharging chambers; and a pair of conductive straps electrically connected, respectively, to alternate and intervening electron-receiving members.

7. An electron-discharge device comprising: a cathode; and an anode structure spaced from said cathode; said anode structure including an envelope member; a pair of supporting members connected to said envelope member; a header having coolant-receiving and coolant-discharging chambers, and inlet and outlet ports communicating, respectively, with said chambers; a plurality of hollow, tubular, U-shaped members carried by said supporting members and communicating at opposite ends, respectively, with said coolant-receiving and coolant-discharging chambers; each pair of adjacent legs of said U-shaped members, together with those portions of said supporting members lying therebetween, constituting a resonant transmission line; a conductive strap electrically connected to both legs of all alternate electron-receiving members; and a second conductive strap electrically connected to both legs of all intervening electron-receiving members.

8. An electron-discharge device comprising: a cathode; and an anode structure spaced from said cathode; said anode structure including an envelope member; a pair of spaced, opposed, electrically-conductive pole pieces connected to said envelope member; a header having coolant-receiving and coolant-discharging chambers, and inlet and outlet ports communicating, respectively, with said chambers; a plurality of hollow, tubular, U-shaped members carried by said pole pieces and communicating at opposite ends, respectively, with said coolant-receiving and coolant- discharging chambers; each pair of adjacent legs of said U-shaped members, together with those portions of said pole pieces lying therebetween, constituting a resonant transmission line; a conductive strap electrically connected to both legs of all alternate U-shaped members; and a second conductive strap electrically connected to both legs of all intervening U-shaped members.

9. An electron-discharge device comprising: a cathode; and an anode structure spaced from said cathode; said anode structure including an envelope member; a pair of supporting members connected to said envelope member; a header having coolant-receiving and coolant-discharging chambers, and inlet and outlet ports communicating, respectively, with said chambers; and a plurality of hollow, U-shaped electron-receiving members carried by said supporting members and having their legs communicating, respectively, with said coolant-receiving and coolant-discharging chambers; all of the legs of said U-shaped members lying in the surface of a cylinder and each pair of adjacent legs of said U-shaped members, together with those portions of said supporting members lying therebetween, constituting a resonant transmission line.

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