June 10, 1947. J. M. SPOONER 2,421,912

ELECTRON DISCHARGE DEVICE OF THE CAVITY RESONATOR TYPE

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Fig. 1.

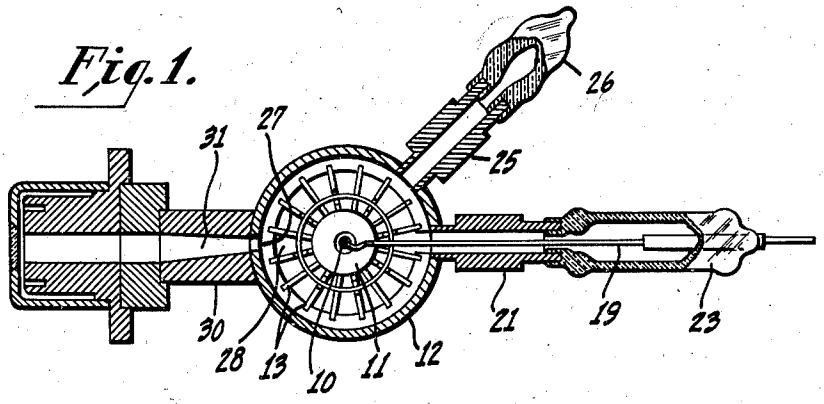
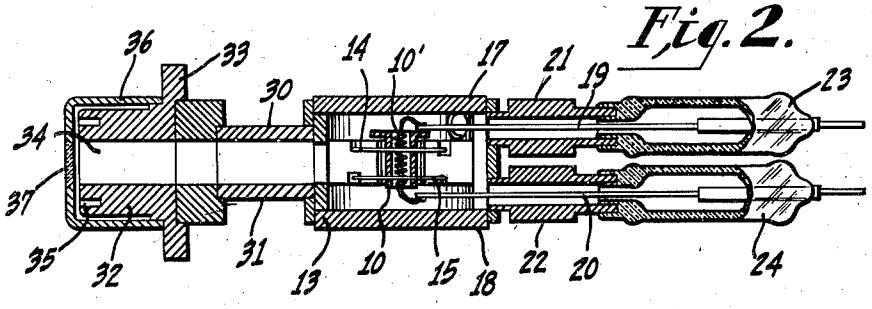


Fig. 2.



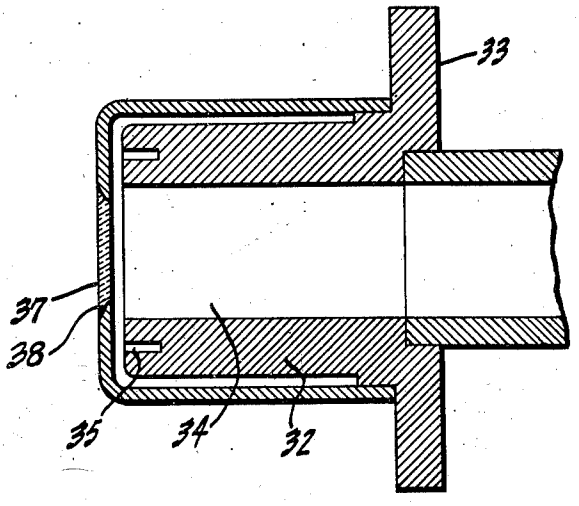


Fig. 3.

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ELECTRON DISCHARGE DEVICE OF THE CAVITY RESONATOR TYPE

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10 Claims. (Cl. 315—39)

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My invention relates to devices useful at ultra high frequencies, more particularly to coupling devices for coupling evacuated structures, for example electron discharge devices employing cavity resonators, to wave guides or resonators.

In certain types of magnetrons the anode segments or elements are interconnected by means of cavity resonator circuits and form together the anode structure for the magnetron.

In one form of magnetron the electrode assembly comprises an elongated centrally positioned cathode having an anode member surrounding the cathode. The anode member is provided with a plurality of anode segments having cavity resonator circuits between segments. The anode member or block may have cavities formed therein, these cavities being radial slots parallel to the cathode and communicating with the space between the cathode and the anode segments or elements. The anode segments or elements are formed by the portions of the anode member positioned between the adjacent slots. The anode structure may be made in other ways, for example, a wide ring may be utilized supporting a plurality of radially and inwardly directed vanes, the inner edges of the vanes providing the anode elements or segments whereas the vanes and the ring provide cavity resonator circuits connected between the anode elements.

Another common method is to broach an anode assembly from a solid cylindrical block, with a central space or chamber having positioned around it a plurality of cavities having a cylindrical transverse section with communicating slots between the central chamber or space and the cylindrically shaped cavities, the slots being parallel to the cathode to provide anode segments between the slots.

It has been proposed to couple the output of the above type magnetron to a wave guide by providing an aperture or slot through the outside wall of the anode block or assembly to one of the cavities, the wave guide communicating with this aperture or slot. This slot provides the communicating passageway between one of the cavity resonators and the wave guide for directing electromagnetic energy into the wave guide. Not only must the wave guide, which acts as an output lead, be properly matched to the aperture, but it must be provided at its outer end with a vacuum-tight seal inasmuch as the cathode and anode assembly is mounted within an evacuated space.

In the past it has been found difficult to properly seal the output lead or output wave guide

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so that it would remain sealed during subsequent manufacturing steps. Failure by cracking or leaking of seals usually resulted when the closure member sealing the wave guide and comprising a window permeable to electromagnetic waves was sealed or soldered to the end of the output wave guide either directly or by means of a circular metal disc apertured to receive the window.

The principal object of my invention is to provide coupling means for use with evacuated devices operated at ultra high frequencies.

Another object of my invention is to provide an electron discharge device of the magnetron type having an improved means for coupling the magnetron to a load.

It is a further object of my invention to provide a coupling means for magnetrons utilizing cavity resonators and which is simple in construction and which is capable of accurate reproduction and can easily be made.

More specifically it is an object of my invention to provide a coupling device of the wave guide type, which is hermetically sealed and which avoids the danger of cracked seals during manufacture and operation.

The novel features which I believe to be characteristic of my 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 an electron discharge device and coupling means made according to my invention, Figure 2 is a longitudinal section taken at 90° to Figure 1, and Figure 3 is an enlarged longitudinal section of the closed end of an output wave guide or output lead for evacuated structures utilized at ultra high frequencies and incorporated in the device shown in Figures 1 and 2.

Referring to Figure 1, a magnetron provided with a coupling device made according to my invention includes the indirectly heated cathode 10 having heater 10' and surrounded by an anode assembly comprising ring or collar member 12, which also forms the envelope of the tube. The collar supports a plurality of radially directed fins or slats 13, the inner edges of which provide the anode segments and define the cathode-anode space. To insure the desired mode of operation, straps 14 and 15 are utilized, each interconnecting different alternate anode segments. Cover members 17 and 18 are sealed to the top and bottom of the collar member 12 to provide the envelope for the electrodes of the magnetron.

The heater and cathode are provided with a pair of leads 19 and 20 extending through the shielding members 21 and 22 and hermetically sealed at their ends by elongated cup-shaped members 23 and 24. The envelope may be exhausted through tubular member 25 and sealed off by the insulating cup-shaped member 26.

Aperture 27 in the form of a slot is extended through collar member 12 so that one of the cavity resonator spaces 28 communicates with the exterior of the envelope. A wave guide 30 is sealed to the envelope and communicates with the aperture 27 and is provided with a flared out passageway 31.

In accordance with my invention I hermetically seal a closure member to the end of the wave guide which consists of a cylindrical member 32 having a flange 33 for engaging the wave guide and passageway 34 therethrough of rectangular transverse section. Positioned around passageway 34 at the outer end of the member 32 is a slot equivalent in electrical length to a quarter wavelength of operating frequency at which the device is intended to operate. This slot acts as a radio frequency choke to prevent loss of energy at this juncture. Cup-shaped member 36 is positioned over the end of the cylindrical member 32, its lip being sealed to the flange 33 preferably by gold solder. The inner wall of the cup-shaped member 36 is spaced from the outer wall of the cylindrical member 32. The outer end of the cup-shaped member is provided with an aperture having a beveled seat 38 into which a window 37 is sealed, the window being preferably of glass or some material permeable to electromagnetic wave energy. After sealing-in the glass window its outside surface is ground down. The flange 33 permits coupling of an additional wave guide on the end of the coupling member. Thus the seal is made at a point remote from the window 37 and the temperature gradient is not great. This eliminates stresses and strains responsible for cracks and leaks at the window.

With the construction shown fabricating difficulties have been eliminated and there is provided a successful hermetically sealed coupling member which may be readily applied to devices of the kind described.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my 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 my invention as set forth in the appended claims.

What I claim as new is:

1. An output lead for an evacuated device operable at ultra high radio frequencies and including a member having a pasageway therethrough, a conducting cup-shaped element mounted over one end of said member, the lips of the cup-shaped element being hermetically sealed to said member and the bottom of said cup-shaped member being closely adjacent the member having said passageway, the inner surface of said cup-shaped element being spaced from the outer surface of said member said surfaces being closely spaced at all points, said cup-shaped element being provided with an aperture registering with the passageway in said member and a member permeable to electromagnetic waves hermetically sealed across said aperture, the area of said aperture and the area of the transverse section of said passageway being substantially equal.

2. A device for use at ultra high frequencies including a cavity resonator sealed vacuum-tight, said resonator having an aperture in the wall thereof, a coupling device for said resonator and including a hollow member having one end opening into said resonator through said aperture, the other end of said coupling device being sealed vacuum-tight by a conducting closure member permeable to electromagnetic waves, said closure member including a cup-shaped member positioned over the end of said hollow member, the lip of said cup-shaped member being sealed to said hollow member said surfaces being closely spaced at all points, the inner surface of said cup-shaped member and the outer surface of said hollow member being spaced from each other the area of said aperture and the area of the transverse section of said pasageway being substantially equal, said cup-shaped member having an aperture registering with the pasageway through said hollow member, and means permeable to electromagnetic waves sealed across the aperture in said cup-shaped member.

3. An electron discharge device including a magnetron assembly comprising a cathode surrounded by an anode assembly, said anode assembly including a plurality of cavity resonators, the wall of said anode assembly having an aperture extending therethrough and opening into one of said cavity resonators, and a coupling device including a hollow member having one end registering with and opening into said one resonator through the aperture in the wall of said anode assembly, and a closure member permeable to electromagnetic waves for sealing the other end of said coupling device, said closure member including a cup-shaped member positioned over the end of said hollow member, the lip of said cup-shaped member being sealed to said hollow member, the inner surface of said cup-shaped member and the outer surface of said hollow member being spaced from each other, said cup-shaped member having an aperture registering with the passageway through said hollow member, and means permeable to electromagnetic waves sealed across the aperture in said cup-shaped member.

4. An apparatus for use at high radio frequencies, including evacuated cavity resonator means, an electron discharge device for exciting said cavity resonator means, said cavity resonator means having an aperture extending through the wall thereof and a coupling device adjacent said cavity resonator means, said coupling device comprising an elongated member provided with a passageway and having one end adjacent said resonator means and registering with said aperture and its end remote from the apertured wall sealed by a closure member permeable to electromagnetic waves, said closure member including a cup-shaped member positioned over the end of said elongated member, the lip of said cup-shaped member being sealed to said elongated member, the inner surface of said cup-shaped member and the outer surface of said elongated member being spaced from each other, said cup-shaped member having an aperture registering with the passageway through said elongated member, and means permeable to electromagnetic waves sealed across the aperture in said cup-shaped member.

5. An output lead for an evacuated device useful at ultra high frequencies and including a wave guide having one end sealed by a closure device comprising a member having a passageway of rectangular transverse section extending therethrough, and a cup-shaped member positioned over said last member, the lip of said cup-shaped member being sealed to said last member, the inner surface of said cup-shaped member being spaced from said last member, said cup-shaped member having an aperture registering with the passageway through said last member, and means permeable to electromagnetic waves sealed within said aperture, the portion of said cup-shaped member defining said aperture being provided with inwardly beveled edges sealed to said means permeable to electromagnetic waves, the end of said last member being provided with a slot extending around said passageway and having a depth equal in electrical length to a quarter wave of the frequency at which said output lead operates.

6. A closure member for a wave guide to be used with an evacuated device useful at ultra high frequencies and including a cylindrical member provided at one end with a flange and having a passageway extending along the axis thereof, said passageway having a rectangularly shaped transverse section, a cup-shaped member positioned over the end of said cylindrical member, the lip of said cup-shaped member being hermetically sealed to said cylindrical member adjacent said flange, said cup-shaped member having an aperture registering with the passageway through said cylindrical member, and means sealed across said aperture permeable to electromagnetic waves, the walls of said cylindrical member and said cup-shaped member spaced apart, the end of said cylindrical member adjacent said aperture having a slot therein circumscribing the passageway through said cylindrical member, said slot having a depth equal to an electrical length of a quarter wavelength of the operating frequency of the evacuated device with which said wave guide is associated.

7. An apparatus for use at high radio frequencies, including evacuated cavity resonator means, means supplying an electron discharge for exciting said cavity resonator means, said resonator means having an aperture extending through the wall thereof and coupling device for said cavity resonator means and having a passageway opening into said cavity resonator means through said aperture, a closure member for said coupling device and including a cylindrical member provided at one end with a flange and having a passageway extending along the axis thereof, said passageway having a rectangularly shaped transverse section, a cup-shaped member positioned over the end of said cylindrical member, the lip of said cup-shaped member being hermetically sealed to said cylindrical member adjacent said flange, said cup-shaped member having an aperture registering with the passageway through said cylindrical member, and means sealed across said last aperture permeable to electromagnetic waves, the walls of said cylindrical member and said cup-shaped member being spaced apart, and the end of said cylindrical member adjacent said last aperture having a slot therein circumscribing the passageway through said cylindrical member.

8. An apparatus for use at high radio frequencies, included evacuated cavity resonator means, means for exciting said cavity resonator means, said cavity resonator means having an aperture extending through the wall thereof, an output lead for said cavity resonator means including a wave guide having one end sealed to said cavity resonator means adjacent said aperture and having its other end sealed by a closure device comprising a member having a passageway of rectangular transverse section extending therethrough, and a cup-shaped member positioned over said last member, the lip of said cup-shaped member being sealed to said last member, the inner surface of said cup-shaped member being spaced from said last member, said cup-shaped member having an aperture registering with the passageway through said last member, and means permeable to electromagnetic waves sealed within said last aperture, the portion of said cup-shaped member defining said last aperture being provided with inwardly beveled edges sealed to said means permeable to electromagnetic waves, said end of the last member adjacent said last aperture being provided with a slot extending around said passageway and having a depth equal in electrical length to a quarter wave of the operating frequency of said cavity resonator means.

9. An electron discharge device including a magnetron assembly comprising a cathode surrounded by an anode assembly, said anode assembly including a plurality of cavity resonators, the wall of said anode assembly having an aperture extending therethrough and opening into one of said cavity resonators, and a coupling device having a passageway registering with the aperture in the wall of said anode assembly, a closure member for said coupling device and including a cylindrical member provided at one end with a flange and having a passageway extending along the axis thereof and opening into the passageway in said coupling device, a cup-shaped member positioned over the end of said cylindrical member, the lip of said cup-shaped member being hermetically sealed to said cylindrical member adjacent said flange, said cup-shaped member having an aperture registering with the passageway through said cylindrical member, and means sealed across said last aperture permeable to electromagnetic waves, the walls of said cylindrical member and said cup-shaped member being spaced apart, the end of said cylindrical member adjacent said last aperture having a slot therein circumscribing the passageway through said cylindrical member, said slot having a depth equal to an electrical length of a quarter wavelength of the operating frequency of the electron discharge device.

10. A device for use at ultra high frequencies including a cavity resonator sealed vacuum-tight, means for exciting said cavity resonator, said cavity resonator having an aperture in the wall thereof, a coupling device for said cavity resonator and including a hollow member having one end communicating with said resonator through said aperture, a closure device for said hollow member and including a cylindrical member provided at one end with a flange and having a passageway extending along the axis thereof, said passageway having a rectangularly shaped transverse section, a cup-shaped member positioned over the end of said cylindrical member, the lip of said cup-shaped member being hermetically sealed to said cylindrical member adjacent said flange, said cup-shaped member having an aperture registering with the passageway through said cylindrical member, and means sealed across said last aperture permeable to electromagnetic waves, the

walls of said cylindrical member and said cup-shaped member being spaced apart, said last aperture being provided with inwardly beveled edges sealed to said means permeable to electromagnetic waves.

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Disclaimer

2,421,912.—*John M. Spooner*, Manheim Township, Lancaster County, Pa. ELECTRON DISCHARGE DEVICE OF THE CAVITY RESONATOR TYPE. Patent dated June 10, 1947. Disclaimer filed Nov. 2, 1950, by the assignee, *Radio Corporation of America.*

Hereby enters this disclaimer to claims 3 to 10, inclusive, of said patent.

[*Official Gazette December 5, 1950.*]