Jan. 4, 1949. B. B. BROWN 2,458,142

ELECTRODE ASSEMBLY FOR ELECTRON DISCHARGE DEVICES

Filed March 8, 1944

Fig. 1.

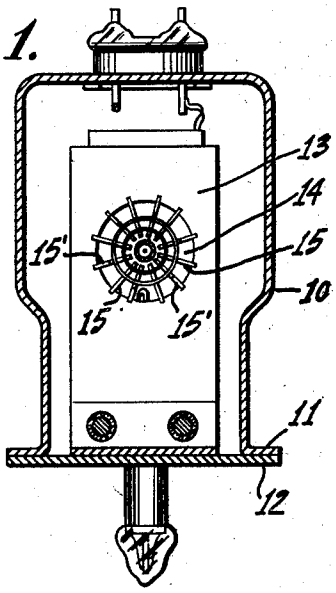


Fig. 2.

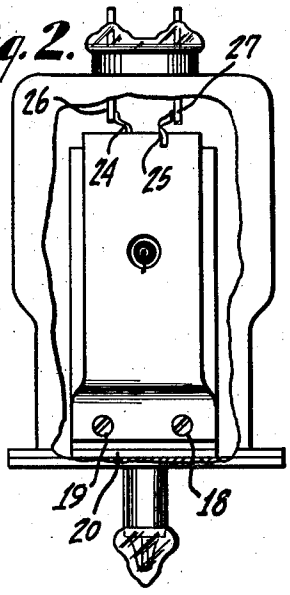


Fig. 3.

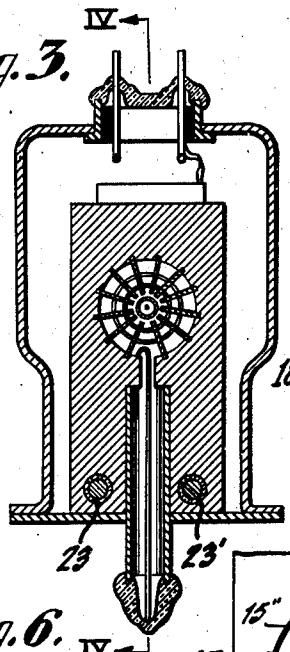
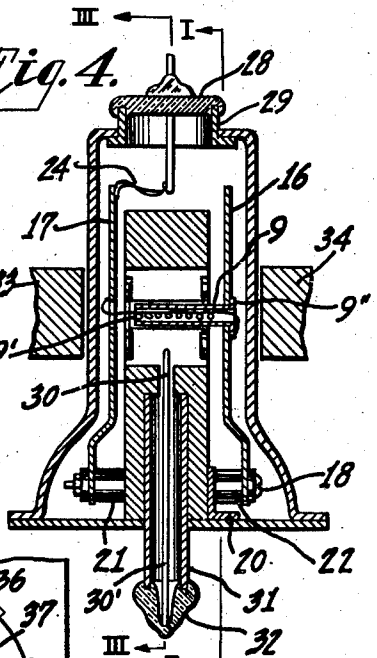


Fig. 4.



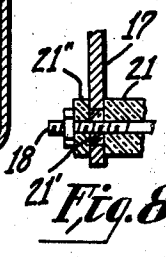


Fig. 8.

Fig. 6.

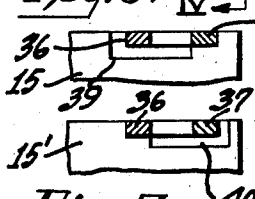


Fig. 7.

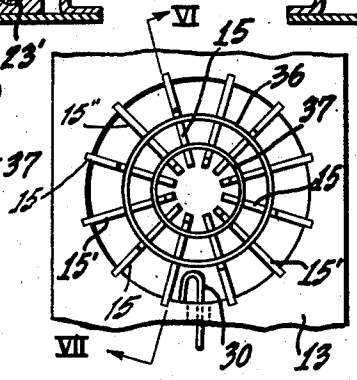


Fig. 5.

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ELECTRODE ASSEMBLY FOR ELECTRON DISCHARGE DEVICES

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Application March 8, 1944, Serial No. 525,516

9 Claims. (Cl. 250—27.5)

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My invention relates to electron discharge devices for use at ultra high frequencies, and more particularly to magnetrons utilizing cavity resonator circuits.

The present application describes a modification of the electron discharge device described and claimed in the co-pending application of Donal et al., Serial No. 525,514, filed March 8, 1944, and assigned to the same assignee as the present application.

In one form of a magnetron utilizing cavity resonators the electrode mount comprises an anode block having a central opening in which a cathode is axially positioned. Radially extending slots communicating with the central opening provide the cavity resonators, the portions of the block adjacent the central opening and between the slots providing the anode segments.

In another form the cavity resonators may be bores or cylindrically shaped chambers extending through the anode block and parallel to the central opening and communicating with the central opening through slots parallel to the axis of the central opening, the portions of the anode block adjacent the central opening and between the slots again providing the anode segments.

In this type of magnetron it has been the usual practice to machine the anode block with its resonant cavities from a solid block of conducting material such as copper, which may be in the form of a cylinder, spaces being machined at both ends of the cylinder to provide room for mounting the cathode and cathode leads, the ends of the cylinder being closed by cover plates soldered or otherwise sealed to the ends of the cylinder to provide an envelope. In a variation, a separate anode has been formed by machining or stamping, this anode being inserted into a machined envelope in the form of a hollow cylinder, end plates again being provided to complete the envelope.

The machining of the envelope is time-consuming and the construction described results in difficulty in mounting and centering of the cathode.

Usually fixed magnets or electromagnets are utilized with the magnetrons of the type described above. Because of the long air gaps made necessary between the electrode mount and the outside of the envelope larger magnets than desired are necessary to provide a field of desired intensity. In any magnetron, leads must be employed to support the cathode and make contact to the cathode and the cathode heater. These leads usually pass through the space at the ends

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of the anode and result in an air gap in the magnetic circuit which is inconveniently large. It is standard practice also to weld a metallic disc to each end of the cathode in order to form electrostatic shields at cathode potential at the ends of the cathode for preventing drift of the electrons out the ends of the anode cavity. This contributes to the necessity for providing larger than desired air gaps.

It is, therefore, an object of my invention to provide an improved electron discharge device of the magnetron type using cavity resonator circuits and particularly useful at ultra high frequencies.

Another object of my invention is to provide such a device of simplified design which will permit ready manufacture and eliminates the need for extensive machining operations.

A still further object of my invention is to provide such a device having a novel and effective means for supporting the cathode and its leads and which facilitates mounting and centering of the cathode.

More particularly it is an object of my invention to provide such a device in which the electrode mount assembly can be mounted on a header to facilitate assembly of the mount and incorporation within an envelope.

A further object of my invention is to provide such a device in which the gaps in the magnetic circuit are substantially reduced, thus decreasing the size and strength of the magnet, electromagnet or coils for providing a magnetic field of required intensity.

Another object of my invention is to provide a device of the kind described, using a smaller header and envelope, and having a large space where the internal mount structure is bolted together and mounting space is needed.

A further object of my invention is to provide an electron discharge device of the type described in which the load line may be taken from the opposite end of the envelope from the electrode leads.

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 vertical section taken along the line I—I of Figure 4 of an electron discharge device made according to my invention, Figure 2 is a side view with portions of the envelope removed of the electron discharge device shown in Figure 1,

Figure 3 is a vertical section taken along the line III—III of Figure 4, Figure 4 is a vertical section taken along the line IV—IV of Figure 3, Figure 5 is an enlarged partial view of the anode assembly showing details of construction and Figures 6 and 7 are enlarged sectional details taken along the lines VI and VIII, respectively, of Figure 5, and Figure 8 shows a detail of construction.

In accordance with my invention I provide an envelope **10** having a lip **11** sealed to a header member **12**. The header consists of metal of a thickness sufficient to give it rigidity and for this purpose I have employed stainless steel .025 inches thick, the non-magnetic properties of which are of advantage in that no disturbance of the internal magnetic circuit of the tube is occasioned by its use. The envelope is also made of stainless steel. The lip **11** may be sealed to the header by atomic hydrogen welding or electrical welding, if desired.

The mount includes the anode block **13** having central chamber **14** in which are supported radially directed anode vanes or slats **15** and **15'**, the inner edges of which define a cathode chamber and provide the anode segments, the space between the vanes providing the cavity resonators connected between adjacent anode segments. The anode block may be secured to the header member by means of the bracket **20**.

Insulatingly supported from the anode block and bracket are the two non-magnetic sheet elements **16** and **17**, which act as the cathode support and electron shields for preventing drift of electrons from the anode-cathode space. They may be spaced close to the anode block. These non-magnetic sheets are retained on the anode block by means of bolts **18** and **19** extending through the anode block and are insulated from each other by the structure shown specifically in Figure 8. As here shown, in addition to the insulating collar members **21** and **22**, the sheet **17** may be supported in insulating relationship with respect to the rod by means of insulating collar **21'** and insulating washer **21''**. This insulates sheet **16** from sheet **17**. The rods **18** and **19** may be insulated from the anode block by means of the insulating collars **23** and **23'**. The cathode **9** having a heater **9'** may be secured to and supported by the sheet member **16** through which it extends by securing the flared end **9''** to the sheet, the cathode extending axially of the chamber within the anode. One end of the cathode heater is electrically and mechanically secured to the sheet member **16** and the other end of the heater is electrically and mechanically secured to the member **17**. These sheet metal members **16** and **17** in turn are electrically connected to conductors **24** and **25**, in turn connected to leads **26** and **27** sealed through the top of the envelope by means of the insulating closure member **28**, preferably of glass, which is sealed to the extension **29** mounted at the top of the envelope. Thus a cathode and cathode heater circuit may be provided which is insulated from the anode block electrically connected to the header member.

Coupling loop **30** extending through the anode block into one of the cavity resonators is extended into an internal conductor **30'** of a coaxial line, the outer tubular conductor **31** of which is sealed by means of cup-shaped element **32** of insulating material. This outer end of the conductor **30'** acts as a radiator which may be coupled to a wave guide or cavity resonator. This coaxial line coupling device is described and claimed in the copending application of Donal and Hegbar, Serial No. 496,570, filed July 29, 1943, and assigned to the same assignee as the present application. This copending application has become U. S. Patent No. 2,442,118, dated May 25, 1948.

In Figures 5 to 7, inclusive, is shown the strapping method employed with an electron discharge device made according to my invention. The purpose of such strapping is to secure the desired mode of operation, thus increasing the efficiency of the tube. Referring to Figure 6, which is a section taken along the line VI of Figure 5, anode vane **15** is provided with a wide slot **39** in which the coupling rings or straps lie, the inner coupling ring or strap **37** being electrically connected to the vane as shown, all of the vanes indicated by the numeral **15** being electrically connected together by means of the strapping means **37**. As shown in Figure 7, which is a section taken along the line VII of Figure 5, alternate vanes **15'** are provided with slots **40** displaced with respect to the slots **39**. In this case the outer coupling strap **36** is electrically connected to the vanes **15**. Thus alternate anode vanes are electrically connected together.

Due to the fact that the anode block is mounted vertically at one end, the size of the header is reduced over that employed in the device described and claimed in the copending applications above identified. The distance through the envelope is also described due to the use of the thin non-magnetic sheets used for the cathode and end shielding instead of the magnetic end inserts and the structure utilized allows the electrode leads to be brought out from the opposite end of the envelope from the load coupling device.

In the final assembly of the tube described the fitting **29** at the top end of the envelope is glassed-in, leaving an opening at the top. The previously assembled tube structure and the header is then inserted into the envelope, the beaded heater leads **26** and **27** protruding through the top of the glass envelope. The internal spacings are adjusted by shims inserted through the open top, the header and envelope assembly welded together, the shims removed and the glass top then shrunk around the glass heater beads to seal the envelope and complete the assembly of the tube.

This form of construction has advantages in simplicity of design, ease of manufacture of parts and of assembly. For any given anode block thickness the end dimensions can be easily fixed to give the maximum efficiency of utilization of the magnetic field which is provided by means of fixed magnet, for example having pole pieces **33** and **34** registering with the cathode-anode space. The envelope **10** being close to the sheets **16** and **17**, the gaps in the magnetic circuit are made very small.

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 electron discharge device having an envelope including a header member, an electrode assembly mounted on said header member including an elongated anode block mounted in a direction normal to said header member and having anode elements surrounding a central space, a cathode for supplying electrons within said space, and a sheet metal member of conducting non-magnetic material extending parallel to one surface of said anode block and insulatingly supported on said anode block and supporting said cathode.

2. An electron discharge device having an envelope including a substantially flat header member, an electrode assembly mounted on said header member and including an elongated anode block mounted endwise in a direction transverse to said header member and having anode elements surrounding a central space, a cathode for supplying electrons, within said central space, a first sheet metal member of conducting non-magnetic material extending parallel to one surface of said anode block and insulatingly supported on said anode block and supporting said cathode in said space, and a second sheet metal member of conducting non-magnetic material extending parallel to the opposite surface of said anode block and insulatingly supported on said anode block and insulated from said cathode and said first sheet metal member.

3. An electron discharge device having a metal envelope including a header member of conducting material, an electrode assembly mounted on said header member including an elongated anode block mounted endwise in a direction transverse to said header member and having anode elements surrounding a central space, a cathode for supplying electrons within said central space, means including sheet metal members of conducting non-magnetic material extending parallel to opposite surfaces of said anode block and insulatingly supported from said anode block, one of said sheet metal members supporting said cathode, said envelope having an aperture in the opposite end from said header member, and a heater for said cathode, one end of said heater being connected to one of said sheet metal members and the other end to the other of said sheet metal members, and current conducting leads extending from said sheet metal members through said aperture and sealed therein.

4. An electron discharge device having a metal envelope including a header member of conducting material, an electrode assembly mounted on said header member including an elongated anode block mounted endwise in a direction transverse to said header member and having anode elements surrounding a central space, a cathode for supplying electrons within said central space, means including sheet metal members of conducting non-magnetic material extending parallel to opposite surfaces of said anode block and insulatingly supported from said anode block, one of said sheet metal members supporting said cathode, said envelope having an aperture in the opposite end from said header member, and a heater for said cathode, one end of said heater being connected to one of said sheet metal members and the other end to the other of said sheet metal members, and current conducting leads extending from said sheet metal members through said aperture and sealed therein, said header member having an aperture and a tubular member extending from said aperture and a coupling loop extending from said anode block through said tubular member and forming therewith a coaxial line.

5. An electron discharge device having an envelope including a flat header member, an elongated anode block supported at one end and transverse to said header member, the longitudinal axis of said block lying perpendicularly to said header member, said anode block having a central opening extending therethrough, a pair of non-magnetic sheet metal members close to and parallel to opposite sides of said anode block, and means on said anode block adjacent said header member insulatingly supporting said sheet metal members on said anode block and insulated from each other, said sheet metal members being spaced further from said anode block at said supporting means, and a cathode supported by one of said sheet metal members and a heater for said cathode, one end of said heater being connected to one of said sheet metal members and the other end of said heater being connected to the other of said sheet metal members, an envelope sealed to said header member and closely surrounding said anode block and sheet metal members and having a pair of current conducting leads sealed through said envelope, each one of said leads being connected to a different one of each of said sheet metal members, said envelope being elongated and having a flared out portion adjacent the means for insulatingly supporting said sheet metal members.

6. An electron discharge device including a flat header member, an elongated anode block supported from said header member transverse to said header member, the longitudinal axis of said block lying perpendicularly to said header member, said anode block having a central opening extending therethrough, a pair of non-magnetic sheet metal members close to and parallel to opposite sides of said anode block, and means on said anode block adjacent said header member insulatingly supporting said sheet metal members on said anode block and insulated from each other, and a cathode supported by one of said sheet metal members, and a heater for said cathode, one end of said heater being connected to one of said sheet metal members and the other end of said heater being connected to the other sheet metal member, an envelope sealed to said header member and closely surrounding said anode block and sheet metal members and having a pair of current conducting leads sealed through said envelope, each one of said leads being connected to a different one of each of said sheet metal members.

7. An electron discharge device having a metal envelope including a header member of conducting material, an electrode assembly mounted on said header member including an elongated anode block mounted endwise in a direction transverse to said header member and having anode elements surrounding a central space, a cathode for supplying electrons within said central space, means including sheet metal members of conducting non-magnetic material extending parallel to opposite surfaces of said anode block and insulatingly supported from said anode block, one of said sheet metal members supporting said cathode, said envelope having an aperture in the opposite end from said header member and a heater for said cathode, one end of said header being connected to one of said sheet metal members, and the other end to the other of

said sheet metal members, and current conducting leads extending from said sheet metal members through said aperture and sealed therein, said header member having an aperture and a tubular member extending from said aperture, and a coupling loop extending from said anode block through said tubular member and forming therewith a coaxial line, said envelope being closely spaced from said sheet metal members and said anode block, and means external of said envelope and registering with said central space for establishing a magnetic field therein.

8. An electron discharge device having an envelope including a header member, an electrode assembly mounted on said header member and including an elongated anode block mounted endwise in a direction transverse to said header member and having anode elements surrounding a central space, a tubular cathode for supplying electrons within said central space, a first elongated sheet metal member of conducting non-magnetic material extending parallel to one surface of said anode block and insulatingly supported at one end on said anode block and supporting said cathode in said space, a second sheet metal member of conducting non-magnetic material extending parallel to the opposite surface of said anode block and insulatingly supported at one end on said anode block and insulated from said cathode and said first sheet metal member, and a heater within said tubular cathode and having current conducting leads extending from the opposite ends of said cathode and connected to said insulated sheet metal members.

9. An electron discharge device having an envelope containing an electrode assembly comprising an anode block having anode segments

surrounding a central space, an elongated tubular cathode for supplying electrons in said central space, and means supporting said cathode in said space including a first sheet metal member extending parallel to one surface of said anode block and attached to one end of said cathode, means insulatingly mounting said first member on said anode block, a second sheet metal member extending parallel to the opposite surface of said anode block adjacent to but spaced from the opposite end of said cathode, means insulatingly mounting said second member on said anode block, a heater disposed within said tubular cathode and having one end connected to said cathode and said first member and the opposite end extending from said tubular cathode and connected to said second member, and current conducting leads extending through said envelope and connected to said two members.

BARREMORE B. BROWN.

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