May 4, 1948. J. S. DONAL, JR., ET AL 2,440,851

ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

Filed March 8, 1944

Fig. 1.

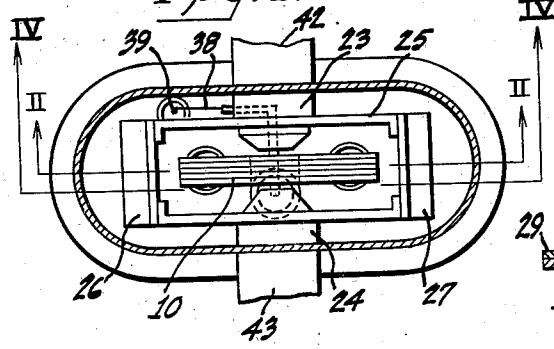


Fig. 2.

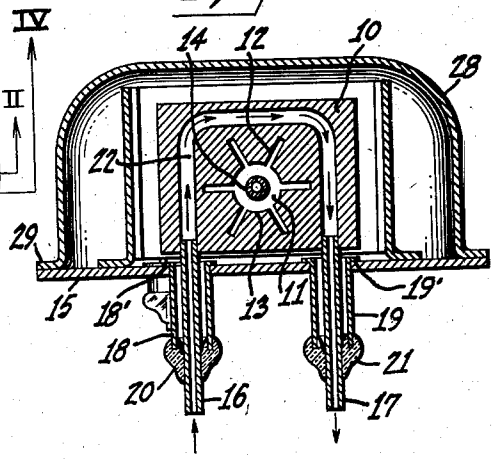


Fig. 3

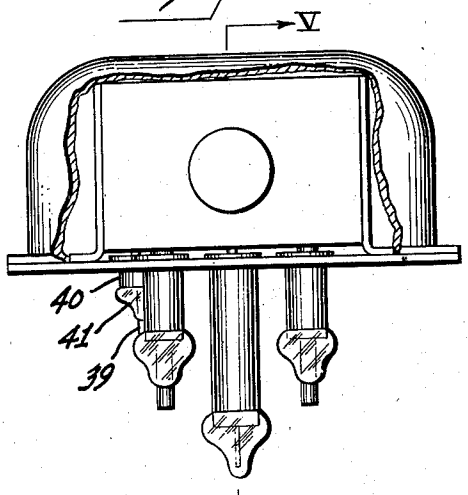


Fig. 4.

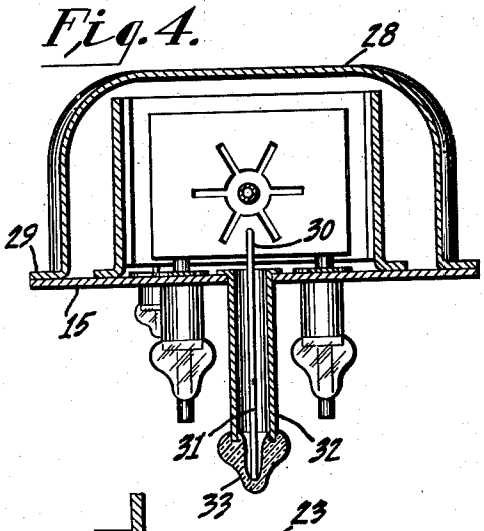


Fig. 5.

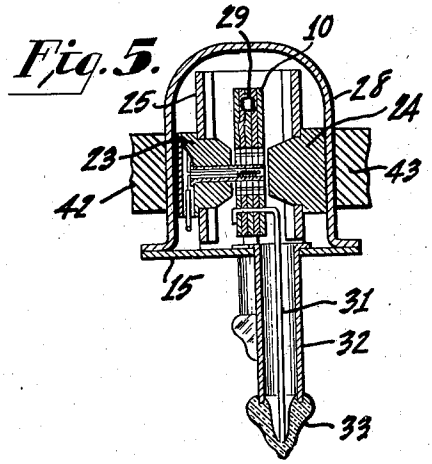
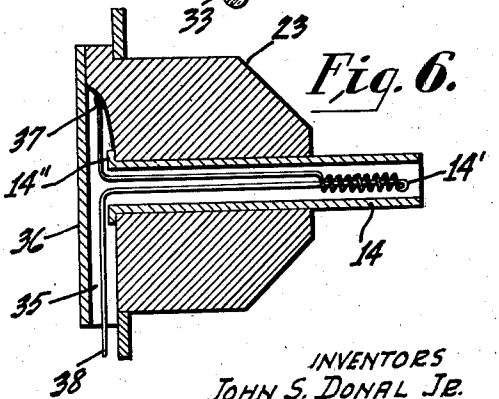


Fig. 6.



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ELECTRON DISCHARGE DEVICE OF THE MAGNETRON TYPE

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8 Claims. (Cl. 315—39)

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

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 and block 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 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 the cathode leads in order to form electrostatic shields at cathode potential at the ends of the cathode for preventing drift of the electrons out

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the ends of the anode cavity. This contributes to the necessity for providing larger than desired air gaps.

It is, therefore, an object of our 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 our invention is to provide such a device of simplified design which will permit ready manufacture and which eliminates the need for extensive machining operations.

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

A further object of our invention is to provide a magnetron in which the conventional end electron shields are eliminated.

Another specific object of our invention is to provide a magnetron which permits pulsing of the anode when the device is in operation, thus eliminating the need for a low capacitance filament transformer and still further reducing the gaps in the magnetic circuit.

The novel features which we believe to be characteristic of our 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 top view with part of the envelope removed showing an electron discharge device made according to our invention, Figure 2 is a vertical section taken along the line II—II in Figure 1, Figure 3 is a side view with part of the envelope removed to show details of construction, Figure 4 is a section taken along the line IV—IV of Figure 1, Figure 5 is a transverse vertical section taken along the line V—V of Figure 3, and Figure 6 is a section showing details of the cathode and its support.

In accordance with our invention we provide

an electrode assembly including an anode block 10 which may be made of a plurality of stacked thin sheets of a conducting material, preferably copper, having a central opening or chamber 11 and radially directed slots 12 providing the cavity resonators, the portions 13 intermediate the slots and defining the central chamber 11 providing the anode segments. Extending axially of the chamber 11 is the indirectly heated cathode 14. Both the anode block and cathode are supported from a header member 15 in a manner to be described.

Tubular members 16 and 17, having one end fitting into the anode block 10, extend through apertures in the header member 15 to which the tubular members 18, 19 are hermetically sealed, preferably by welding to the header the flanges 18' and 19'. The outer ends of the tubular members 16 and 17 are insulatingly sealed to the end of the tubular members 18 and 19 by means of the seals 20 and 21.

The punched sheets forming the anode stack or block are provided with the punched-out portions forming the passageway 22 communicating with the interior of the tubular members 16 and 17 thus providing a means for cooling the anode block. These tubular members 16 and 17 are the sole means for insulatingly supporting the anode block from the header member.

On each side of the anode are mounted the elements or inserts of magnetic material which form part of the magnetic circuit and also provide a support for the cathode within the anode chamber 11. These inserts are supported by means of the tubular or box-like structure 25 having flanges 26 and 27 secured to the header member 15. The cathode and anode are insulatingly supported with respect to each other.

The method of supporting the cathode is shown in Figure 6. The magnetic insert 23 is provided with a central bore through which the cathode 14 having the heater 14' is extended, the flange 14'' of the cathode being secured to the insert. The end of the insert is provided with a groove 35 in which lie the ends of the cathode heater, one end 37 being electrically connected or welded to the insert and the other end of the cathode heater 38 extending from the groove which is covered by means of plate member 36. It is, of course, understood that the cathode is coated with emitting material and that the heater 14' is sprayed with the usual insulating material to prevent short circuit within the sleeve.

The end 38 of the heater is secured to a lead 39 extending through the eyelet 40 and sealed by means of the seal 41 thus providing a circuit to one side of the cathode heater, the other side of the heater circuit being connected through the header 15 or the envelope 28 of the tube having a lip 29 welded to the header member.

A fixed magnet may be used having pole pieces 42 and 43 contacting the outer shell of the envelope and providing with the inserts 23 and 24 the magnetic circuit. Because the box-like member 25 is connected to the header member, the envelope 28 may contact the inserts, thus reducing the gap in the magnetic circuit.

The load may be coupled out of the magnetron by means of the coupling loop 30 extended into the internal conductor 31 of the coaxial line comprising conductor 31 and outer tubular member 32 sealed at its end by means of cup-shaped element 33. This coupling device may be coupled into a wave guide or resonator, the end of the conductor 31 acting as a radiator. This construction is described and claimed in a copending application of Donal and Hegbar, Serial No. 496,570, filed July 29, 1943, and assigned to the same assignee as the present application.

The header member and the envelope may be made of stainless steel having non-magnetic properties so that it does not interfere with the magnetic circuit. The magnetic inserts 23 and 24 may be made of cold rolled steel. The header may consist of an oval plate of metal of a thickness sufficient to give suitable rigidity. In one example stainless steel .025 inch thick was employed. The tubular members 18, 19 and 49 in the form of eyelets are welded to the header to permit sealing-in of the heater and heater cathode leads and it is convenient to make the junctions of these tubular members with a header vacuum-tight by melting silver-nickel solder at these junctions in an atmosphere of chemically dried hydrogen. Other materials are equally suitable.

The magnetic inserts eliminate the air gaps which are inconveniently large in previous magnetrons of this type and also eliminate the necessity for electron shields to prevent drift of electrons from the anode space.

The construction also avoids the necessity for having separate cathode leads for supporting the cathode and shields within the anode. The spaces between the inserts and the anode may be of the order of .030 to .040 inch. These spaces plus the thin walls of the envelope are the only air gaps in the magnetic circuit, except for the anode thickness. Thus no space is lost due to the thickness of a non-magnetic cathode support. Also the fact that the inserts can be varied in height, also means tubes of different anode length may be fitted into the same envelope by merely changing the thickness of the inserts.

As pointed out above, the advantages of the construction described which permits pulsing of the anode are, first, that a low capacitance filament transformer is no longer necessary, and, secondly, only between the cathode support and anode need a gap for voltage clearance be left so that the support may be at the potential of the envelope. The second condition results in a reduction of the gap between the pole faces of the magnet and permits the use of a lighter magnet.

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

What we claim as new is:

1. An electron discharge device including a flat header member of conducting material, an anode block insulatingly supported from said header member and extending transversely thereto and having a plurality of anode elements defining a central space having a longitudinal axis parallel to said header member, a cathode for supplying electrons within said central space, means supporting said cathode including a member of magnetic material supported on said header, and an envelope enclosing said anode block, cathode and supporting means and sealed to said header member.

2. An electron discharge device including a flat header member of conducting material, an anode block insulatingly supported on said header member and having leads extending through and sealed to said header member, said anode block having a plurality of anode elements defining a central space, a hollow conducting member surrounding said anode block and supported by said header member, said hollow conducting member supporting an element of magnetic material on each side of said anode block registering with said central space, one of said elements of magnetic material supporting a cathode for supplying electrons within said central space, and an envelope sealed to said header member and surrounding said anode block and said hollow conducting member and having walls closely adjacent said elements of magnetic material, and magnetic means registering with said magnetic elements for providing a magnetic field within said central space.

3. An electron discharge device having an envelope including a header of conducting material and including a cathode and an anode, a plurality of tubular members insulatingly sealed through said header and supporting said anode, said anode having a passageway therethrough, said passageway opening into said tubular members supporting said anode on said header, said tubular members and passageway providing means permitting circulation of a cooling medium through said anode.

4. An electron discharge device having an envelope including a header of conducting material, an anode electrode having a central chamber, a plurality of tubular members insulatingly sealed through said header and supporting said anode electrode, said anode having a passageway therethrough, said passageway opening into said tubular members supporting said anode on said header for providing means permitting circulation of a cooling medium through said anode, said anode being surrounded by a tubular member supported on said header, an element of magnetic material supported by said tubular member adjacent and in registry with the central chamber in said anode, and a cathode for supplying electrons within said central chamber and supported by said element of magnetic material.

5. An electron discharge device having an envelope including a header of conducting material, an anode having a plurality of anode elements defining a central space, conducting members insulatingly sealed through said header and supporting said anode, a hollow conducting member supported on said header and surrounding said anode, an element of magnetic material supported by said hollow conducting member on each side of said anode and adjacent and in registry with said central space, and a cathode supported by one of said elements of magnetic material.

6. An electron discharge device having an envelope including a header of conducting material and an anode having a plurality of anode elements defining a central space, conducting members insulatingly sealed through said header and supporting said anode, a box-like hollow conducting member supported on said header and surrounding said anode, and an element of magnetic material on each side of said anode and

supported by and extending through the walls of the box-like member toward and in registry with said central space, and a cathode supported by one of said elements of magnetic material.

7. An electron discharge device having an envelope including a header member of flat conducting material and an elongated flat anode block mounted normal to said header member having a plurality of anode elements defining a central space, said header member having a plurality of apertures extending therethrough and a pair of conducting members extending through said apertures and insulatingly sealed therein to said header and connected to the ends of said anode block insulatingly supporting said anode block from said header member, and a hollow conducting member of rectangular transverse section supported on said header member and surrounding said anode, and an element of magnetic material supported by and extending through said hollow conducting member on each side of said anode and adjacent and in registry with said central space, said cathode being supported by one of said elements of magnetic material, and means external of said envelope providing with said elements of magnetic material a magnetic circuit.

8. An electron discharge device having an envelope including a header member of flat conducting material and an elongated flat anode block mounted normal to said header member and having a plurality of anode elements defining a central space, said anode block having a passageway extending therethrough, said header member having a plurality of apertures extending therethrough and tubular conducting members extending through said apertures and insulatingly sealed therein to said header and opening into the passageway through said anode block for permitting circulation of a cooling medium through said block, said tubular conducting members insulatingly supporting said anode block from said header member, and a hollow conducting member of rectangular transverse section supported on said header member and surrounding said anode, and an element of magnetic material supported by said hollow conducting member on each side of said anode and adjacent and in registry with said central space, and a cathode for supplying electrons within said central space and supported by one of said elements of magnetic material, and magnetic means registering with said elements of magnetic material and providing therewith a magnetic circuit.

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