April 6, 1948. D. B. LANGMUIR 2,439,173

ELECTRON DISCHARGE DEVICE

Filed Aug. 12, 1943 2 Sheets-Sheet 1

Fig. 1.

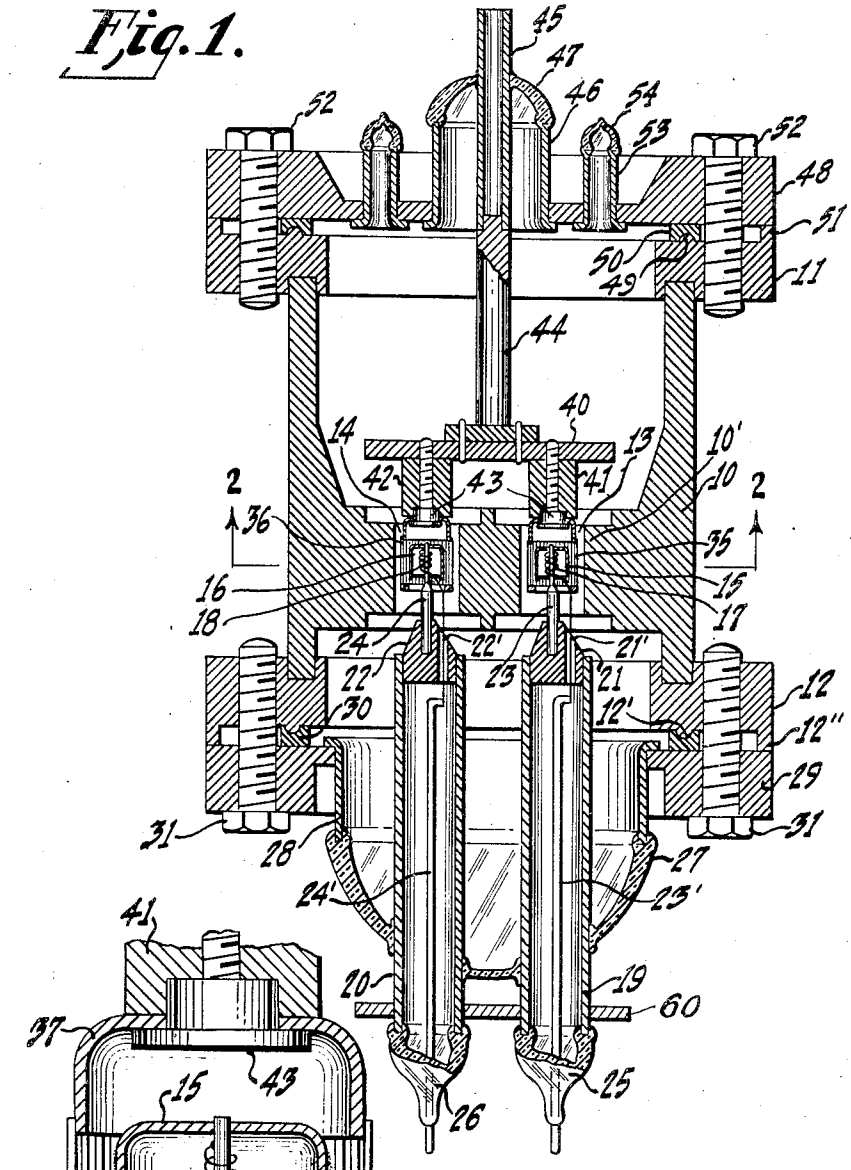


Fig. 4.

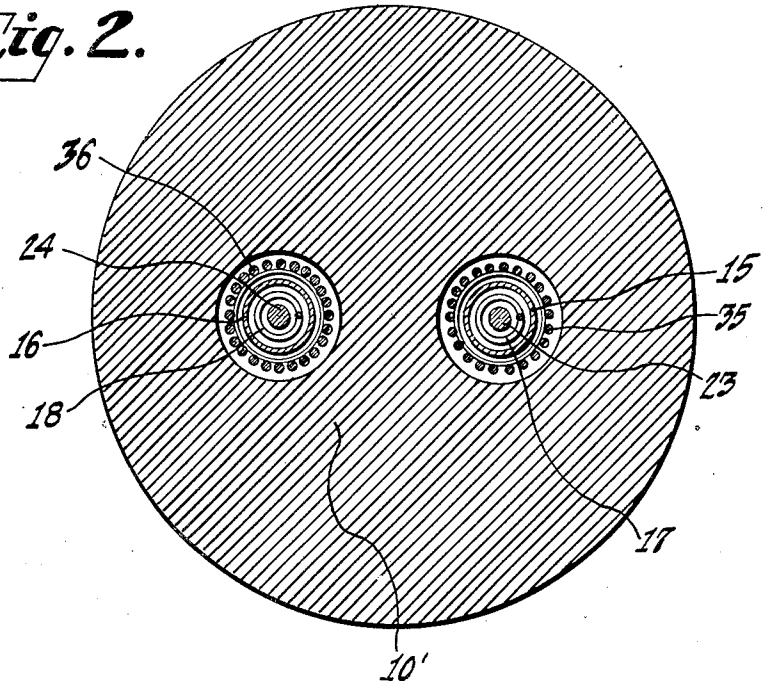
INVENTOR
DAVID B. LANGMUIR
BY
Charles McCaw
ATTORNEY

April 6, 1948. D. B. LANGMUIR 2,439,173

ELECTRON DISCHARGE DEVICE

Filed Aug. 12, 1943 2 Sheets-Sheet 2

Fig. 2.



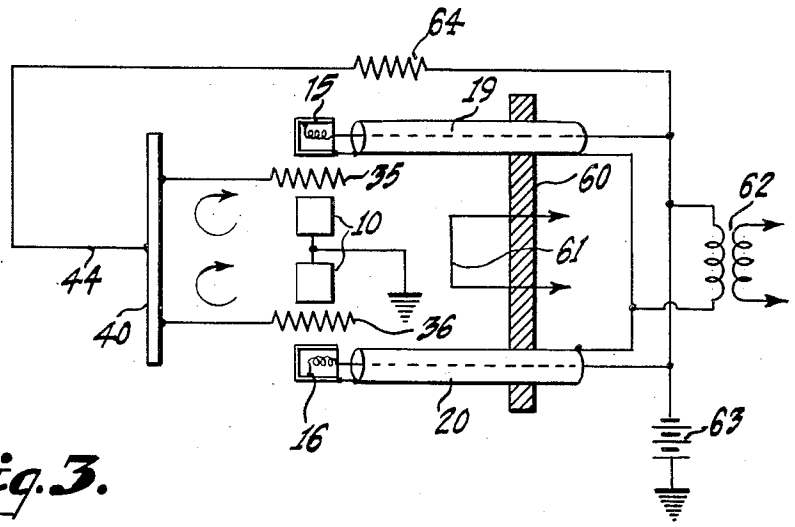


Fig. 3.

INVENTOR
DAVID B. LANGMUIR
BY
Charles McClaur
ATTORNEY

Patented Apr. 6, 1948

2,439,173

UNITED STATES PATENT OFFICE

2,439,173

ELECTRON DISCHARGE DEVICE

David B. Langmuir, Englewood, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application August 12, 1943, Serial No. 498,271

10 Claims. (Cl. 250—27.5)

1

My invention relates to electron discharge devices particularly useful at ultra high frequencies and associated circuit elements.

Broadly, the electrode elements utilized in electron discharge devices for use at high frequencies must be small and closely spaced to reduce the inductance of the electrodes and leads as well as the interelectrode capacities so that the device may operate at the high frequencies. On the other hand, in order to obtain high power output, electron discharge devices must be able to dissipate large amounts of power and heat. In devices of this kind, problems involving seals, circuits and assembly of the electrode mounts must be solved with other than conventional structures.

In more detail the more important features of such electron discharge devices are that the cathode must be capable of producing comparatively large emission currents and close spacing between electrodes must exist to permit advantageous and efficient use of these emission currents. The electrode structures must be such that there exists a minimum capacitance between the electrodes and their leads considering their characteristics. Connections of high conductance and low inductance must be provided between the electrodes of the device and the circuits associated with the device. Interelectrode insulating supports must withstand high voltages and have low losses at the high frequencies. Structural designs must be such as to permit large power and heat dissipation by thermal conduction and radiation. While compact mount assembly is required the design must be such as to facilitate the use of jig assemblies for rapid and accurate assembly of the device. It is also desirable that such devices may be easily disassembled for repairs.

It is therefore an object of my invention to provide an electron discharge device particularly useful at ultra high frequencies and capable of generating comparatively high power.

Another object of my invention is to provide an electron discharge device in which the cathode is capable of providing comparatively large emission currents.

A further object of my invention is to provide such a device having close spacings between electrodes which will enable advantageous use to be made of the emission currents to thereby provide higher operating efficiency.

Another object of my invention is to provide an electron discharge device of the type described having minimum capacitance between electrodes.

2

A still further object of my invention is to provide an electron discharge device in which the connections between the electrodes of the electron discharge device and circuits associated therewith are of high conductance and low inductance.

A further object of my invention is to provide such a device in which insulation losses are low at high frequencies and in which the structural design is such as to provide comparatively high power heat dissipation by thermal conduction and radiation.

A further object of my invention is to provide such a device and circuit which is of reasonable size and economical to operate.

A still further object of my invention is to provide a device of the type described in which seals between envelope and leads are facilitated and accuracy of electrode alignment promoted by simple construction permitting the use of accurate jigs for this purpose.

Another object of my invention is to provide such a device in which dismantling of the device is facilitated for repair purposes.

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 Fig. 1 is a longitudinal section of an electron discharge device made according to my invention; Fig. 2 is a transverse section taken along the line 2—2 of Fig. 1; Fig. 3 is a schematic diagram of an electron discharge device made according to my invention and its associated circuit; Fig. 4 is a longitudinal section of an enlarged detail of Fig. 1.

In accordance with my invention I provide an electron discharge device with an envelope mostly of metal, a portion 10 of which includes the transverse anode block 10'. This portion may be cylindrical and is terminated by means of the flanges 11 and 12 which are sealed to end closure members to be described to provide an evacuated envelope. The transverse section 10' has extending therethrough chambers or anode cavities 13 and 14 of cylindrical shape. Positioned within these cavities are indirectly heated cathodes 15 and 16 provided with heaters 17 and 18 as shown in greater detail in Fig. 4. The drum-shaped cathodes which may be coated on the outside with the usual electron emitting coatings are supported by tubular leads 19 and 20 having at their upper ends the metallic conducting inserts

21 and 22 provided with the supporting and pin-like leads 23 and 24. One end of the cathode heaters is directly connected to the pins 23 and 24, and the other end of the leads extends thru apertures 21' and 22' in the inserts 21 and 22 and are electrically connected to the leads 23' and 24' coaxial with members 19 and 20, and sealed at their ends to the tubular members 19 and 20 by the cup-shaped insulating members 25 and 26. These tubular members may form with a shorting bar 60 a Lecher wire system connected between the cathodes. The tubular members 19 and 20 extend through and are sealed to a cup-shaped closure member 27 supported and sealed to a collar-like member 28 brazed or welded vacuum tight to the ring member 29 which cooperates with the flange 12.

To provide a vacuum tight seal between the closure member supporting the cathode and cathode leads and the flange 12, I provide a bead or rib 12' extending around the surface of the flange 12 which is pressed into a metallic gasket 30 preferably of copper so that a diffusion seal results when the bolt members 31 are screwed up tight. In order to definitely limit the spacing between the electrode elements I provide a lip 12'' extending around the periphery of flange 12. With this arrangement it is possible with jigs to accurately position the cathodes within the anode cavities during assembly when the other closure member cooperating with the flange 11 is not in position. The seals for the cathode leads can be made and the jigs then withdrawn. The process may be repeated for the grid members when the cathode closure and supporting member is removed from the end of the anode block cylinder.

The grids are supported from the opposite end of the device by means of a second closure member cooperating with the flange 11. A cross member 40 supports the studs 41 and 42. Supported from the studs and secured thereto are a pair of grid members 35 and 36 one of which is shown in greater detail in Fig. 4. As shown each grid comprises an inverted cup-shaped member 37 and a bottom ring 38 between which extends the grid wires 39 the ends of which may be welded to the cup 37 and ring 38. The cup-shaped member 37 is provided with an aperture through which the screw 43 extends to secure the grid to the stud 41. The grids therefore are connected to the terminals of a Lecher wire system comprising cross member 40 and studs 41, the entire assembly being supported and sealed through the closure member 11 by means of the rod 44 brazed or welded vacuum tight to the tubular member 45 which in turn is sealed vacuum tight to the collar 46 by means of the dome-shaped insulating sealing element 47. The closure member 48 is sealed vacuum tight to the flange 11 when the metallic gasket 50, preferably of copper, receives the rib or bead 49 when bolt members 52 are screwed up tight, the closure member being limited in longitudinal movement by the lip 51 on flange 11. The envelope may be exhausted through the tubular exhaust member 53 sealed vacuum tight by the cup-shaped element 54.

The circuit arrangement utilized with an electron discharge device made according to my invention is disclosed in Fig. 3. The grids 35 and 36 are connected in Lecher wire fashion by means of the supporting and connecting bar 40. As described, the cathodes 15 and 16 are likewise connected into a Lecher wire system by means of the tubular cathode leads 19, 20 and a slidable shorting bar 60. If desired and if necessary, radio frequency currents may be eliminated in the cathode heater leads by tuning these leads in the usual way. The shorting bar 60 may be placed across the ends of the members 19 and 20 and may be moved longitudinally along these tubular members to tune the circuit. A coupling loop 61 may be utilized to extract energy from the device. Cathode heater current may be supplied by the transformer 62 and anode voltage by means of the voltage source 63, the anodes and voltage source being grounded. Bias on the grids 35 and 36 is provided by means of the bias resistor 64. The device operates in a push-pull manner.

Because of the large mass of the anode block, heat is quickly conducted from the interior to the exterior of the block where it may be removed either by a cooling medium flowing through a jacket applied to the block or if desired cooling fins and forced air may perform this function. The small electrode structures reduce interelectrode capacities and inductances and permit operation of the device at ultra high frequencies. Simplicity of construction and assembly facilitates the use of jigs of comparatively simple design and reduces the time required for assembly while at the same time insuring accurate interelectrode spacing. A comparatively large cathode surface emitting area with respect to the size of the grid and anode give a high current to electrode area ratio. High efficiency is promoted due to the close grid cathode spacing permissible by the structural design utilized in a device made according to my invention. These and the other objects noted above in connection with my invention are promoted by an electron discharge device made according to my invention.

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 including a solid anode block having only a single pair of adjacent separate tubular cavities extending therethrough, a cathode and grid within each of said cavities, said grids being electrically connected together through a common U-shaped conducting support, opposite legs of which are connected to said grids, parallel lines connected to said cathode and oppositely disposed to the grid support, each line being connected to a different cathode, said grid support providing a Lecher wire system, and said parallel lines being adapted to provide an oppositely disposed Lecher wire system, said cathodes and grids being supported independently of each other.

2. An electron discharge device including a tubular member containing an anode block having a pair of adjacent separate tubular cavities extending therethrough, a cathode and grid within each of said cavities, said grids being electrically connected together through a common U-shaped conducting support, parallel lines connected to said cathodes and oppositely disposed to the grid support, said grid support providing a Lecher wire system and said parallel lines being adapted to provide an oppositely disposed Lecher

wire system, a first closure member for one end of said tubular member insulatingly supporting said grid support, and a second closure member for the other end of said tubular member and insulatingly supporting said cathodes and cathode lines.

3. An electron discharge device having a metallic envelope including an anode block member of tubular form having intermediate its ends a comparatively thick transverse partition, said partition having a plurality of adjacent separate tubular cavities extending through said partition and communicating with the spaces within the tubular member only at their ends, a cathode and grid supported within each of said cavities, said anode block member having at one end a transverse flange, and means closing said end of said anode block member including a ring-like member registering with said flange and having an insulating closure element extending thereacross, said cathodes being provided with parallel leads and supports extending through the insulating closure element and sealed therethrough, and means closing the other end of said anode block member and supporting said grids, said grids and cathodes being supported independently of each other.

4. An electron discharge device having a metallic envelope including an anode block member of tubular form having intermediate its ends a comparatively thick transverse partition, said partition having a plurality of adjacent cavities extending through said partition, a cathode and grid supported within each of said cavities, said anode block member having at one end a transverse flange, and a first means closing said end of said anode block member including a ring-like member registering with said flange and having an insulating closure element extending thereacross, said cathodes being provided with parallel leads and supports extending through the insulating closure element and sealed therethrough, and a second means closing the other end of said anode block member, a grid supporting structure comprising a conducting element extending transversely of the envelope and electrically and mechanically connected to said grids, the transverse element being provided with a longitudinally extending lead and support sealed through said second means.

5. An electron discharge device having a metallic envelope including an anode block member of tubular form having intermediate its ends a comparatively thick transverse partition, said partition having a plurality of parallel adjacent cavities of cylindrical form extending through said partition and communicating with the space within the anode block only at the ends of said cavities, a cathode and grid supported within each of said cavities, said anode block member being provided with a transverse flange at one end and means closing said end of said block member including a ring-like member registering with said flange and having an insulating closure element extending thereacross, said cathodes being provided with parallel leads and supports extending through the insulating closure element and sealed therethrough, a grid supporting structure comprising a conducting element extending transversely of the envelope and electrically and mechanically connected to said grids, the transverse element being provided with a longitudinally extending lead and support, and a closure member for the other end of said anode block member and including a plate-like element having a collar-like element extending therefrom the grid lead and support extending through and insulatingly sealed to the collar-like element.

6. An electron discharge device having an anode and a cathode, said cathode including a drum-shaped hollow conducting member coated on the outside thereof, a pin of conducting material extending through and supporting said hollow conducting member and supporting a heater thereon, one end of said heater being connected to said pin and a tubular conducting lead supporting said cathode and having an insert of conducting material connected to and supporting said pin, and a heater lead connected to the other end of said heater and extending coaxially of and within the tubular conducting lead supporting said cathode.

7. An electron discharge device having an anode block of cylindrical shape and provided with tubular extensions on opposite sides thereof, said cylindrical portion having a pair of cylindrically shaped cavities extending therethrough, a hollow cathode positioned within each of said cavities and a cup-shaped grid positioned over each of the cathodes and between the cathodes and the walls of said cylindrically shaped cavities, a transverse conducting element positioned adjacent said grids and studs extending from said transverse conducting element and connected to and supporting said grids, said transverse conducting element being provided with a longitudinally extending support and lead, said cathodes being provided with parallel leads and supports extending in the opposite direction from the lead and support for said grids, closure members for the ends of said tubular extensions, one of said closure members comprising a plate-like element having a collar-like member extending therefrom, the grid lead and support extending through said collar-like element and insulatingly sealed thereto, and another closure member comprising a ring member supporting a cup-shaped transverse element of insulating material, the cathode leads and supports extending through and sealed to said cup-shaped element.

8. An electron discharge device having an anode block of cylindrical shape and provided with tubular extensions on opposite sides thereof, said anode block having a pair of cylindrically shaped cavities extending therethrough, a cathode positioned within each of said cavities and a cup-shaped grid positioned over each of said cathodes and between said cathodes and the walls of said cylindrically shaped cavities, a transverse conducting element positioned adjacent said grids and studs extending from said transverse conducting element and connected to and supporting said grids, said transverse conducting element being provided with a longitudinally extending support and lead, said cathodes being provided with parallel leads and supports extending in the opposite direction from the lead and support for said grids, closure members for the ends of said tubular extensions, one of said closure members comprising a plate-like element having a collar-like member extending therefrom, the grid lead and support extending through said collar-like element and insulatingly sealed thereto, and another closure member comprising a ring member supporting a cup-shaped transverse element of insulating material, the cathode leads and supports extending through and sealed to said cup-shaped element, said tubular extensions being provided with transverse flanges, said

flanges having a bead extending around the surface thereof, and metallic gaskets positioned between said bead and said closure members, and means forcing said closure members against said gaskets providing a vacuum tight diffusion seal.

9. An electron discharge device having an anode block of cylindrical shape and provided with tubular extensions on opposite sides thereof, said anode block being provided with a pair of cylindrically shaped cavities extending therethrough, a drum-shaped cathode positioned within each of said cavities, a heater within each of said cathodes and a cup-shaped grid positioned over each of said cathodes and between said cathodes and the walls of said cylindrically shaped cavities, a transverse conducting element positioned adjacent said grids and studs extending from said transverse conducting element and connected to and supporting said grids, said transverse conducting element being provided with a longitudinally extending support and lead, said cathodes being provided with parallel leads and supports extending in the opposite direction from the lead for said grids, the cathode leads comprising tubular members, closure members for the ends of said tubular extensions, one of said closure members comprising a plate-like element having a collar-like member extending therefrom, the grid lead and support extending through said collar-like element and insulatingly sealed thereto and the other of said closure members comprising a ring member supporting a cup-shaped transverse element of insulating material, the cathode leads and supports extending through and sealed to said cup-shaped element, each of said cathode heaters having a lead extending through the tubular cathode lead supporting its cathode.

10. An electron discharge device including a

solid anode block having only a pair of adjacent seperate tubular cavities extending therethrough, a cathode and grid within each of said cavities, said grids being electrically connected together through a common U-shaped conducting support, opposite legs of which are connected to said grids, straight parallel lines connected to said cathodes, one line being connected to each cathode, and oppositely disposed to the grid support, and a conducting member extending between said parallel lines, said grid support and said parallel lines and conducting member providing oppositely disposed Lecher wire systems, said cathodes and grids being supported independently of each other.

DAVID B. LANGMUIR.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,097,552	Kramer	May 19, 1914
1,113,380	Story, Jr.	Nov. 24, 1914
1,264,270	Carpenter	Apr. 30, 1918
1,353,976	Stockle	Sept. 28, 1920
1,580,855	Prindle	Apr. 13, 1926
1,591,432	Noble	July 6, 1926
1,817,762	Prince	Aug. 4, 1931
2,006,904	Runge et al.	July 2, 1935
2,086,578	Samuel	July 13, 1937
2,108,539	Lindenblad	Feb. 15, 1938
2,228,939	Zottu et al.	Jan. 14, 1941

FOREIGN PATENTS

Number	Country	Date
265,977	Italy	July 13, 1929