July 16, 1946. H. M. WAGNER 2,404,113

ELECTRON DISCHARGE DEVICE

Filed March 31, 1943 3 Sheets-Sheet 1

Fig. 1.

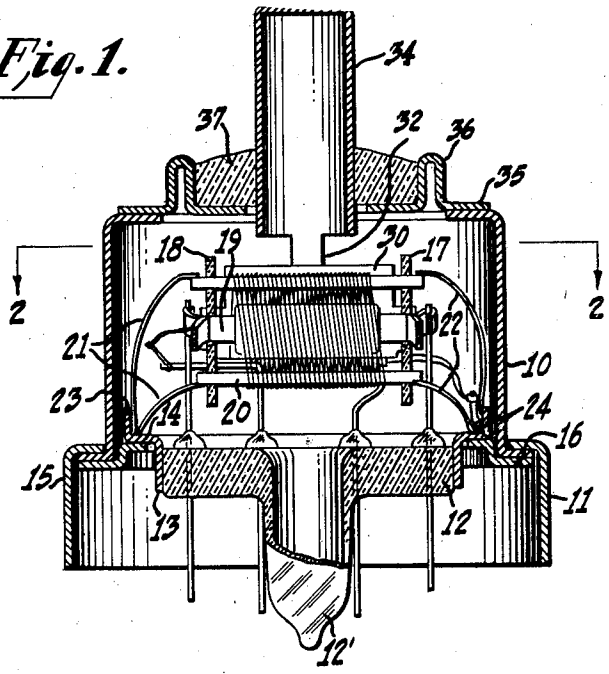
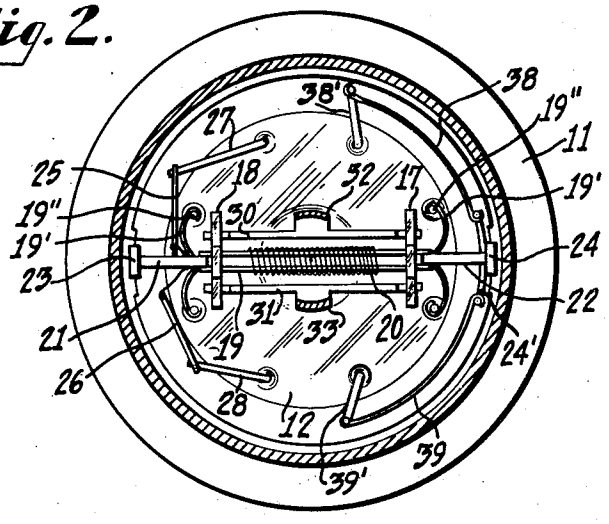


Fig. 2.



Inventor

HERBERT M. WAGNER

By Charles McClair

Attorney

July 16, 1946. H. M. WAGNER 2,404,113

ELECTRON DISCHARGE DEVICE

Filed March 31, 1943 3 Sheets-Sheet 2

Fig. 3.

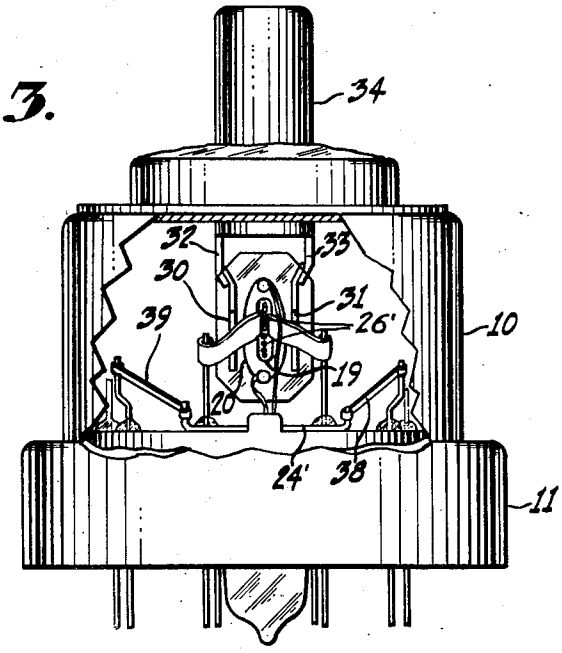
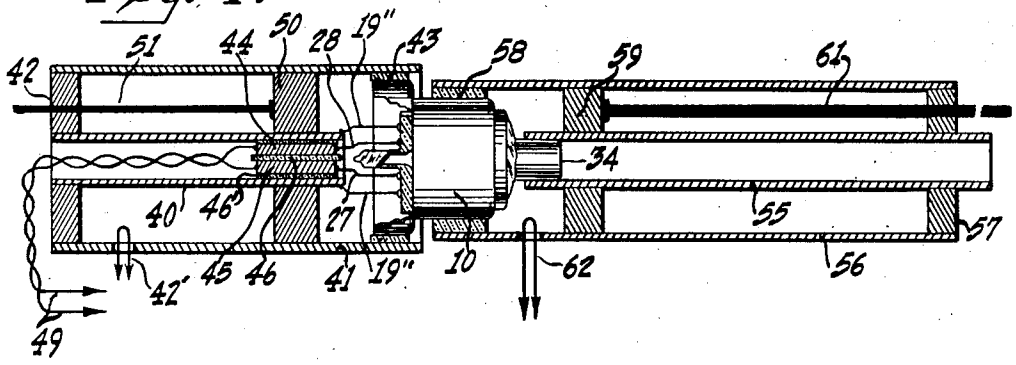


Fig. 4.



Inventor

HERBERT M. WAGNER

By Charles M'Clean

Attorney

July 16, 1946. H. M. WAGNER 2,404,113

ELECTRON DISCHARGE DEVICE

Filed March 31, 1943 3 Sheets-Sheet 3

Fig. 5.

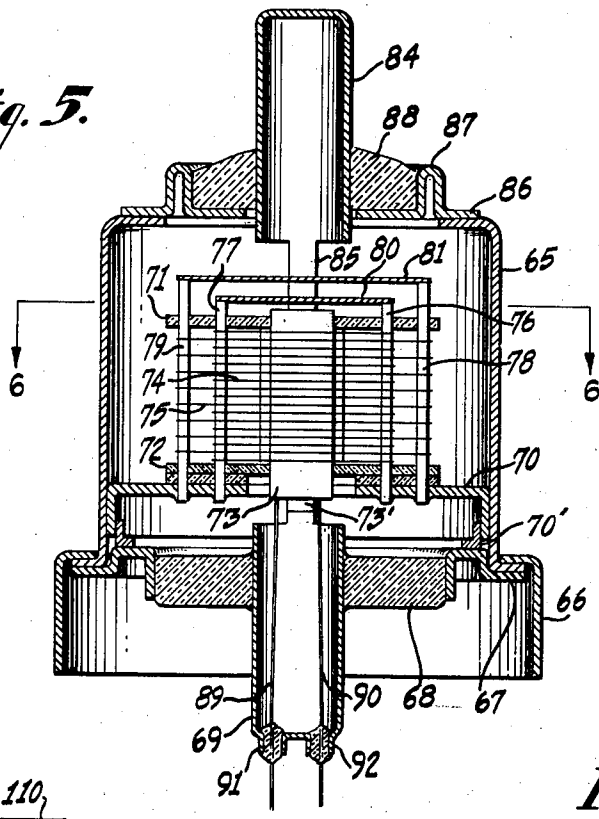


Fig. 7.

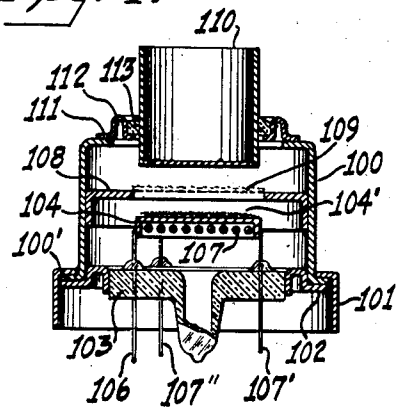
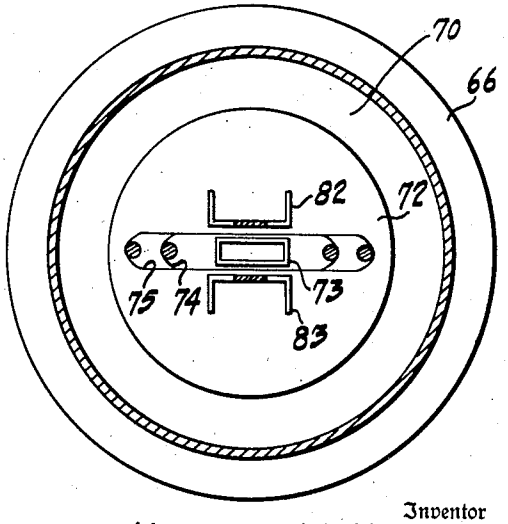


Fig. 6.



Inventor

HERBERT M. WAGNER

By Charles McClair

Attorney

Patented July 16, 1946 2,404,113

UNITED STATES PATENT OFFICE

2,404,113

ELECTRON DISCHARGE DEVICE

Herbert M. Wagner, Long Branch, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application March 31, 1943, Serial No. 481,187

15 Claims. (Cl. 250—27.5)

1

My invention relates to electron discharge devices particularly useful at ultra high frequencies and suitable for use as oscillators, amplifiers or mixers.

At ultra high frequencies it is desirable to use electron discharge devices with circuits of the hollow conducting type, such as resonators, closed wave guides or coaxial lines. Such circuits which form closed systems prevent spurious radiations, thus reducing losses of the radio frequency energy generated by electron discharge devices used in conjunction with these closed systems. These closed systems also provide resonant sealing between the input and output circuits, which is a particularly desirable feature in amplifiers as well as in oscillators. In the case of amplifiers undesirable feedback is prevented and in the case of oscillators, definite control of the phase relationship and the amount of feedback energy is made possible. These closed circuits also permit practically complete shielding between any circuits which may be used, for example, in the case of mixers where separate energizing circuits are utilized for providing a plurality of separate voltages of different frequencies on an electrode or electrodes of the device being used. Conventional tubes, however, are not suitably designed for incorporation in such closed resonant circuit systems.

A further problem in connection with an electron discharge device useful at ultra high frequency, particularly when used for transmitting purposes, is the problem of heat dissipation due to power losses when conventional leads and structures are employed.

It is an object of my invention to provide an improved electron discharge device useful at ultra high frequencies.

It is another object of my invention to provide an electron discharge device useful at ultra high frequencies and particularly suitable for use with resonators which may be, for example, of the coaxial line type.

A still further object of my invention is to provide such an electron discharge device in which the electrode and electrode lead structure is such as to facilitate heat dissipation due to power losses and particularly when used with resonators which may be of the coaxial line type.

A still further object of my invention is to provide an electron discharge device so designed that the electrodes form continuations of the walls of the resonators whereby closed conducting circuit systems result with the accompanying complete shielding of the device and circuits to

2

prevent radio frequency losses and to completely shield the various circuits connected to the tube electrodes from each other.

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 drawings in which Figure 1 is a longitudinal section of an electron discharge device made according to my invention, Figure 2 is a plan view in section taken along the line 2—2 of Figure 1, Figure 3 is an end view with shell partially broken away of the electron discharge device shown in Figures 1 and 2 and showing the relation of the electrodes within the envelope, Figure 4 is an ultra high frequency apparatus utilizing an electron discharge device made according to Figures 1, 2 and 3, Figure 5 is a longitudinal section of a modification of an electron discharge device made according to my invention, Figure 6 is a section taken along the line 6—6 of Figure 5, and Figure 7 is a longitudinal section of a still further modification of an electron discharge device made according to my invention.

Referring to Figure 1 an electron discharge device made according to my invention has an envelope including in part a tubular external shell-like member 10 having a skirt 11 and an insulating closure member or press 12 supported in a ring-like member 13 provided with outwardly extending flange or lip 14, preferably welded to the ring-shaped element 15, this element in turn being welded to the flange 16 of the tubular member 10. It is obvious, of course, that the members 13 and 15 could be made as a single unit. The press 12 from which extend the lead and support wires supporting the mount within the envelope of the tube is provided with the exhaust tube 12'.

The mount includes the mount assembly comprising the mica end spacers 17 and 18 between which and supported by which is the indirectly heated cathode 19 surrounded by the grid 20, the side rods of which extend through the mica spacers. The cathode is provided with tabs, such as 19', electrically connected to the lead wires 19'' which extend through the press 12. The grid side rods have straps, such as 21 and 22, connected to their ends, these straps in turn being welded to and electrically connected to the ears or lugs 23—24 integrally formed with the flange 14 so that the grid is electrically connected to the tubular shell 10. The cathode is

provided with a heater 26' (see Figure 3), having the leads 25 and 26 which are in turn electrically connected to the leads 27 and 28 extending through the press for supplying the heating current to the cathode heater.

The anode comprises a pair of longitudinally extending plate elements 30—31 which are connected by means of the tabs 32—33 to the elongated tubular conducting member 34, which extends through the top of the envelope of the tube. The member 34 is supported and sealed to the top of the tube by means of the ring-like member 35 provided with the annular deformation 36 to which the member 34 is sealed by means of the glass seal 37. The deformation 36 serves to take up strains due to temperature differentials during manufacture and use.

Getter supports 38 and 39 are U-shaped channels filled with the getter material and are connected to the leads 38' and 39' extending through the press and to the U-shaped yoke member 24' welded to the lug 24. The getter may be flashed by applying a voltage between the shell 10 and either of the leads.

An application of an electron discharge device such as shown in Figures 1 to 3 inclusive, is shown utilized in Figure 4 in an ultra high frequency apparatus including concentric line resonant cavity circuits serving as the input and the output circuits. The input circuit includes the inner tubular member 40 and the outer tubular member 41 coaxial therewith, one end of the coaxial line being closed by the conducting member 42. The outer tubular member surrounds but is spaced from the skirt 11 by means of the insulating ring 43, preferably of mica. The cathode leads 19'' are electrically connected to the inner tubular member 40 and the cathode heater leads 27 and 28 are electrically connected to the members 44 and 45 of semi-circular transverse section electrically insulated from each other by means of the insulating strip 46 and insulated from the inner tubular member by insulating collar 46', these elements being connected to the heater leads 49. The members 44 and 45 provide a by-pass condenser for R.-F. currents while at the same time permitting a D. C. voltage to be applied to the heater of the tube. The coaxial line resonator may be tuned by means of a sliding condenser 50 which may be adjusted by means of the operating handle 51. An input coupling loop 42' is used.

The output coaxial line resonator includes the inner tubular member 55 electrically connected to the anode cap 34 and an outer conductor 56 surrounding the shell 10 but insulated therefrom by means of the insulating ring or collar 58, preferably of mica. A closure member 57 closes the ends of members 55 and 56. Tuning condenser 59 permits tuning of the output resonator by means of the adjusting handle 61 and the output is taken by means of the coupling loop 62.

A modification of the electron discharge device described above is shown in Figures 5 and 6. The envelope includes the tubular shell 65 provided with skirt 66, the lower end being closed by means of the collar-like member 67 supporting the transverse insulating press 68. The mount within the envelope includes conducting disc 70 extending transversely of the tubular member 65 and electrically connected to and supported by the tabs 70' connected to the header 67. A pair of insulating spacing members 71 and 72 have mounted between them the indirectly heated cathode 73 and the grid members 74 and 75 provided with the side rods 76 and 77 and 78 and 79,

respectively. The lower ends of these side rods are supported in and electrically connected to the conducting disc 70 so that the grids are electrically connected to the tubular member 65. The upper ends of the side rods of the grid are electrically connected to the shield members 80 and 81 for shielding the cathode from the anode. The anode includes the pair of plates 82 and 83 supported by means of tabs, such as 85, from the elongated tubular member 84 again sealed in the other end of the envelope by means of the apertured disc-like member 86 having the annular deformation 87, the elongated member 84 being sealed to the inner edge of the member 86 by means of the sealing material, such as glass 88.

The cathode is indirectly heated by means of a heater, not shown, but provided with the leads 89 and 90 extending through the tubular member 69 sealed through the insulating member 68, the leads 89 and 90 being sealed, for example, by means of beads in tubular extensions 91 and 92. The tubular member 69 in turn is connected to the cathode by means of tabs, such as 73'. The device may be incorporated in an apparatus, such as shown in Figure 4, in the same manner as the electron discharge device shown in Figures 1 to 3, inclusive.

A still further modification of my invention is shown in Figure 7. In this arrangement a tubular shell 100 is provided with skirt 101 and is closed at one end by means of collar-like member 102 supporting the transverse insulating press 103 sealed to member 102, which in turn is sealed and electrically connected to the flange 100', preferably by welding. An indirectly heated cathode 104 in the form of an inverted cup and coated with emitting material 104' is supported by conductors 106—107' extending through the press. The heater 107 may have an end connected to lead 107' and the other to lead 107''. The grid 108 in the form of an inverted cup is provided with a centrally positioned aperture registering with the emitting surface on the cathode and provided with foraminous material or screen 109. The anode 110 is in the form of an elongated element of circular transverse section, the lower end of which registers with the grid and cathode emitting surface. It is supported at the upper end of the tube and sealed thereto by means of the disc-like member 111 provided with an annular deformation 112 and sealed by means of the ceramic material or glass seal 113.

An electron discharge device made according to my invention as described above is particularly suitable for use at ultra high frequencies and due to the large conducting surfaces to which the various electrodes are secured, particularly the grid and the anode and the connection between the anode cap, for example, and the circuit, effective heat dissipation due to power losses is no longer a problem. The small size of the tube and the arrangement of the electrode elements permits operation at ultra high frequencies and because of the construction employed is particularly adaptable for use in coaxial lines so prevalent at the present time for use at ultra high frequencies. My construction permits the merger of the electrode elements themselves with the circuit elements used in the combined high frequency apparatus.

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 inventions as set forth in the appended claims.

What I claim as new is:

1. An electron discharge device having a tubular conducting shell, a header member closing one end of said shell and comprising a conducting ring provided with a transverse flange and a transverse member of insulating material sealed to said ring closing one end of said conducting shell, an electrode mount mounted on said transverse member of insulating material and including a cathode and a grid, one end of said tubular conducting shell being secured to said flange, a conductor coaxial with said conducting shell and extending through the other end of said conducting shell, a seal between the other end of said conducting shell and said coaxial conductor, electrically conductive connections between said grid and said shell, conductors for said cathode extending through said transverse member of insulating material, an anode within said shell, and electrically conductive connections between the anode and said coaxial conductor.

2. An electron discharge device including a tubular conducting shell, a transverse insulating member closing one end of said shell and provided with a plurality of leads and supports extending through said transverse insulating member, an elongated conductor of circular cross section extending through the other end of said shell coaxially thereof and sealed thereto, an electrode mount assembly comprising a cathode, grid and anode supported within said shell, said cathode being provided with a plurality of tabs electrically connected to different ones of said leads, said grid being provided with a plurality of tabs electrically connected to said tubular conducting shell, said elongated conductor of circular cross section being electrically connected to said anode.

3. An electron discharge device including a tubular conducting shell, a transverse insulating member closing one end of said shell and provided with a plurality of leads and supports extending through said transverse insulating member, an elongated conductor of circular cross section extending through the other end of said shell coaxially thereof and sealed thereto, an electrode mount assembly comprising cathode, grid and anode supported within said shell, said cathode being provided with a plurality of tabs electrically connected to different ones of said leads, said grid being provided with a plurality of tabs electrically connected to said tubular conducting shell, said elongated conductor of circular cross section having a plurality of tabs electrically connected to said anode.

4. An electron discharge device including a tubular conducting shell provided with an outwardly extending flange at one end thereof, a closure member for said shell provided with a collar having a flange secured to said flange on said conducting shell, and a transverse member of insulating material provided with a plurality of leads extending therethrough and sealed to said collar, an electrode mount assembly positioned within said shell, the longitudinal axis of which extends transversely of said shell, said mount including a cathode and grid, and a pair of anode plates, said plates being positioned on opposite sides of said cathode and grid, a plurality of leads extending from said cathode and electrically connected to the leads in said transverse member of

insulating material, and a plurality of leads extending from said grid and electrically connected to said flange on said collar, an elongated conducting member of circular cross section extending from the other end of said tubular shell and sealed thereto, and tabs on said conducting member, said last tabs being electrically connected to said anode plates.

5. An electron discharge device including a tubular conducting shell, a closure member for said shell having a transverse member of insulating material provided with a plurality of leads extending therethrough, an electrode mount assembly positioned within said shell, the longitudinal axis of which extends transversely of said shell, said mount including a cathode and grid, and a pair of anode plates, said plates being positioned on opposite sides of said cathode and grid, a plurality of leads extending from said cathode and electrically connected to the leads in said transverse member of insulating material, and a plurality of leads extending from said grid and electrically connected to said shell, an elongated conducting member of circular cross section extending from the other end of said tubular shell, and tabs on said elongated conducting member, said last tabs being electrically connected to said anode plates, the other end of said tubular shell being closed by a disc having a central aperture through which said elongated conducting member extends and provided with an annular U-shaped depression, and a ring-like seal of insulating material extending between the elongated conducting member and the edge of said disc adjacent said elongated conducting member.

6. An electron discharge device including a tubular conducting shell having an outwardly extending flange at one end thereof, a header member closing one end of the conducting shell and including a collar member of conducting material provided with a flange secured to the flange on said tubular conducting shell, and supporting a transverse closure element of insulating material having a plurality of leads extending therethrough, an electrode mount assembly positioned within said shell and extending transversely of the longitudinal axis of said shell, and including a pair of spaced insulating members, a cathode and a grid supported between said insulating members, said cathode being electrically connected to said plurality of leads, and said grid to said shell, and a pair of anode plates positioned on opposite sides of said cathode and grid, an elongated cup-shaped tubular member axially positioned within the other end of said tubular conducting shell having tabs at the lip of said cup-shaped tubular member electrically connected to said anode plates, a transverse conducting member having a central opening closing the other end of said tubular conducting shell, and having an annular elevation positioned intermediate the outer edges of said member and said central opening, and an insulating seal between said cup-shaped tubular member and the edge of said transverse conducting member around said central opening.

7. An electron discharge device including a tubular conducting shell, means closing one end of said tubular conducting shell including an annular conducting means having a U-shaped transverse section, one leg of which is sealed to said shell and a transverse insulating member sealed to and supported within said annular conducting member, a plurality of leads and conductors

extending through said transverse insulating member and an electrode mount positioned within said tubular shell and including a cathode, grid and an anode, said cathode being provided with a plurality of leads extending from each end thereof, each of said cathode leads being electrically connected to a lead in said transverse insulating member, said grid being provided with a plurality of leads extending from each end thereof, said last leads being electrically connected to said annular conducting means of U-shape transverse section, said anode having a pair of plates positioned on opposite sides of said cathode and grid, an elongated cup-shaped conducting member extending through the other end of said tubular conducting shell, its open end being provided with tabs electrically connected to said anode plates and insulating means sealing said elongated cup-shaped conducting member to the other end of said tubular conducting shell.

8. An electron discharge device including a tubular conducting shell, means closing one end of said tubular conducting shell including a transverse insulating member sealed to and supported within one end of said conducting shell, a plurality of leads and conductors extending through said transverse insulating member and an electrode mount positioned within said tubular conducting shell and including a cathode, grid and an anode, said cathode being provided with a plurality of leads extending from said cathode, each of said cathode leads being electrically connected to a lead extending through said transverse insulating member, said grid being provided with a plurality of conductors extending therefrom, said grid conductors being electrically connected to said tubular conducting shell, an elongated conducting member coaxial with and extending through the other end of said tubular shell, one end of said elongated conducting member being electrically connected to said anode and insulating means sealing said elongated electrically conducting member to the other end of said tubular shell, and a getter support electrically connected between said conducting shell and a lead extending through said transverse insulating member.

9. An electron discharge device including a tubular conducting shell, means closing one end of said tubular conducting shell including a transverse insulating member sealed to and supported within one end of said tubular conducting member, a plurality of leads and conductors extending through said transverse insulating member, an electrode mount positioned within said tubular shell and including a cathode, grid and an anode, said cathode being provided with a plurality of leads, each of said cathode leads being electrically connected to a lead extending through said transverse insulating member, said grid being provided with a plurality of conductors extending therefrom, said grid conductors being electrically connected to said tubular conducting shell, an elongated conducting member coaxial with and extending through the other end of said tubular shell, and electrically connected to said anode, and insulating means sealing said elongated conducting member to the other end of said tubular conducting shell.

10. An electron discharge device having a tubular conducting shell, one end of which is closed by a transverse insulating member, a lead extending through said transverse insulating member, a mount within said tubular conducting shell and comprising a cathode, and a pair of grids surrounding said cathode, and an anode, each of said grids being provided with a pair of oppositely disposed side rods, a transverse disc of conducting material positioned at one end of said cathode and said grids, said side rods being fixed to and electrically connected to said grids, said disc having an aperture through which said cathode extends and being electrically connected to said tubular conducting shell, said cathode being electrically connected to the lead in said transverse insulating member, an elongated conducting member extending through the other end of said tubular conducting shell and insulatingly sealed thereto, and an electrical connection between said anode and said elongated conducting member.

11. An electron discharge device having a tubular conducting shell, one end of which is closed by a transverse insulating member, a lead extending through said insulating member, a mount within said tubular conducting shell comprising a cathode, and a pair of grids surrounding said cathode, and an anode, each of said grids being provided with a pair of oppositely disposed side rods, a transverse disc of conducting material positioned at one end of said cathode and said grids, said side rods being fixed to and electrically connected to said disc, said disc being electrically connected to said tubular conducting shell and having an aperture, and said cathode being electrically connected through said aperture to the lead in said transverse insulating member, an elongated conducting member extending axially through the other end of said tubular conducting shell and insulatingly sealed thereto and an electrical connection between said anode and said elongated conducting member, the free ends of said grids being provided with shielding means extending between the side rods and shielding the end of said cathode from said elongated conducting member.

12. An electron discharge device having a tubular conducting shell, one end of which is closed by a transverse insulating member, a mount within said tubular conducting shell and including an indirectly heated cathode, a heater for said cathode and an anode, an elongated conducting member extending axially through the other end of said tubular conducting shell and insulatingly sealed thereto and an electrical connection between said anode and said elongated conducting member, said transverse insulating member having a tubular conducting member extending through and sealed thereto, said cathode heater having leads extending through said last named tubular conducting member and sealed therein, said tubular conducting member being electrically connected to said cathode.

13. An electron discharge device having a tubular conducting shell, one end of which is closed by a transverse insulating member, a lead extending through said insulating member, a mount within said tubular shell comprising a cathode, a grid and an anode, said grid being provided with a pair of oppositely disposed side rods, a transverse disc of conducting material positioned at one end of said cathode and grid, said side rods being fixed to and electrically connected to said disc, said disc being electrically connected to said tubular conducting shell and having an aperture through which said cathode extends and is electrically connected to the lead extending through said transverse insulating member, an elongated conducting member extending axially through the other end of said tubular conduct-

ing shell and insulatingly sealed thereto, and an electrical connection between said anode and said elongated conducting member.

14. An electron discharge device having a tubular conducting shell, one end of which is closed by a transverse insulating member, a mount within said tubular conducting shell and including an indirectly heated cathode, a heater for said cathode, a grid and an anode, a transverse disc of conducting material positioned adjacent said transverse insulating member and electrically connected to said grid, and having an aperture through which said cathode extends, said disc being electrically connected to said tubular conducting shell, a lead for said anode extending axially through the other end of said tubular conducting shell and insulatingly sealed thereto, said transverse insulating member having a tubular conducting member extending through and sealed to said insulating member, and tabs on said tubular conducting member electrically connected to said cathode, said heater having leads extending through said tubular conducting member and sealed therein.

15. An electron discharge device having a tubular conducting shell, means closing one end of

said shell and including an annular member having a central aperture, said central aperture being sealed by a transverse insulating member, said annular member being provided with a flange-like element, a cathode and grid within said tubular conducting shell and a plurality of supporting leads extending between said grid and said flange-like element, and a lead extending through said transverse insulating member and electrically connected to said cathode, said tubular conducting shell being sealed to a portion of said flange-like element, an anode within said tubular conducting shell and conducting means extending axially through the other end of said tubular conducting shell and electrically connected to said anode, and means supporting and sealing said conducting means to said other end of said tubular conducting shell and including a ring-like element having an annular deformation intermediate its edges, the outer edge of said ring-like element being sealed to said tubular conducting shell and the inner edge of said ring-like element being sealed to said conducting means.

HERBERT M. WAGNER.