Dec. 7, 1948. J. E. BEGGS 2,455,851

IMPROVED ELECTRODE AND ENVELOPE STRUCTURE FOR ELECTRIC DISCHARGE DEVICES

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Fig. 1.

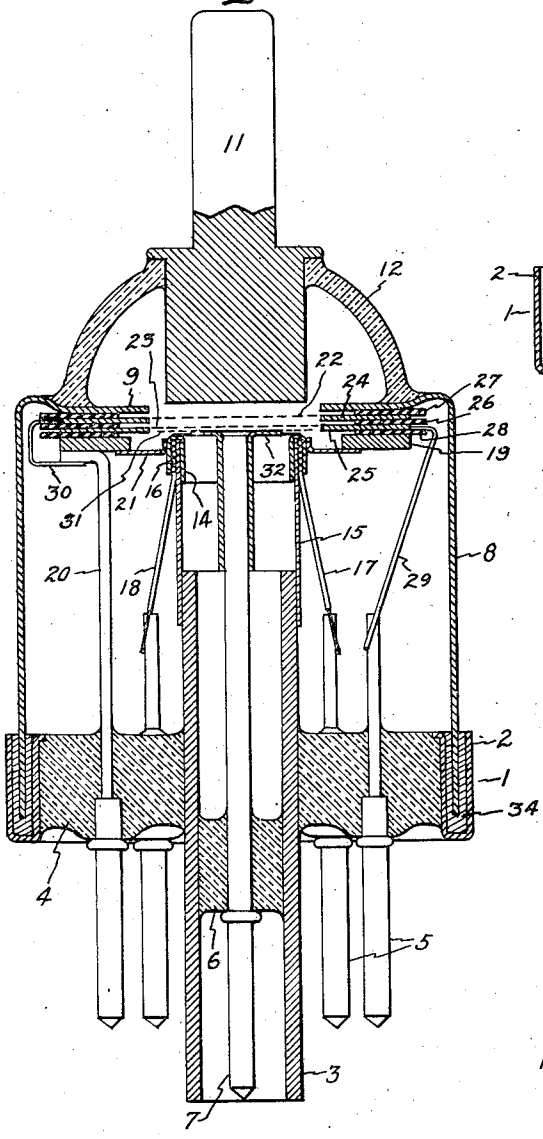


Fig. 2.

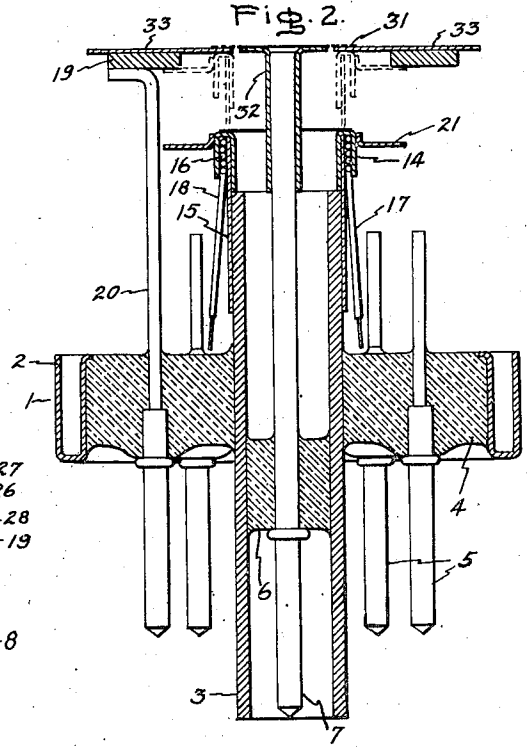


Fig. 3.

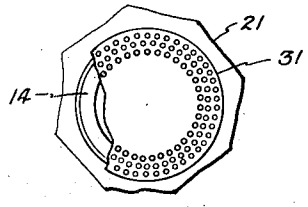
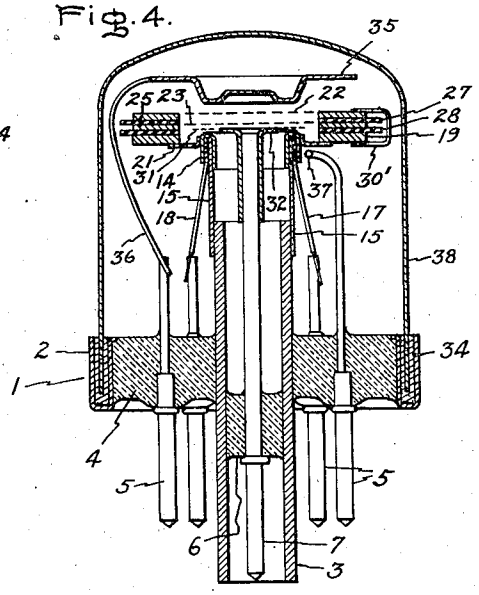


Fig. 4.



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IMPROVED ELECTRODE AND ENVELOPE STRUCTURE FOR ELECTRIC DISCHARGE DEVICES

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13 Claims. (Cl. 250—27.5)

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My invention relates to electric discharge devices and particularly to improvements in such devices which are operable over a wide range of frequencies in connection with either wire or cavity circuits.

In recent years there have been many improvements in the design of electric discharge devices, particularly with reference to the upper limit of operating frequency, and to improvements in the operating characteristics at the higher frequencies. Many of the improvements have related particularly to discharge devices for use in what has been known as grounded grid or grid return circuits. In accordance with my invention, I provide new and improved electric discharge devices which have desirable operating characteristics over a wide frequency range, and which are particularly well suited for operation at high frequencies in grounded cathode or cathode return circuits.

It is an object of my invention to provide a new and improved electric discharge device.

It is another object of my invention to provide a new and improved electric discharge device in which the grid lead-in conductor is completely shielded.

It is another object of my invention to provide a new and improved electric discharge device which is readily operated in either wire or cavity circuits.

It is a still further object of my invention to provide electric discharge devices having desirable operating characteristics at high frequencies, and which is at the same time readily manufactured by mass production methods and which may be employed in connection with standard types of radio sockets.

Further objects and advantages of my invention will become apparent as the following description proceeds, reference being had to the accompanying drawing, and its scope will be pointed out in the appended claims. In the drawing, Fig. 1 is an elevational view, in section, of an electric discharge device embodying my invention; Fig. 2 is an elevational view, in section, of a portion of the device of Fig. 1 illustrating a step in the assembly of the device; Fig. 3 is a plan view showing the relation of the control grid to the cathode of the device, and Fig. 4 is an elevational view, in section, of a modification of my invention.

Referring now to the drawing, I have shown my invention embodied in an electric discharge device having a base 1 which is adapted to be received in a miniature socket of commercial

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form. As illustrated in the drawing, the base or header 1 forms one end of the envelope and includes an outer channel member 2, a central cylindrical lead-in conductor 3 and an annular body of glass or other insulating material 4 which is sealed between the member 2 and conductor 3. A plurality of lead-in conductors 5 are sealed through the annular ring 4 to provide contact prongs for the device and power supply connections for certain of the electrodes. The header is completed by a body of glass 6 sealed to the interior of the cylindrical lead-in conductor 3 and a lead-in conductor 7 which is supported centrally within the conductor 3. As will be brought out at a later point in the specification, the conductor 7 provides a lead-in and support for the control grid of the device. The header assembly 1 may to advantage be manufactured in accordance with the method described and claimed in my application Ser. No. 651,233, filed concurrently herewith and assigned to the assignee of this application.

The envelope of the device includes, in addition to the header 1, a generally cylindrical metal enclosure 8 having an inwardly directed flange 9 at its upper end. The anode 11 of the device is supported from the flange 9 by a hollow dome-like insulator 12 having a circular cross section which is sealed at one end to the flange 9. The anode is supported in alinement with the upper end of the cylindrical lead-in conductor 3 which also provides a support for the cathode structure of the device. As illustrated in the drawing, the cathode is provided by an annular sheet metal member 14 of U-shape cross section which is supported in inverted relation from the upper end of the lead-in conductor 3 by a sleeve 15 of thin metal. This sleeve may to advantage be formed of a metal foil which has relatively good electrical conductivity and which, because of its small cross section, conducts relatively small amounts of heat from the cathode structure to the lead-in sleeve 3. The sleeve 15 is bonded to the upper end of the conductor 3 and to the member 14. The cathode is heated by a heater element 16 positioned within the channel of the member 14 and insulated therefrom by suitable material such as alumina. If desired, the heater element may be retained in position by small tabs (not shown) formed integrally with the member 14. The terminal conductors 17 and 18 of the heater are connected with two of the lead-in conductors 5. It will be understood that the upper surface of the cathode member 14 is coated with an electron emission enhancing material such as

may be produced from alkaline earth compounds in accordance with methods generally known in the art.

External connections with the cathode are also provided by an apertured disk or washer 19 of conducting material and of larger diameter than the cathode which is supported within the envelope near the plane of the upper surface of the cathode by a plurality (preferably 3) of lead-in conductors 20 and only one of which is visible in Fig. 1. It is apparent that only one of the conductors so employed for supporting the disk 19 needs to extend through the header. As illustrated in the drawing, these conductors are extensions of the contact prongs 5 and are bent outwardly at their upper ends to provide a support for the washer 19. The washer 19 is connected electrically with the cathode 14 by a foil member 21 which may take the form of a plurality of tabs or, as illustrated, may be a continuous washer. The washer 19 provides an intermediate part of a direct current circuit between the cathode 14 and the lead-in conductors 20. The washer 19 also provides a part of a high frequency circuit between the cathode 14 and the flange 9 of the member 8. As illustrated in the drawing, the member 19 is spaced from the flange 9 by an appropriate distance for the accommodation of a plurality of control members or grids 22 and 23 which are adapted to operate at the same high frequency potential as the cathode. The grids 22 and 23 are of the planar type and each includes a central portion of fine mesh connected respectively with suitable supporting washers 24 and 25 which are mutually insulated by an insulating spacing washer 26. In a similar manner, the grid washer 24 is insulated from the flange 9 by a washer 27, and the grid washer 25 is insulated from the conducting washer 19 by an insulating washer 28. The grid 23 may function as a screen grid and is adapted to be connected to a suitable source of direct current voltage by a conductor 29 joined at one end to the supporting washer 25 and at the other end to one of the lead-in conductors 5. The grid 22 may function as a suppressor grid and is connected directly with the cathode of the device by one or more conductors 30 connected between the supporting washer 24 of the suppressor grid and some portion of the conductive structure which is at cathode potential, for example one of the lead-in conductors 20. It will be apparent that the screen and suppressor grids are connected with the cathode, as far as high frequency currents are concerned, by the by-pass capacitors provided by the conducting washers 19, 24 and 25 and the insulating spacers 26, 27 and 28. It will also be appreciated that the by-pass connection is closer to the emitting surface of the cathode than is possible with conventional tube structures.

In accordance with an important feature of the present invention, the control grid is completely shielded from the anode and the other conductors by means of the cathode structure. To this end, the control member or grid 31 is supported from the lead-in conductor 7 which is positioned within the hollow cylindrical lead-in conductor 3 of the cathode. The control member is secured to the upper end of a flanged eyelet 32 which is, in turn, supported on the upper end of the lead-in conductor 7. The outer portion of the grid overhangs the active surface of the cathode as indicated in Figs. 1 and 3. The manner in which the desired grid-cathode spacing is obtained with the structure just described will be better understood by reference to Fig. 2 in which the parts are shown at an intermediate stage in the assembly. After the member 19 has been secured to the supporting lead-in conductors 20, the grid is positioned by positioning the supporting eyelet 32 on the lead-in conductor 7 so that the grid lies against the upper surface of a pair of flat generally semi-circular shims 33 having a thickness equal to the desired grid-cathode spacing, and which are supported on the washer 19. After the grid supporting eyelet has been bonded to the grid lead-in conductor, the cathode assembly, including sleeve 15, which has previously been slipped over the upper end of the cathode supporting cylinder 3, is moved upwardly until the upper surface of the cathode engages the lower face of the shims 33 as shown in dotted lines in Fig. 2. The cathode structure is then secured in fixed relation to the mount by welding together the lower end of the sleeve 15 and the cathode lead-in cylinder 3. The shims 33 are then removed leaving the overhanging portion of the grip spaced from the cathode by the thickness of the shims. The screen and suppressor grids and spacers are then assembled on the ring 19 and the envelope slipped over the assembled electrodes and the tube completed in accordance with processes well understood by those skilled in the art. As illustrated in the drawing, the lower end of member 8 is received in the channel of member 2 and bonded thereto by a body of solder 34.

It will be apparent from the foregoing description that the grid lead 7 is surrounded by the cathode supporting conductor 3 and is completely shielded from the anode by this conductor. In use, the conductors 3 and 7 provide a concentric line connection for the grid-cathode or input circuit, and the cylindrical shell 8 of the envelope and the exposed portion of the anode 11 form connections for a concentric anode-cathode or output circuit. The direct current connections for the cathode, cathode heater and screen grid are readily made with the appropriate contact prongs 5. It is apparent that the direct current circuits and the high frequency circuits are completely isolated when the device is used with concentric circuits as described above. The device shown in Figs. 1 and 4 is eight times the actual size of a tube embodying my invention which has been constructed and which fits into a socket having the same dimensions as a commercial miniature socket. It will also be apparent that if it is desired to operate the tube in a conventional wired circuit, the connections may readily be made to the various electrodes without difficulty.

In Fig. 4 is shown a modification of my invention in which the anode of the device is supported in the interior of a metal envelope and which is not as well suited for operation at extremely high frequencies as the modification of Fig. 1. The device, on the whole, is similar to that shown in Fig. 1 and corresponding parts have been designed by the same reference numerals. In the particular arrangement shown in Fig. 4, the supporting and lead-in conductors for the supporting washer 19 are not visible. It will be understood, however, that it is supported in the same manner as that described in connection with Fig. 1. As shown in Fig. 4, the anode is provided by a disk-like sheet metal punching 35 connected to one of the lead-in conductors 5 by a conductor 36. The grids 22 and 23 and insulating spacers 27 and 28 may be held assembled

on the washer 19 by suitable conductors 30', similar to the conductors 30 of Fig. 1. In Fig. 4 I have also indicated how an additional discharge device may be incorporated in the same envelope. In the particular embodiment illustrated a diode has been added by positioning an auxiliary anode 37 in proximity to the outer surface of the cathode assembly which may be coated with an oxide to improve the electron emitting qualities thereof. This auxiliary anode is supported from one of the lead-in conductors 5. As illustrated, the envelope 38 of the device shown in Fig. 4 is an open-ended metal cylinder having the lower end received in and bonded to the channel member 2.

It will be apparent from the foregoing description that devices embodying my invention provide exceptionally complete shielding between the grid-cathode and anode-cathode circuits, thereby adapting the devices for operation in cathode return circuits. The devices are equally well adapted for use in conventional circuits at lower frequencies and the improved structure permits their rapid assembly by mass production methods so that the cost of the devices will not prevent their use in conventional circuits at lower frequencies.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects, and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric discharge device including an envelope, an anode having a planar active surface supported within said envelope, a cathode structure extending transversely of said envelope and having a planar annular emitting surface surrounding a centrally located aperture, a planar control grid positioned between said cathode structure and the active portion of said anode, a cylindrical conductor sealed through said envelope and joined to said cathode around said aperture, and a support and lead-in conductor for said grid extending through the aperture in said cathode structure.

2. An electric discharge device comprising an envelope, an anode supported from one end of said envelope, a control member supported from the other end of said envelope, a cathode structure positioned on the side of said control member remote from said anode, a metal terminal forming a part of the wall of said envelope between the ends thereof, means connecting said cathode structure with said terminal with respect to high frequency currents, and a conductive cylinder sealed through said other end of said envelope and connected with said cathode.

3. An electric discharge device comprising an envelope, an anode supported from one end of said envelope, a control grid, a conductor supporting said grid from the other end of said envelope, a cathode structure positioned on the side of said control grid remote from said anode, a metal terminal forming a part of the wall of said envelope between the ends thereof, means connecting said cathode structure with said terminal with respect to high frequency currents, and a hollow conducting structure surrounding said conductor and extending from said envelope to provide a second high frequency terminal for said cathode.

4. An electric discharge device comprising an envelope, an anode and a cathode having planar active surfaces, a planar control electrode interposed between said anode and said cathode, a cylindrical conductive structure sealed through said envelope and supporting said cathode, a lead-in conductor supported concentrically within said cylinder and in insulated relation with respect thereto, said lead-in conductor providing a support for said control electrode.

5. An electric discharge device comprising a header, an annular cathode structure supported from said header including a planar emitting portion and a marginal portion, a control grid supported from said header and overlying the emitting portion of said cathode, and an envelope joined to said header and including a terminal member having an inwardly extending planar portion positioned in opposed relation with respect to the marginal portions of said cathode structure.

6. An electric discharge device comprising a header, an annular cathode structure supported from said header including a planar emitting portion and a planar marginal portion, a control grid supported from said header and overlying the emitting portion of said cathode, and an envelope joined to said header and including a terminal member having an inwardly extending planar portion positioned in opposed spaced relation with respect to the marginal portions of said cathode structure, and an additional control member having a portion thereof received between the opposed portions of said cathode structure and said terminal member.

7. An electric discharge device comprising an envelope, an anode supported from one end of said envelope, an annular cathode supported from the other end of said envelope, a control member interposed between said anode and said cathode and a support for said control member positioned within and supported in insulated relation with respect to the support for said cathode, a planar member surrounding said cathode and connected therewith with respect to high frequency currents, and a terminal member forming part of the wall of said envelope and including a portion extending within said envelope in opposed relation to the planar portion and said cathode structure.

8. An electric discharge device comprising an envelope, an anode supported from one end of said envelope, a control member supported from the other end of said envelope, an annular cathode positioned on the side of said control member remote from said anode and surrounding the support for said control electrode, a metal cylinder forming a side wall of said envelope and having an inwardly directed flange at one end therefor, said cathode structure including a marginal planar portion extending in opposed relation to said inwardly directed flange, and a second electrode interposed between the marginal portion of said cathode structure and said flange and capacitively coupled therewith.

9. An electric discharge device comprising an envelope, an anode supported from one end of said envelope, a control member supported from the other end of said envelope, an annular cathode positioned on the side of said control member remote from said anode and surrounding the support for said control electrode, a metal terminal sealed through a side wall of said envelope

and having an inwardly directed portion extending within said envelope, said cathode structure including a marginal planar portion extending in opposed relation to said inwardly directed portion, and a second electrode interposed between the marginal portion of said cathode structure and said inwardly directed portion and capacitively coupled therewith.

10. An electric discharge device comprising an envelope, an anode and an annular cathode of U shaped cross-section, a control electrode interposed between said anode and said cathode, a cylindrical conductive structure sealed through said envelope and supporting said cathode with the base of the U shaped section facing said anode, a lead-in conductor supported concentrically within said cylinder and in insulated relation with respect thereto, said lead-in conductor providing a support for said control grid.

11. An electric discharge device comprising an envelope, a terminal member sealed through said envelope, an apertured cathode including a marginal portion connected with said terminal member with respect to high frequency currents, a hollow conductor connected with said cathode around said aperture and extending through said envelope in a direction substantially perpendicular to said marginal portion, and a plurality of direct current terminals sealed through said envelope in the region between said terminal member and said hollow conductor.

12. An electric discharge device comprising an envelope, a terminal member sealed through said envelope, an apertured cathode having a generally planar emitting portion and a marginal portion lying in substantially the same plane as said emitting portion, a screen grid including a marginal portion positioned between said terminal member and the marginal portion of said cathode and insulated therefrom with respect to direct current voltages and capacitively coupled therewith with respect to high frequency currents, a control grid interposed between the emitting portion of said cathode and said screen grid, and a conductor connected with said grid and extending through said aperture.

13. An electric discharge device comprising an envelope, an anode supported from one end of said envelope and having a planar active surface presented to the interior of said envelope, a hollow cylindrical conductor sealed through the opposite end of said envelope and extending into said envelope a substantial distance in the direction of said anode, an annular cathode supported from the upper end of said cylinder, a control member interposed between said cathode and the active surface of said anode and an elongated conductor supported within said conducting cylinder and hermetically sealed thereto, said member being joined to said control member and providing a support therefor.

JAMES E. BEGGS.

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