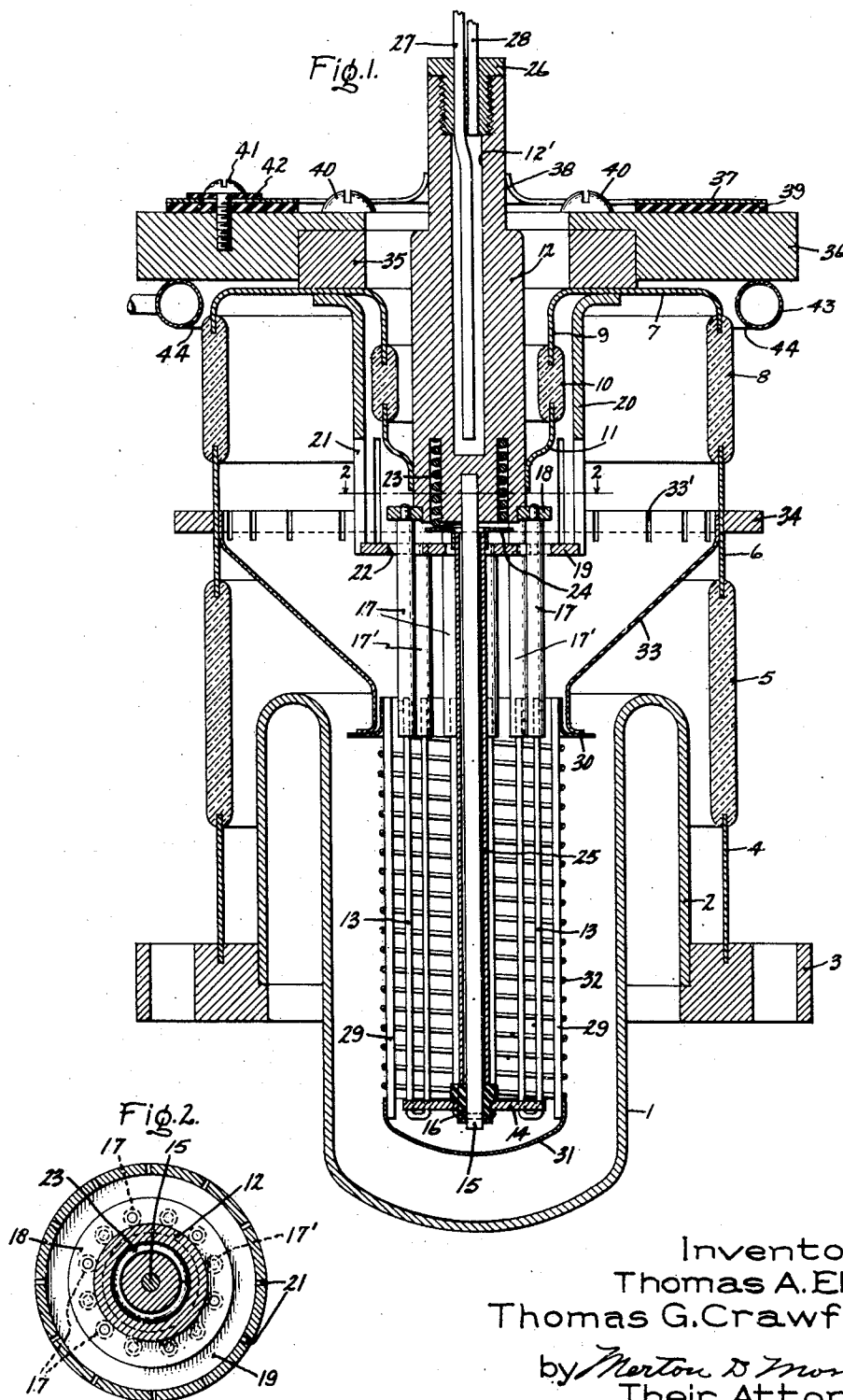


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 ENVELOPE AND ELECTRODE MOUNTING STRUCTURE FOR
 ELECTRIC DISCHARGE DEVICES
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ENVELOPE AND ELECTRODE MOUNTING
STRUCTURE FOR ELECTRIC DISCHARGE
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1

Our invention relates to improved electric discharge devices and particularly to discharge devices having high power ratings at high operating frequencies.

In recent years considerable progress has been made in the construction of electric discharge devices for operation at high frequencies. However, as the operating frequency increases it becomes more and more difficult to maintain high power ratings since high operating frequencies are obtained by decreasing the dimensions of the various parts of the discharge devices to reduce interelectrode capacitances and by minimizing the length of the lead-in conductors to reduce inductance. In accordance with an important aspect of our invention, we provide a high power electric discharge device employing a high wattage cathode which is very compact and in which the lead-in inductance, particularly of the grid and cathode leads, is reduced to a minimum.

It is an object of our invention to provide new and improved electric discharge devices particularly adapted for high frequency operation at high power ratings.

It is another object of our invention to provide a new and improved envelope and lead-in structure for an electric discharge device.

It is another object of our invention to provide a new and improved lead-in and supporting arrangement for a filamentary-type cathode which is characterized by low inductance.

It is still another object of our invention to provide an improved cathode mount and tensioning means for a filamentary cathode.

Further objects and advantages of our invention will become apparent as the following description proceeds, reference being had to the accompanying drawing in which Fig. 1 is an elevational view, in section, of one embodiment of our invention, and Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1.

Referring now to the drawing, we have shown our invention embodied in a tube particularly adapted for operation as a high frequency amplifier or oscillator in a grounded grid circuit. As illustrated in the drawing, the anode 1 forms a part of the envelope and includes a generally cylindrical body portion closed at one end and folded back on itself at the opposite end to provide a cylindrical portion 2 of larger diameter terminating intermediate the ends of the active portion of the anode. The end of the cylindrical portion 2 is received within and bonded to an annular supporting flange 3 which may be formed of copper. A hollow cylinder of sheet metal 4, such as fernico, is positioned around the outer

2

portion 2 of the anode and bonded to the supporting flange 2. As illustrated in the drawing, the lower edge of the cylinder 4 is received in a suitable groove in the upper face of the mounting flange and brazed thereto. The upper end of the cylinder 4 is sealed to an insulating cylinder 5, preferably formed of glass, and having the upper edge thereof sealed to a cylinder 6 which may be similar to the cylinder 4 and which, as will become apparent, provides a support and terminal for the grid structure of the device. The upper end wall of the envelope is provided by an annular member 7 which may also be formed of fernico and which is provided at its edges with circular flanges, the outer wall of which is sealed to the upper end of a cylindrical insulator 8 which is, in turn, sealed at its lower edge to the upper end of the grid cylinder 6. The inner cylindrical flange 9 of the member 7 forms a part of a re-entrant portion of the envelope which is completed by a cylindrical insulator 10 and an additional cylindrical conductor 11 hermetically sealed at one end to the insulator 10 and bonded at its other end to a lead-in conductor 12.

The conductor 12 forms a part of the cathode supporting structure as well as a lead-in for supplying heating current to the cathode which, in the illustrated embodiment, is made up of a plurality of U-shaped elements 13 arranged in a generally circular array extending within the cylindrical anode 1. Each of the U-shaped elements is threaded through openings in a spacing disk 14 located at the lower end of the cathode structure and positioned laterally, with respect to the envelope, by means of an axially extending rod 15 secured at its upper end to the lead-in conductor 12. The lower end of the rod 15 is slidably received within a flanged insulator 16 which surrounds the rod 15 and engages the upper surface of end plate 14. One end of each of the U-shaped conductors is secured to the lower end of the lead-in conductor 12 by connecting conductors 17 joined at one end respectively with one end of each of the cathode elements and at the other end to a washer 18 secured to the lower end of the conductor 12. In a similar manner, the opposite end of each of the cathode elements is connected by connecting conductors 17' with a perforated disk 18 supported parallel to and in concentric relation, with respect to the washer 18, by a cylindrical conductor 20 which surrounds the re-entrant portion of the envelope and is bonded at its upper end to the end wall 7 of the envelope. The conductor 20 provides for the supply of heating current to one end of each of the

cathode elements as well as a high frequency conductor connecting the cathode with the header or end wall 7. Cylinder 20 is preferably slotted at its lower end, as indicated at 21', to minimize stresses caused by unequal expansion of the assembled parts under operating conditions. The washer 19 is supported at a lower level than the cylinder 17 and is provided with clearance openings 22 for the passage of the supporting rods 18. In order to tension the filamentary elements 13 and thereby maintain minimum distortion during operation, we provide a novel tensioning arrangement including a helical spring 23 housed within an annular groove formed in the lower end of the supporting and lead-in conductor 12 and surrounding the rod 15. The lower end of the spring bears against a flanged eyelet 24 carried on the upper end of a tubular member 25 surrounding the rod 15 and engaging at its lower end the insulator 12. It will be appreciated that the force of the compression spring is transmitted through the tubular member 25 to the insulator 16 and disk 14 to the lower end of the filamentary element so that the filaments are maintained under tension.

In order to render it possible to position the tensioning spring in such proximity to a high wattage filamentary cathode and to render the internal cathode seal including the insulator 10 practical, we provide for the dissipation of a large amount of heat by the lead-in conductor 12 with the result that the operating temperature of the spring and of the seal including insulator 10 is kept relatively low. As indicated in the drawing, the lead-in conductor 12 is preferably of relatively large mass and formed of a material having high heat conductivity. A copper rod of relatively large diameter has been found satisfactory for this purpose. The relatively small cross section of the member 11, which may be formed of fernico material, minimizes the heat transmitted to the glass insulator 10. In addition, we provide means for fluid cooling the conductor 12 in the vicinity of the seal and compression spring. As illustrated in the drawing, the conductor 12 is provided with a central bore 12' and provided at its upper end with a member 26 which supports a fluid supply conductor in proximity to the lower end of the bore and a return conductor 28.

As previously indicated, the grid construction is supported from the cylinder 6 of the envelope. As illustrated, the grid comprises a generally cylindrical structure including a plurality of side rods 29 secured at one end to a circular eyelet 30, and at the other end to the side wall of an end cap 31. The side rods are over-wound in the region between the eyelet 30 and end cap 31 by a helical grid wire 32. The grid structure is supported from the grid cylinder 6 by a generally conically-shaped member 33 which is secured, as by welding, at its lower end to the flanged eyelet 30 and at its upper end to the cylinder 6. As indicated in the drawing, the upper end of the member 33 is shaped to conform with the internal surface of the cylinder 6 and is preferably provided, at intervals, with slots 33' to facilitate obtaining a close fit between surfaces of parts 6 and 33. If desired, an additional grid terminal member, in the form of a conducting ring 34 on the exterior of the envelope, may be provided in the region of the junction of cylinder 6 and the conical supporting member 33. While in the drawing the member 33 and also the supporting cylinder 20 for the cathode are shown as

continuous members, it is apparent that many of the electrical advantages of the illustrated embodiment may be secured by providing a plurality of individual conductors arranged in angularly spaced relation.

In order to provide readily usable external terminals for the cathode a metallic ring 35 is bonded to the outer surface of the external wall 7 in the region of the junction between the cylinder 20 and end wall 7. In the drawing, we have also shown an additional terminal member which connects with the terminal 35 and with lead-in conductor 12 as far as high frequency currents are concerned, thereby to by-pass high frequency currents from the heater voltage supply which in operation energizes terminals 12 and 35. This terminal construction includes a large terminal ring 36 and a thin disk-like member 37 having contact fingers 38 engaging the lead-in conductor 12. The disk 37 is separated from the cylindrical terminal 36 by an insulating washer 39. The terminal 36 is secured to the envelope by suitable screws 40 which threadingly engage the terminal member 35. In a similar manner, the parts 37 and 39 are secured to the terminal 35 by screws 41 which are maintained in insulated relation with respect to the disk 37 by insulating washers 42 and clearance openings (not shown) through the member 37. The terminal member 36 has large heat conducting capacity and helps to maintain the seal 10 at a safe operating temperature. If desired the member 36 may be provided with passages for cooling fluid. In the drawing, we have also illustrated means for cooling the seal between the header 7 and the insulating ring 8 including the tubular member 43 secured to the bottom of the terminal 36 and provided with a plurality of apertures 44 directed toward the seal.

From the foregoing description it will be apparent that our improved construction makes possible the use of a re-entrant envelope including a seal in the re-entrant portion. We also provide a cylindrical conductor of relatively large diameter for the high frequency connections with the cathode elements. These features result in short cathode lead-in conductors and a minimum inductance in the grid-cathode circuit. The novel arrangement of the tensioning spring also renders it unnecessary to space this element of the device a considerable distance from the high wattage cathode in order to avoid loss of tension due to excessive spring temperature, with the result that the overall length of the envelope is kept small and the lead-in conductors are short. As a result of the various features incorporated in the illustrated embodiment of our invention, we have been able to operate tubes in a grounded grid cavity circuit with an output of 6 kilowatts per tube and at an operating frequency considerably in excess of 200 megacycles.

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

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

1. An electric discharge device comprising an envelope including an annular metal end wall having an inwardly directed flange at the inner edge thereof, a lead-in conductor extending

5

through the opening defined by said flange and supported therefrom by means including an insulating seal, a cathode including a plurality of elongated conducting elements each having a pair of terminals, means connecting one terminal of each element to said lead-in conductor, and conducting means positioned around said flange and connecting the other terminals of said elements with said annular end wall.

2. An electric discharge device comprising an envelope including an annular metal end wall having an inwardly directed flange at the inner edge thereof, a lead-in conductor extending through the opening defined by said flange and supported therefrom by means including an insulating seal, a cathode including a plurality of elongated conducting elements each having a pair of terminals, means connecting one terminal of each element to said lead-in conductor, and a cylindrical conductor surrounding said flange and connecting the other terminals of said elements with said annular end wall.

3. An electric discharge device comprising an envelope including an annular metal end wall, a lead-in conductor extending through the opening defined by said annular wall and supported therefrom by means including an insulating seal, a cathode including a plurality of elongated conducting elements each having a pair of terminals, means connecting one terminal of each element to said lead-in conductor, and a hollow cylindrical conductor surrounding said lead-in conductor and connecting the other terminals of said elements with said annular end wall.

4. An electric discharge device comprising an envelope including an annular metal end wall, a lead-in conductor extending through the opening defined by said annular wall and supported therefrom by means including an insulating seal, a cathode including a plurality of elongated conducting elements each having a pair of terminals, means connecting one terminal of each element to said lead-in conductor, conducting means positioned around said lead-in conductor and connecting the other terminals of said elements with said annular end wall, and means including a spring for tensioning said elements, said lead-in conductor being of larger transverse dimensions than said spring and recessed at its inner end and said spring being positioned in said recess.

5. An electric discharge device comprising an envelope having an annular end wall including an inwardly directed circular metal flange at the inner edge thereof, a cylindrical insulator sealed to the inner end of said flange, a lead-in conductor extending through the opening defined by said flange, and a metal sleeve joined at one end to said conductor and at the other end to said cylindrical insulator to seal said lead-in conductor through said envelope.

6. An electric discharge device comprising an envelope having an annular end wall including an inwardly directed circular metal flange at the inner edge thereof, a cylindrical insulator sealed to the inner end of said flange, a lead-in conductor extending through the opening defined by said flange, a metal sleeve joined at one end to said conductor and at the other end to said cylindrical insulator to seal said lead-in conductor through said envelope, a cathode structure including a plurality of elongated elements each having a pair of terminals, means connecting

6

one terminal of each element with said lead-in conductor, and a cylindrical conductor surrounding said flange and connecting the other of said terminals with said end wall.

7. An electric discharge device comprising an envelope having an annular end wall including an inwardly directed circular metal flange at the inner edge thereof, a cylindrical insulator sealed to the inner end of said flange, a lead-in conductor extending through the opening defined by said flange, a metal member joined to said conductor and to said cylindrical insulator to seal said lead-in conductor through said envelope, a cathode structure including a plurality of elongated elements each having a pair of terminals, means connecting one terminal of each element with said lead-in conductor, a cylindrical conductor surrounding said flange and connecting the other of said terminals with said end wall, and a spring for tensioning said elements, said lead-in conductor being of larger transverse dimensions than said spring and recessed at its inner end and said spring being positioned in said recess.

8. An electric discharge device comprising a generally cylindrical envelope having a re-entrant portion at one end thereof, a lead-in and supporting conductor sealed through said re-entrant portion, a cathode within said envelope including a plurality of elongated elements supported at one end in fixed relation to said envelope and adjacent the inner end of said lead-in conductor, means engaging said elongated elements at their opposite ends, and a spring cooperating with said means to tension said elements, said lead-in and supporting conductor being of larger transverse dimensions than said spring and provided with a recess in the inner end thereof, said spring being positioned within said recess.

9. An electric discharge device comprising a generally cylindrical envelope, a lead-in conductor sealed through one end of said envelope, a cathode within said envelope including a plurality of elongated elements supported at one end in fixed relation to said envelope, means engaging said elongated elements at their opposite ends, and a spring cooperating with said means to tension said elements, said lead-in conductor having larger transverse dimensions than said spring and provided with a recess at the inner end thereof, said spring being positioned in said recess.

10. An electric discharge device comprising a generally cylindrical envelope having a re-entrant portion at one end thereof, a lead-in and supporting conductor sealed through said re-entrant portion, a cathode within said envelope including a plurality of elements supported at one end in fixed relation to said envelope and adjacent said lead-in conductor, means engaging said elongated elements at their opposite ends, and a spring received within said lead-in conductor and cooperating with said means to tension said elements, said lead-in having an axial bore extending to the region thereof within which the spring is received so that cooling fluid may be introduced to cool said spring and the seal supporting said lead-in conductor.

11. An electric discharge device comprising an envelope having an annular end wall including an inwardly directed circular flange at the inner

edge thereof, a cylindrical insulator sealed to the inner end of said flange, a lead-in conductor positioned within the opening defined by said flange, a metal sleeve joined at one end to said conductor and at the other end to the other end of said cylindrical insulator to seal said lead-in conductor through said envelope, and a cathode structure supported from said lead-in conductor, the heat conducting capacity of said sleeve being small compared with the heat conducting capacity of said lead-in conductor to minimize the transfer of heat from said cathode to said cylindrical insulator.

12. An electric discharge device comprising an envelope having an annular end wall including an inwardly directed circular flange at the inner edge thereof, a cylindrical insulator sealed to the inner end of said flange, a lead-in conductor positioned within the opening defined by said flange, a metal sleeve joined at one end to said conductor and at the other end to the other end of said cylindrical insulator to seal said lead-in conductor through said envelope, a cathode structure supported from said lead-in conductor including a plurality of elongated elements each secured at one end thereof in fixed relation to said envelope, and means engaging said elements to maintain them under tension including spring means, said lead-in conductor being of larger transverse dimensions than said spring means and provided with a recess at the inner end thereof, said spring means being housed within the recess in said lead-in conductor.

13. An electric discharge device comprising a cylindrical anode structure closed at one end and having a hollow cylindrical portion extending oppositely with respect to said closed end, a cylindrical insulator sealed at one end to said cylindrical portion, a conductive cylinder sealed to the opposite end of said insulator, a second cylindrical insulator sealed to the other end of said conductive cylinder, an annular conductive member having a flange at the outer edge sealed to the other edge of said second cylindrical in-

ulator and an inwardly directed flange at the inner edge thereof, a lead-in and supporting conductor sealed to said inwardly directed flange by a third cylindrical insulator, a cathode positioned within said anode and supported from said lead-in conductor, a control grid interposed between said cathode and anode, and means for supporting said grid including a conical member joined at one end to said conductive cylinder and at the other end to said grid.

14. An electric discharge device comprising an envelope including a hollow cylindrical conductor, a cylindrical anode structure supported from one end of said conductor and in insulated relation with respect thereto, a cathode structure supported from the opposite end of said cylindrical conductor in insulated relation with respect thereto and extending within said anode, a cylindrical grid structure interposed between said cathode structure and said anode structure, and means for supporting said grid structure including a conical member having the upper end thereof secured to the inner wall of said cylindrical conductor.

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