April 21, 1959 R. E. MANFREDI 2,883,577

ENVELOPE STRUCTURE FOR ELECTRIC DISCHARGE DEVICE

Filed March 19, 1954

FIG. 1.

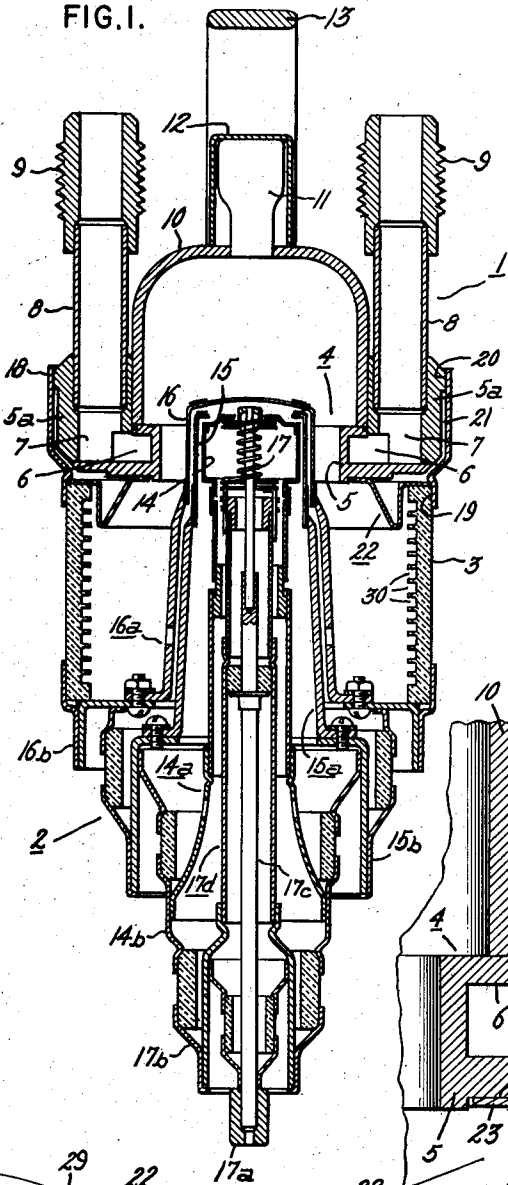


FIG. 2.

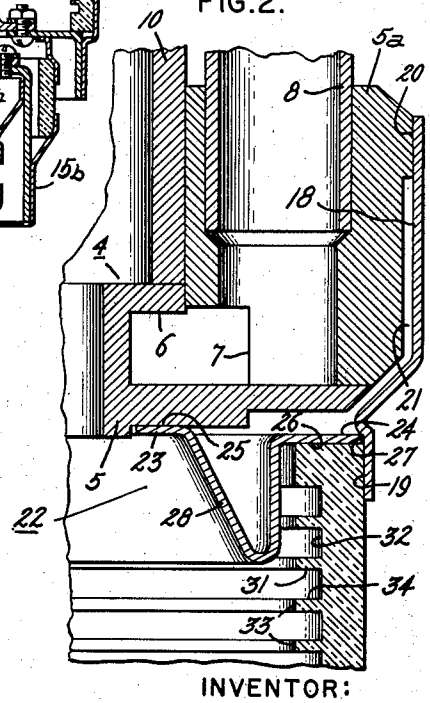
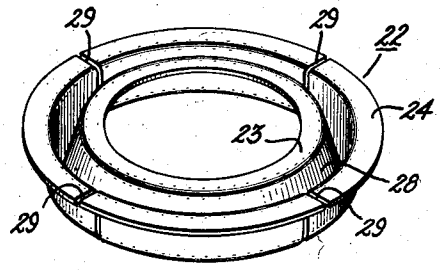


FIG. 3.



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ENVELOPE STRUCTURE FOR ELECTRIC DISCHARGE DEVICE

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Application March 19, 1954, Serial No. 417,385

5 Claims. (Cl. 313—290)

My invention relates to improved electric discharge devices for high frequency applications and more particularly to such devices including ceramic-to-metal seals in the envelope structures thereof.

In producing high frequency electric discharge devices in which the envelope structures are formed by sealing together alternate metal members and ceramic insulating members, difficulties are encountered in providing ceramic-to-metal seals which will stand up during manufacturing operations and under operating conditions and will not cause cracking of the insulating members. That is, in constructing the envelopes of some electric discharge devices it is necessary to provide seals between relatively massive metal members, such as the anodes, and ceramic insulating members. Differences in the coefficients of expansion of these elements make it essential that the sealing be effected by means whereby stresses are prevented from being set up in the insulating members thereby to avoid cracking of the insulating members. Additionally, since the means usually employed to effect the seals between the anodes and insulators are generally adapted to serve further as terminal or contact members, it is desirable that a good short electrical path be provided between the sealing means and the anode, thereby to minimize radio frequency losses.

In order further to avoid cracking of the insulating members, it is also desirable to provide means for shielding the portions of the insulating members adjacent the ceramic-to-metal seals from heat radiation from the internal electrodes of the devices, such as the cathodes and grids. Additionally, during operation of the device, vaporization of the internal electrodes tends to cause continuous metal deposits over the interior walls of the insulating members. Such deposits tend to create short circuits across the insulating members and to heat up in the electric field of the device and thereby cause hot spots in the ceramic insulating members. These hot spots have the tendency of effecting high temperature gradients and thereby cracking the insulating members. Thus it is desirable to provide means for preventing deposition of continuous metallic coatings across the insulating members.

Accordingly, the primary object of my invention is to provide a new and improved high frequency electric discharge device construction.

Another object of my invention is to provide, in an electric discharge device including an envelope structure comprising metal and ceramic members, a new and improved arrangement for effecting ceramic-to-metal seals therebetween.

Another object of my invention is to provide, in an electric discharge device including an envelope structure comprising metal and ceramic members, new and improved means for preventing cracking of the ceramic members.

Another object of my invention is to provide, in an electric discharge device including an envelope structure comprising metal and ceramic members of different coefficients of expansion, new and improved means for sealing these members together so as to avoid cracking of the ceramic member during manufacture and under operating conditions of the device.

Another object of my invention is to provide, in an electric discharge device including an envelope structure comprising metal and ceramic members, new and improved sealing means between said members adapted for serving as a terminal, preventing cracking of the ceramic members and affording a good short electrical path between the metal member and the sealing means.

Another object of my invention is to provide, in an electric discharge device including a ceramic-to-metal seal, new and improved means for shielding the seal from radiation from electrodes of the device.

Another object of my invention is to provide, in an electric discharge device including an envelope comprising contact members separated by a ceramic insulating member new and improved means for preventing deposition across the insulating member of a continuous coating of metal vaporized from the electrodes of the device.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In carrying out the objects of my invention I provide an envelope structure including an anode and a ceramic insulating member. A relatively flexible metal sealing member of a material of substantially the same coefficient of expansion as the ceramic member is sealed at one end to the ceramic member. The other end is sealed to the anode at a point remote from the ceramic member and is otherwise spaced from the anode. A conductive member is secured between the anode and the sealing member at a point adjacent the ceramic member to provide a short electrical path between these members. The connecting member is formed to provide for thermal expansion of the various members and for shielding the ceramic-to-metal seal between the sealing member and the ceramic member from radiation from internal electrodes of the device. The conductive member and annular grooves formed in the interior wall of the insulating member prevent a continuous deposition, across the insulating member, of a coating of metal vaporized from the electrodes.

For a better understanding of my invention reference may be had to the accompanying drawing in which:

Fig. 1 is a longitudinal sectional view of an electric discharge device incorporating my invention;

Fig. 2 is an enlarged fragmentary sectional view illustrating details of my invention; and

Fig. 3 is an enlarged perspective view of a particular element of my structure.

Referring to the drawing, I have shown my invention embodied in an electric discharge device, particularly suitable for use in high frequency transmitter applications. The discharge device may be of the tetrode type and includes an envelope structure made up of alternate members of insulating and conducting material, the conducting elements providing the mutually insulated terminals for the various electrodes. It will, of course, be understood that the features of my invention are not restricted to use in electric discharge devices of the type here illustrated, but are applicable to other types with equal effect.

Referring now to Fig. 1, it will be seen that the device includes an anode sub-assembly generally designated **1** separated from a lower sub-assembly generally designated **2** by a cylindrical ceramic insulator **3**.

The anode sub-assembly **1** includes a substantially cylindrical anode **4** which comprises an inner anode member **5** suitably fitted in an outer anode member **5a**. The mating surfaces of the members **5** and **5a** are formed

to provide an annular cooling fluid passage 6. Additionally formed in the outer anode member 5*a* are diametrically opposed bores 7 which communicate with the annular passage 6. Suitably fitted in the bores 7 are tubes 8 to the ends of which are fitted hose couplings 9. The just described arrangement adapts the anode 4 for having a cooling fluid circulated therethrough.

Fitted in the outer anode member 5*a* and suitably secured thereto, as by brazing, is a dome-like member 10. Suitably fitted in the top of the member 10 is an exhaust tabulation 11 protected by a cap 12 fitted thereover. Provided for facilitating handling of the discharge device is a bail 13 which extends over the member 10 and has its ends suitably secured at diametrically opposite positions to the outer anode member 5*a*.

The lower sub-assembly 2 may be of a type similar to that described in my co-pending application Serial No. 275,522, filed March 8, 1952, and assigned to the assignee of the present invention. It is constructed and adapted for completing the envelope of the device and providing support and electrical terminals for the electrodes of the device, namely, the cathode 14 and coaxially arranged grids 15 and 16 and for a cathode heater 17. As shown, the cathode 14 is suitably mounted on top of a conductive support generally designed 14*a* which is electrically connected to a cathode terminal ring 14*b*. In a similar manner the grid 15, which is of the usual basket type is mounted on a conductive support structure generally designated 15*a* and connected to a grid terminal ring 15*b*. The grid 16 is similar to the grid 15 and is mounted on another conductive support generally designated 16*a* and electrically connected to another grid terminal ring 16*b*. The heater 17 is provided with a pair of terminals, namely, a plug 17*a* and a ring 17*b*. A conductive support member generally designated 17*c* connects the terminal 17*a* with one side of the heater 17. The other side of the heater 17 is connected to the other heater terminal 17*b* by a conductive support structure generally designated 17*d*. The grid terminal 16*b* is suitably sealed to the lower end of the insulator 3. Additionally, in the just described arrangement the several support structures are suitably spaced to provide satisfactory insulation between the electrodes and the envelope is completed and the several electrode terminals are insulated by annular ceramic members suitably sealed therebetween. The ceramic-to-metal seals between the individual electrode terminals and the associated ceramic members may be effected according to the teaching of United States Patent No. 2,667,427, dated January 26, 1954, issued to H. J. Nolte and assigned to the assignee of this application.

In constructing the discharge device, and particularly during the operations of brazing the various elements together and exhausting the completed device, the anode 4 heats up and expands at a much higher rate than the ceramic insulator 3, owing to the difference in the coefficients of expansion of the materials of which these members are formed. For the same reason the anode and insulator cool down and contract at different rates following the mentioned manufacturing operations. Additionally, during operation of the discharge device the anode is cooled by the cooling fluid circulated therethrough and does not expand to the same degree as the ceramic insulating member 3 which is heated by radiation from the internal electrodes and its intrinsic losses due to the presence of an intense radio-frequency field. Consequently, it is essential to provide between the anode and the ceramic insulator a seal of such construction as to allow for these differences in expansion and contraction, thereby to prevent cracking of the ceramic insulator and to insure a good ceramic-to-metal seal between the members. To accomplish this, and as perhaps better seen in Fig. 2, I have provided a flexible metal sealing member 18 which, in construction, resembles a relatively long sleeve and is formed of a material having substantially the same coefficient of expansion as the ceramic insulator 3. The lower end of the sealing member 18 is reduced in diameter and is fitted over and sealed to the upper edge of the insulator 3 at 19 by a suitable ceramic-to-metal seal. The sealing member receives the anode 4 and the upper end of the sealing member is suitably sealed, as by brazing, to the upper portion of the outer anode member 5*a* at 20, which is relatively remote from the ceramic-to-metal seal. Additionally, the portion of the anode between the ceramic-to-metal seal 19 and the metal-to-metal seal 20 is reduced in diameter thereby to provide a space designated 21 between the anode 4 and the sealing member 18 below the seal 20. Thus, the ceramic-to-metal seal 19 and, indeed, the whole insulator 3 are substantially thermally isolated from the anode. This, together with the considerable free length of the sealing member provided by the space 21 and the flexibility of the sealing member permits the anode to expand radially substantially freely during manufacture of the device and the insulator to expand similarly during operation of the device without effecting substantial stresses in the ceramic-to-metal seal at 19 or in the insulator 3. In this manner, adverse effects on the ceramic-to-metal seal 19 and cracking of the insulator 3 as a result of relative thermal movement of the anode and insulator during manufacture and operation of the discharge device are prevented. Additionally, the thermal isolation of the ceramic insulator relative to the anode minimizes heat shock and thereby minimizes the possibility of cracking as a result thereof.

In the above described structure the sealing member 18 additionally serves as the anode terminal of the device. Therefore, in order to minimize radio-frequency losses it is desirable to provide an electrical path between the inner face of the anode 4 and the sealing member 18 which is shorter than that afforded by the sealing member itself. This I accomplish by securing a short-circuiting member 22 formed of a low resistance material such as soft copper between the anode 4 and the sealing member 18. As best seen in Fig. 3, the member 22 is formed to include an inner flange 23 and an outer flange 24. The inner flange is secured, as by brazing, to an annular portion of the inner anode member 5 adjacent the inner face of the anode at 25. The outer flange 24 is secured to the upper end of the insulator 3 by a ceramic-to-metal seal indicated at 26 and also to the sealing member at 27 as by a braze. Thus, a relatively short electrical path is provided between the inner surface of the anode 4 and the anode terminal 18.

In order to protect the ceramic-to-metal seals the member 22 is formed to include a downwardly extending re-entrant portion 28. Thus, strain at the ceramic-to-metal seals due to radiation from the internal electrodes of the device is avoided, thereby further to insure a good seal and to protect the ceramic insulator 3 from cracking.

For the purpose of facilitating thermal movement of the insulator 3 and the sealing member 18 I have formed the member 22 to include a plurality of quadrantally spaced slots 29 (Fig. 3) which extend through the outer flange 24 and the outer side of the re-entrant portion 28. Thus, the insulator and sealing member may expand and contract freely without resulting in stresses being set up in the seals 26 and 27.

During operation of the device there is some vaporization of the internal electrodes which tends to result in deposition of a continuous metallic coating across the internal wall of the insulator 3. Such a coating, if permitted to form, would tend to create an electrical short circuit across the insulator. Additionally, such a metal coating would tend to heat up in the electrical field of the device and thereby cause hot spots in the ceramic insulator which would result in high temperature gradients between the inner and outer walls of the insulator and thereby cause cracking of the insulator. Thus it is desirous to prevent, or at least to "break up," any continuous

metallic coating which might tend to be deposited on the inner wall of the insulator **3**.

The re-entrant portion **28** of the member **22** in my structure is effective for preventing deposition of any metallic coating on the upper portion of the insulator **3**. To prevent a continuous metallic coating from being deposited on the remainder of the inner wall of the insulator **3** I have formed the insulator to include a plurality of re-entrant portions in the inner wall thereof. In the preferred embodiment shown this is accomplished by forming the insulator to include a plurality of transserse or annular grooves **30** in the inner wall of the insulator **3**. Now the metal vaporized from the internal electrodes tends to travel in straight lines toward the insulator. Thus due to the offset positions of the internal electrodes and the insulator in the present device the metal travels in an inclined path toward the insulator and cannot reach the upper walls **31** of the re-entrant portions or grooves of the insulator. I have found that by providing grooves **30** of sufficient depth, it is possible to prevent deposition of any metallic coating on both the upper and sidewall portions **31** and **32**, respectively, of the grooves **30**. That is, vaporized metal will tend to be deposited on only the lands **33** between the grooves and the bottom sides **34** of the grooves **30**. It is to be understood that while in the present arrangement the internal electrodes are in an offset position relative to the insulator **3** whereby the vaporized metal is caused to travel an inclined path toward the insulator, the electrodes and insulator could be in horizontal alignment and the metallic coating on the insulator would be "broken up" by not being deposited on the top and bottom sides **31** and **32**, respectively, of the grooves **30** to the same thickness as on the side walls **32**. Thus it will be seen that by means of the re-entrant portion **28** of the member **22** and the grooves **30**, I have prevented the deposit on the inner wall of the ceramic insulator **3** of any continuous metallic coating which would have any adverse effects on the insulative quality of the member **3** or which would cause high temperature gradients between the inner and outer walls of the insulator which might result in cracking thereof.

It will be apparent from a consideration of the foregoing description that my invention provides a new and improved electric discharge device construction in which an anode-to-ceramic seal is included which is adapted to stand up during manufacture and under operating conditions, to compensate for differences in thermal movement of the anode and ceramic insulator, and to provide a good short electrical path between the anode and the anode terminal, thereby to minimize radio frequency losses. Additionally, it will be seen that my invention provides means for protecting the ceramic-to-metal seal between the anode and the ceramic member from the effects of radiation from the internal electrodes of the device. Still further, my invention avoids cracking of the insulator by heat shock and provides means for preventing deposition of a continuous metallic coating on the internal wall of the ceramic member from vaporization of metal from the internal electrodes thereby to prevent short circuiting across the insulator and to prevent such temperature gradients between the inner and outer walls of the insulator that would result in cracking thereof during operation of the discharge device.

While I have shown a particular embodiment of my invention, I do not desire my invention to be limited to the particular form shown and described, and I intend by the appended claims to cover all modifications within the spirit and scope of my invention.

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

1. In an electric discharge device, a tubular insulator, an elongated coaxial tubular terminal having one end sealed to an end of said insulator and extending longitudinally therefrom, an electrode extending coaxially in said terminal through the opposite end thereof, the inner end of said electrode including an active portion inwardly spaced from the walls of said terminal, said electrode being sealed to said opposite end of said terminal at a point on said electrode longitudinally spaced from the seal between said terminal and insulator and from said active portion, and a coaxial annular conductor having the inner rim thereof bonded to the inner end of said electrode adjacent said active portion thereof and the outer rim bonded to the inner surface of said terminal for minimizing the electrical path between said active portion of said electrode and said terminal.

2. In an electric discharge device, a tubular insulator, an elongated coaxial tubular terminal having one end sealed to an end of said insulator and extending longitudinally therefrom, an electrode having an active portion at one end thereof extending coaxially in said terminal through the opposite end of said terminal, said electrode being sealed to said opposite end of said terminal at a point on said electrode longitudinally spaced from the seal between said terminal and insulator and from said active portion, a coaxial annular conductor including an inner flange bonded to the inner end of said electrode adjacent said active portion thereof and an outer flange bonded to an intermediate portion internal surface of said terminal for minimizing the electrical path between said active portion of said electrode and said terminal, and said conductor including an annular portion intermediate said flanges extending coaxially in said insulator in overlapping relation to said seal between said terminal and insulator.

3. In an electric discharge device, a tubular insulator, an elongated coaxial tubular terminal having one end sealed to an end of said insulator, a plurality of electrodes including a coaxial anode, said anode having an active portion on one end thereof extending in said terminal through the opposite end of said terminal, said anode being sealed to said opposite end of said terminal at a point on said anode longitudinally spaced from the seal between said terminal and insulator and from said active portion, a coaxial annular conductor of flexible folded sheet construction and having inner and outer flanged portions, said inner flanged portion being bonded to said anode adjacent said active portion and said outer flanged portion being bonded to the inner surface of said terminal for minimizing the electrical path between said active portion of said anode and said terminal, the folded portion of said conductor extending in said insulator in overlapping relation to said seal between said terminal and insulator and part of the wall of said insulator for shielding said seal from radiation from said electrodes and for preventing deposition across said insulator of a continuous coating of conductive material from said electrodes, and said flanged portion of said conductor being slotted and thereby weakened to increase the flexibility thereof.

4. In an electric discharge device, a tubular insulator, an elongated coaxial tubular terminal having one end sealed to an end of said insulator, a plurality of electrodes including a coaxial cylindrical anode, said anode having an internal cylindrical active portion at one end thereof extending coaxially in said terminal through the opposite end of said terminal, said anode being sealed to said opposite end of said terminal at a point on said anode longitudinally spaced from the seal between said terminal and insulator and from said active portion, an annular coaxial conductor having the inner edge bonded to said one end of said anode adjacent said active portion and the outer edge bonded to the inner surface of said terminal for minimizing the electrical path between said active portion of said anode and said terminal, said conductor including an annular pendant portion extending coaxially in said insulator for shielding said seal from radiation from said electrodes and for preventing deposition across said insulator of a continuous coating of conductive material from said electrodes, and the inner wall

of said insulator being annually recessed behind said pendant portion of said conductor, thereby to assist in preventing deposition of a continuous conductive coating across said insulator.

5. In an electric discharge device, a plurality of electrodes including a cylindrical anode, said anode having one end of reduced outer diameter and including an active portion, a tubular coaxial ceramic insulator longitudinally disposed relative to said anode, a coaxial flexible tubular terminal formed of a material of substantially the same coefficient of expansion as said insulator and having one end thereof fitted over and in spaced relation with said one end of said anode, a metal-to-metal seal between said anode and said one end of said terminal at a point of larger diameter on said anode and longitudinally remote from said insulator and said active portion, a ceramic-to-metal seal between said insulator and the other end of said terminal, an annular coaxial conductor having the inner edge bonded to said one end of said anode adjacent said active portion and the outer edge bonded to a portion of said terminal intermediate said anode and insulator for minimizing the electrical path between said active portion of said anode and said terminal, and said conductor including an annular portion extending coaxially and reentrantly in said insulator for shielding said ceramic-to-metal seal from radiation from said electrodes and for preventing deposition across said insulator of a continuous coating of conductive material from said electrodes.

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