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ANODE STRUCTURE

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Fig. 1.

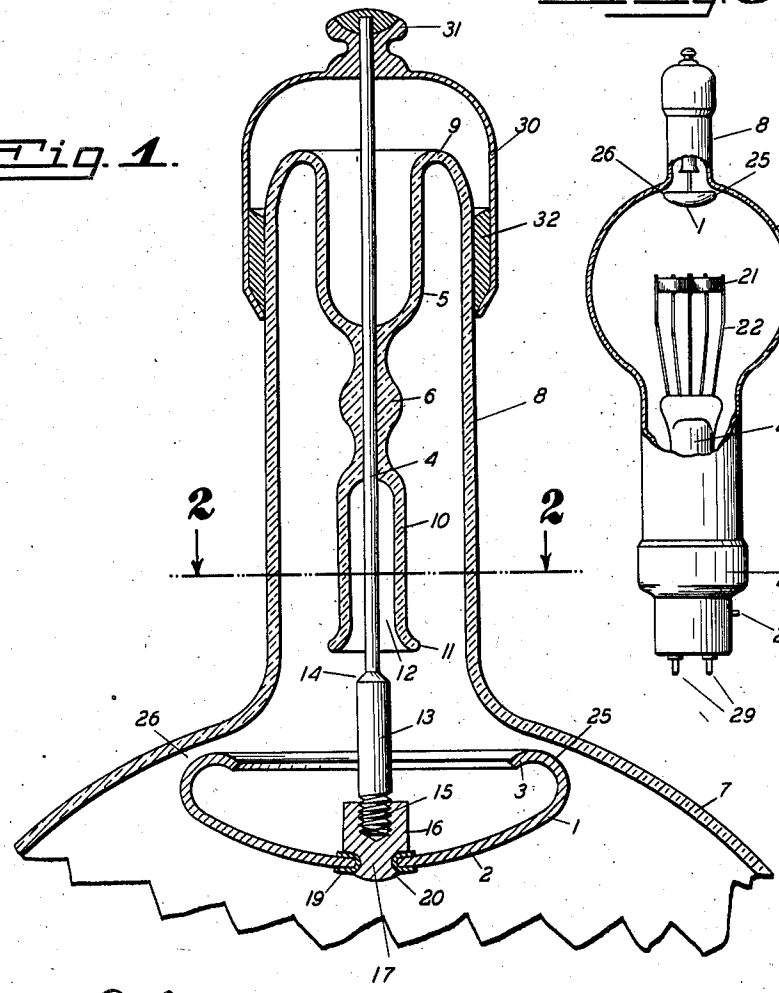
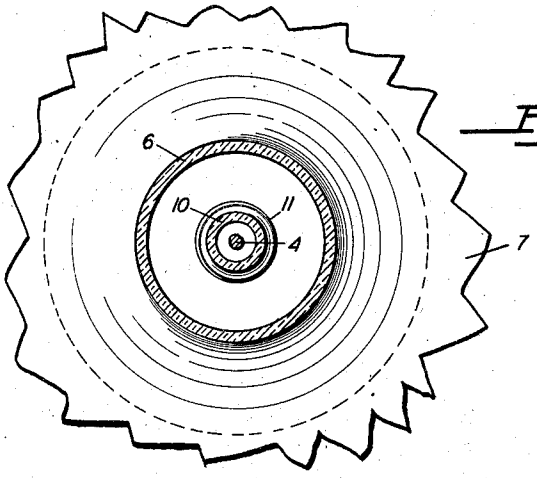


Fig. 3.

Fig. 2.



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ANODE STRUCTURE

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3 Claims. (Cl. 250—27.5)

Our invention relates to an anode and support for an anode, and more specifically to an anode and support to be used in high voltage gas-filled rectifiers.

Among the objects of this invention are:

To provide an anode for an electron discharge device which will handle heavy currents at high voltage; to locate an anode in a high voltage rectifier tube so that erosion of the anode support will not occur; to provide an anode in a rectifier which will not cause field concentrations at any point sufficient to puncture the envelope; to provide a simple shield for an anode support; to provide an anode structure capable of operating at continuous anode potentials of 10 to 15,000 volts; and to provide an anode mounting in a rectifier tube which interposes a high resistance gas path between the cathode and the anode support.

Other objects of this invention will be apparent or will be specifically pointed out in the description forming a part of this specification; but we do not limit ourselves to the embodiment of the invention herein described, as various forms may be adopted within the scope of the claims.

Figure 1 is a slightly enlarged longitudinal sectional view of an anode structure embodying our invention.

Figure 2 is a cross sectional view of the anode structure shown in Figure 1 taken in the plane indicated by the line 2—2 in Figure 1 and looking toward the anode.

Figure 3 is a greatly reduced view, partly in elevation and partly in section, showing our invention as applied to a mercury vapor rectifier tube.

In rectifiers modern practice demands both heavy currents and high voltages. When voltages of from 10 to 15,000 volts are applied to gas-filled rectifiers, problems arise which are not present, at least to such a high degree, in low voltage devices of the same sort.

One of these problems is the erosion of the anode supports by the space current, and it has been found necessary to prevent such erosion in order to obtain commercial life at high voltages. Absorption of current by the support heats the support and often causes cracked seals.

Our invention, broadly speaking, comprises a circular anode for an electron discharge device containing a conductive gas, which is mounted on a conductive support sealed in a tubular projection from the envelope of the device. This anode is slightly larger in diameter than the projection, and is mounted so that its periphery is so closely adjacent the wall of the envelope that no appreciable ionization can take place in the space between. In addition, the support is shielded by a concentric skirt of insulating material spaced apart from the support at a distance substantially corresponding to the mean free path of the gas.

Referring to the drawing, the circular anode 1 is preferably of fungiform shape, having a rounded face 2 and a recurving inturned lip 3. This anode is preferably formed from nickel sheet, although in tubes of extreme power, tantalum or tungsten is to be preferred. Anode support 4 is preferably tungsten rod and is sealed into the reentrant stem 5 at 6. If tungsten rod is used it is customary to use a glass known in the trade as G702P for the reentrant stem. Envelope 7, preferably of pyrex or other heat resisting glass, is provided with a tubular projection 8 and stem 5 is sealed into its distal end at 9, as glass of the G702P type seals readily to pyrex.

The seal 6 is provided with a concentric tubular sleeve 10 surrounding the anode support and extending toward the anode. While this sleeve is preferably a continuation of the seal material, it is obvious that it may be of any insulating material suitable for vacuum use, such as lavite, isolantite or like material, and held in place by being slipped over the seal. The anode end of the sleeve is slightly flared as shown at 11. A space 12 is left between the anode support 4 and the inner wall of the sleeve 10. This space should not be materially greater than the mean free path of the gas contained in the finished tube.

Anode support 4 has a threaded rod 13 welded to it at 14, preferably of nickel and of substantially heavier gauge than the support. This rod is threaded at 15 and screwed into rivet 16, also preferably of nickel.

In mounting the anode on its support, a hole 17 is provided in the center of the anode. A collar 19 is crimped around the periphery of this hole, and a portion of the rivet passed through and burred over as shown at 20.

Envelope 7 as shown in Figure 3, contains a cathode filament 21 capable of emitting electrons when heated, mounted on filament supports 22 and sealed into a filament stem 24 which in turn is sealed into the envelope, thus forming a conventional rectifier tube utilizing the anode of our invention, with the curved surface of the anode facing the cathode as shown in this figure.

While conductive gas fillings of the rare gases such as neon, helium and the like, may be used, we prefer to introduce a small quantity of

mercury in the tube and operate the tube as a mercury vapor rectifier, within the customary pressure ranges.

In mounting the anode of our design in the tube the periphery 25 is positioned closely adjacent the wall of the envelope 7. The space 26 between this periphery and the wall should substantially correspond to the mean free path of the gas filling when the tube is in operation. The gas pressure may be regulated by the size of the envelope or other suitable methods. In practice it has been found that a space of not over $\frac{1}{16}$ inch is correct for the gas pressures generally used.

When the edges of an anode are placed close to the envelope as has been described, field concentrations especially at high voltages are apt to develop between these edges and the glass, and often cause puncture during operation due to actual melting of the glass at the point of concentration. We have found that such punctures may be avoided by rounding the edge of the anode as shown at 3, and presenting only a continuously curving surface of the anode to the glass at the nearest point.

After the anode has been mounted in the manner described, the tube is exhausted in the customary manner, either given a rare gas filling, or supplied with a few drops of mercury, and sealed off the pump.

A base 27 carrying filament contacts 29 and positioning pin 28 is cemented to the envelope in the ordinary manner. An anode cap 30 is slipped over the projection 8 and the end of the anode support 4 which is soldered or otherwise secured to the anode connection post 31. The cap is held in position by the customary cement 32.

In operation, the filament is heated and a voltage applied to the anode. Current passes between the anode and cathode in one direction only, aided by the gas filling in a manner well known in the art.

It has been found that when high currents and high voltages are used with small anodes, the current density is so high that all exposed metal of anode potential is sought out by the current, and as the anode supports are not sufficiently heavy to withstand such currents erosion occurs, and the supports become unduly heated, and often the seal is cracked by the excessive heat, and the tube fails.

By reducing the distance between the periphery of the anode and the envelope wall to a distance comparable to the mean free path of the gas, ionization at that point is reduced to a minimum and that space forms a high resistance barrier, or short path insulator, between the gas in the main body of the envelope and that in the projection. It follows that a minimum of current can get by the edges of the anode to attack the anode support, and the support is relatively cool at all times.

To allow for inequalities in the spacing and small leaks of current past the edges of the anode, the support is still further shielded by the spaced concentric sleeve. The space between the support and the sleeve is also a short path insulator and prevents ionization adjacent a major portion of the support. That portion of the support not protected by this sleeve is made substantially larger to better withstand current, and is far enough from the seal so that a slight increase in temperature will be unobjectionable.

When a mercury vapor rectifier using our anodes is energized with high powers, only a faint blue-white color is noticed in the tubular projection, and there is a definite transition to a rich blue-green mercury spectrum at the point where the periphery of the anode approaches the wall of the envelope.

By the use of anodes mounted as described, we have been able to handle large amounts of power at anode voltages up to 15,000 volts without unduly increasing the size of the anode or the envelope.

We claim:

1. A rectifier tube comprising an envelope having a tubular projection therefrom, a cathode and a conductive gas within said envelope, an anode structure comprising an anode, a conductive anode support exposed to said gas sealed into said projection, and a concentric tubular sleeve of insulating material extending toward said anode from the point of sealing spaced away from said anode support, and a flare on the end of said sleeve nearest said anode.

2. A rectifier tube comprising an envelope having a tubular projection therefrom, a cathode, and a conductive gas within the envelope and the projection, an anode structure comprising an anode support having a conductive surface exposed to the gas sealed into the projection, a circular anode mounted on the anode support and having its periphery spaced from the envelope a distance less than the mean free path of the gas, and a concentric tubular sleeve of insulating material extending toward said anode and surrounding said conductive surface from the point of sealing and spaced away from said anode support, and a flare on the end of said sleeve nearest said anode.

3. A rectifier tube comprising an envelope having a tubular projection therefrom, a cathode, and a conductive gas within the envelope and the projection, an anode structure comprising an anode support having a conductive surface exposed to the gas sealed into the projection, a circular anode mounted on the anode support and having its periphery spaced from the envelope a distance less than the mean free path of the gas, said periphery being turned to present a curved surface to the envelope whereby field concentrations are prevented when said anode is energized, and a concentric tubular sleeve of insulating material extending toward said anode and surrounding said conductive surface from the point of sealing and spaced away from said anode support, and a flare on the end of said sleeve nearest said anode.

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