Jan. 3, 1956 M. BOSCH 2,729,761

THERMIONIC RECTIFIER TUBE

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Fig. 1

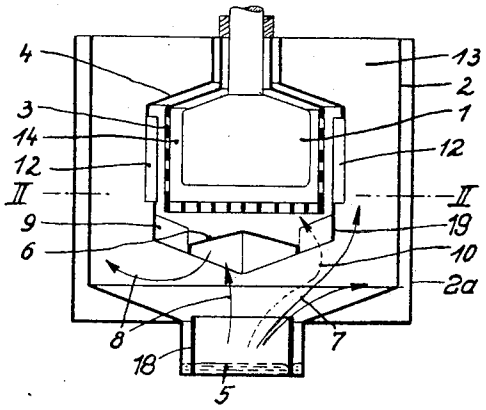
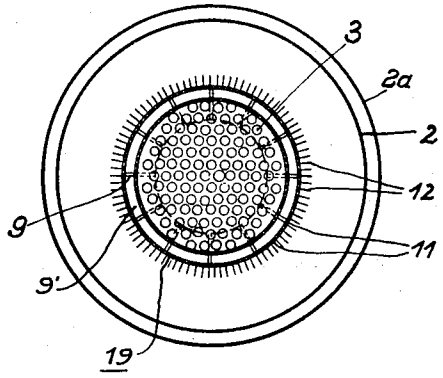


Fig. 2



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Fig. 3

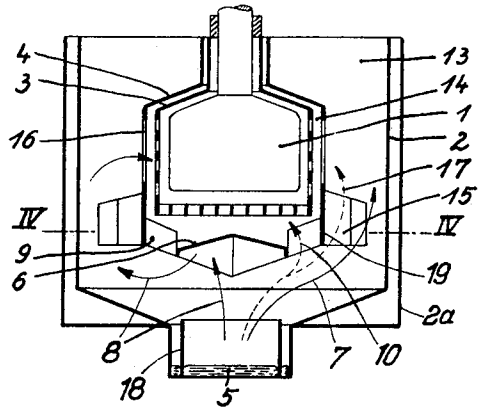
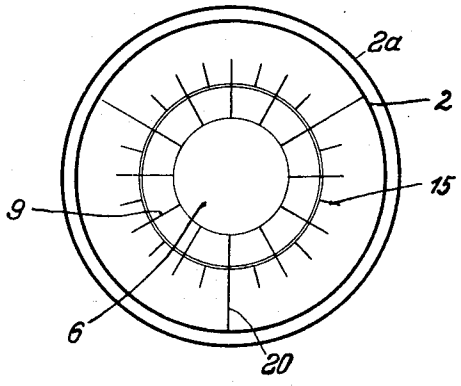


Fig. 4



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THERMIONIC RECTIFIER TUBE

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Application April 1, 1952, Serial No. 279,799

Claims priority, application Germany April 3, 1951

4 Claims. (Cl. 313—167)

My invention relates to a thermionic rectifier tube or vessel and, more particularly, to a thermionic tube of the type including a single plate electrode and a cathode electrode in co-axial relationship thereto and axially spaced therefrom.

In rectifier tubes or rectifier vessels of that type the vapors located in the path of the thermionic discharge arcs are highly heated during the discharge phase thereby expanding considerably. As a result, the vapors travel out of the space surrounding the plate electrode. At the same time, the positive mercury ions travel towards the negative cathode during the discharge phase. After extinction of the discharge arc and after the vapors have cooled off subsequently, a vacuum arises in the space surrounding the plate causing the vapors to flow into such space.

The present invention relates more specifically to thermionic rectifier tubes of the type above indicated in which the plate electrode is surrounded by a spaced jacket member having a lateral portion surrounding the plate circumferentially and having a bottom portion located between said electrodes, such bottom portion having apertures through which the thermionic discharge arcs extend. Prior to the present invention the lateral portion of the jacket member surrounding the plate electrode was closed. Therefore, the vacuum produced upon extinction of the discharge caused the vapors to enter the interior of the jacket member through the bottom apertures only, that is to say on the same path along which the discharge took place. As a result, the residual ions left in this path may be swept away into the interior space of the jacket surrounding the plate and may cause a considerable return current entailing a tendency to back-firing.

It is an object of the present invention to afford a thermionic rectifier tube in which improved de-ionizing means are provided reducing the back-firing tendency to a minimum.

More particularly, it is an object of the present invention to provide the protective jacket, surrounding the plate and having bottom apertures opposite to the cathode for the discharge, with improved de-ionizing means that utilize vapors collecting in a buffer space to secure more favorable conditions of flow of the vapors during the non-arcing or checking period of the tube or vessel. I attain this object by providing the jacket surrounding the plate with lateral openings, preferably slots; and I also give the enclosed buffer space such a vapor-storing capacity and arrangement that this buffer space is capable of supplying the anode space through the slots with de-ionized vapor which, after cessation of the arc discharge, minimizes in the anode space the occurrence of a pressure drop that may result in sucking ionized vapor from the cathode space back in the anode space and thus may be the cause of arcback. The jacket may be provided with de-ionizing fins that extend radially outwardly from the jacket through the buffer space to safely prevent vapors from the neighborhood of the cathode to pass through the jacket slots in the ionized condition. The fins form sufficiently narrow and long de-ionizing channels to prevent arc discharges through the lateral jacket openings. As a result, the arc discharge is substantially limited to the paths extending from the cathode to the plate through the apertures provided in the bottom of the jacket member, notwithstanding the provision of the lateral slots in the jacket member. The fins, according to another feature of my invention, are preferably disposed so that they extend to below the lateral jacket openings, that is, are located between these openings and the cathode space of the vessel so as to form de-ionizing surfaces in the path of any vapor that may pass from the cathode into the buffer space around and above the jacket. Further features of the present invention will appear from the following description of two preferred embodiments of my invention.

In the drawings:

Fig. 1 is an axial section of a thermionic rectifier tube including a single plate and provided with my improved de-ionizing means, the cover of the tube having been omitted to simplify the illustration;

Fig. 2 is the horizontal section taken along the line II—II of Fig. 1;

Fig. 3 is an axial section of a thermionic rectifier tube differing from that shown in Fig. 1 by the provision of additional de-ionizing fins; and

Fig. 4 is the horizontal section taken along the line IV—IV of Fig. 3.

The cylindrical tube or vessel **2** is provided with a cooling jacket **2***a* and with a cover (not shown) from which a head-shaped plate electrode **1** depends in co-axial relationship to the vessel **2**. In a depressed bottom portion of the vessel **2** there is provided the cathode electrode formed by a quantity of mercury **5**, a cylindrical sleeve **18** of a suitable insulating material serving to confine the arcing space laterally.

The head-shaped plate **1** is surrounded by a control grid **3** suitably attached to the cover, not shown, in insulated relation to the plate **1** and the vessel **2**. The elements **1**, **2** and **3** are preferably made of conductive material, such as sheet metal.

A protective jacket member **4** which preferably likewise consists of a conductive material, such as sheet metal, has a lateral substantially cylindrical portion **19** surrounding the head-shaped plate electrode **1** circumferentially in spaced relationship to the control grid **3**. The jacket member **4** has a bottom portion formed by an inverted dish-shaped rebounding member **6** and by a plurality of peripherally distributed radial ribs **9** connecting the lateral circumferential jacket portion **19** with the member **6**. The ribs **9** form apertures **9'** between each other through which the arc discharge can take place along the paths indicated by the arrow **10** between the cathode **5**, **18** and the plate **1**. The rebounding member **6** serves the purpose of guiding the flow of vapors along the paths indicated by the arrows **7** and **8**. A plurality of vertical radial baffles are mounted on the bottom face of member **6**.

For the purpose of the present invention the lateral circumferential portion **19** of the jacket member **4** which, in the present embodiment, is substantially cylindrical, is provided with openings **11** which are so dimensioned as to prevent a thermionic discharge arc from extending therethrough. Preferably, the openings **11** are circumferentially evenly distributed and formed by slots associated with de-ionizing fins **12**. Preferably, the fins are radially disposed, as shown in Fig. 2, so as to minimize their interference with the heat radiation emanating from the plate **1**. The slots **11** are so narrow and the fins **12** are so wide as to prevent an extension therethrough of an arc discharge during the discharging phase of the operation of the thermionic rectifier valve. Therefore, such discharge can take place through the apertures **9'** between the ribs **9** only.

From Fig. 1 it will appear that the walls **2** of the tube

are laterally and upwardly spaced from the openings 11 to provide a buffer space 13 outside of the jacket member 4, 19, 9, and 6. In this buffer space the density of the ions rapidly decreases with increasing distance from the arcing path 10, that is, the ion density is lower in the upper regions of space 13 than in its lower regions. During the blocking phase of the thermionic valve after the arc has been extinguished, the vapors in the space 14 surrounding the plate 1 cool and contract, thereby producing a suction effect which causes a flow of vapors through the slots 11 from the buffer space 13 into the interior space 14 of the jacket member. The flow has a blowing effect counteracting any stream of vapors that might tend to develop along the path 10 from below into the interior of the jacket member. The vapors flowing through the slots 11 inwardly when passing over the radial fins 12 become de-ionized thereby, the ions remaining in such vapors being rapidly removed.

Therefore, the free ions left in the space 14 during the checking phase of the operation will be reduced to a minimum, thus effectively counteracting any back-firing tendency.

In Figs. 3 and 4 I have illustrated a somewhat modified form of my improved thermionic rectifier valve, similar elements being provided with the same reference numerals as in Figs. 1 and 2. While in this embodiment de-ionizing fins are likewise provided in the paths of the vapors extending from the cathode 5, 18 via the buffer space 13 to slots in the jacket member 4, the de-ionizing fins are not located between the slots but, as shown in Fig. 4, are formed by radial vertical sheet metal projections 15 and 20 extending outwardly from the lower end of the circumferential portion 19 of the jacket member beneath vertical slots 16 that are provided in the circumferential portion 19 of the jacket member and corresponding to the slots 11 of the embodiment of Figs. 1 and 2. The radial fins 15 and 20 serve to de-ionize the vapors flowing from the cathode 5, 18 towards the buffer space 13 along the paths indicated by the arrows 7 and 17. Since the vapors reaching the slots 16 have passed in contact with the de-ionizing fins 15 and 20 and have been thus substantially deprived of the free ions, the slots 16 may be made considerably wider than the slots 11 without risking any arc discharge therethrough. Also, the discharge fins 12 (Figs. 1, 2) located between the slots may be dispensed with in this embodiment. The radial sheet metal fins 15 and 20 may taper in width outwardly, as shown in Fig. 3. Moreover, such radial fins may be of different lengths. In the embodiment shown, for instance, the fins 20 are longer than the fins 15 and extend to the wall 2 and are connected therewith to brace the jacket member.

The effectiveness of the improved arrangement may be enhanced by a favorable relationship of the flow resistance encountered by the vapors flowing through the discharge apertures between the ribs 9 to the flow resistance encountered by the vapors flowing through the slots 16. Such relationship can be easily ensured by an appropriate choice of the number, the width and the spacing of the de-ionizing fins or ribs 12, 15, 20, and 9.

The spaces traversed by the vapor streams and provided with the improved de-ionizing means may be so dimensioned that the vapors are partially de-ionized on their path 17 through the slots 16 in the circumferential portion 19 of the protective jacket. As a result, the current load imposed on the head-shaped plate 1 and on the plate space 14 becomes more uniform and the density of the ions is reduced which will favorably affect the residue of ions. By appropriately choosing the arrangement and the dimensions of the elements described, care may be taken to keep the partial discharge of the vapors on their passage through the slots 11 or 16 so small that the density of the ions resulting then and there will remain small (about one-quarter or less) compared with the density existing near the bottom face of the plate 1. This improves the effectiveness of the desired buffering function.

My invention is applicable to all kinds of single-plate discharge tubes of the permanently energized type or of the ignitron type, regardless of whether such tubes or vessels are cooled by water or air. Similarly, my invention is applicable to plural-plate discharge tubes, particularly of the kind in which the plates are included within an evacuated vessel.

While I have described my invention with reference to two preferred embodiments, I wish it to be clearly understood that the same is in no way limited to the details thereof, but is capable of numerous modifications within the scope of the appended claims.

What I claim is:

1. An arc-discharge rectifier, comprising a rectifier vessel containing a vaporous atmosphere, an anode and a thermionic cathode disposed in said vessel in spaced relation to each other, and a jacket having a peripheral wall portion surrounding said anode in spaced relation thereto and being open toward said cathode to permit arc discharges to pass from said cathode to said anode, said jacket having in said peripheral wall portion a plurality of elongated openings, said openings being narrow enough to deionize said vapor during flow therethrough, said openings being of such aggregate area as to offer no more resistance to the inflow of said vapor to the interior of said jacket than the resistance offered by said opening in said jacket toward said cathode, said vessel forming together with said jacket a buffer space around said jacket on the axial jacket end remote from said cathode, said buffer space being of such volume as to limit the concentration of ionization of the vapor surrounding said jacket wall portion to such a degree that substantially deionized vapor will be drawn through said openings to within said jacket to equalize pressure therein during half-cycles of non-conduction, whereby the occurrence of arc-back is minimized.

2. An arc discharge rectifier, comprising a vessel containing a vaporous atmosphere, a thermionic cathode at the bottom of said vessel, an anode structure upwardly spaced from said cathode in said vessel and having an annular top exposed to said atmosphere in said vessel, and a jacket having a peripheral wall portion surrounding said anode structure and having a top portion above said top of said anode structure, said jacket being open toward said cathode for the passage of arc discharges and having in said wall portion a plurality of elongated openings, said openings being narrow enough to deionize said vaporous atmosphere during flow therethrough, said openings being of such aggregate area as to offer no more resistance to the inflow of said vapor to the interior of said jacket than the resistance offered by said opening in said jacket toward said cathode, said vessel forming together with said jacket a buffer space around said anode structure and above said top of said anode structure, said buffer space being of such volume as to limit the concentration of ionization of the vapor surrounding said jacket wall portion to such a degree that substantially deionized vapor will be drawn through said openings to within said jacket to equalize pressure therein during half-cycles of non-conduction, whereby the occurrence of arcback is minimized.

3. A single-anode arc-discharge rectifier, comprising a rectifier vessel containing a vaporous discharge atmosphere, an anode and a thermionic cathode centrally disposed in said vessel in axially spaced relation to each other, and a jacket having a peripheral wall portion surrounding said anode in spaced relation thereto and having a bottom portion centrally located and axially spaced from said cathode, said bottom portion having apertures to be traversed by arc discharges from said cathode to said anode, said jacket having in said peripheral wall portion a plurality of elongated openings, said openings being narrow enough to deionize said vapor during inflow

therethrough, said openings being of such aggregate area as to offer no more resistance to the inflow of said vapor to the interior of said jacket than the resistance offered by the apertures in said bottom portion, said vessel forming together with said jacket a buffer space around said jacket on the axial jacket end remote from said cathode, said buffer space being of said volume as to limit the concentration of ionization of the vapor surrounding said jacket wall portion to such a degree that substantially deionized vapor will be drawn through said openings to within said jacket to equalize pressure therein during half-cycles of non-conduction, whereby the occurrence of arcback is minimized.

4. An arc-discharge rectifier, comprising a rectifier vessel containing a vaporous atmosphere, an anode and a thermionic cathode disposed in said vessel in spaced relation to each other, a jacket having a peripheral wall portion surrounding said anode in spaced relation thereto and being open toward said cathode to permit arc discharges to pass from said cathode to said anode, said vessel forming together with said jacket a buffer space around said jacket on the axial anode and remote from

said cathode, said jacket having in said wall portion a number of peripherally distributed openings, said openings being of such aggregate area as to offer no more resistance to the inflow of said vapor to the interior of said jacket than the resistance offered by said opening in said jacket toward said cathode, and deionizing sheet-metal fins extending radially away from said jacket in said buffer space and being joined with said wall portion at places between said openings and said cathode, said buffer space being of such volume and so cooperative with said fins as to limit the concentration of the vaporous atmosphere surrounding said jacket wall portion to such a degree that substantially deionized vapor will be drawn through said openings to within said jacket to equalize pressure therein during half-cycles of non-conduction, whereby the occurrence of arcback is minimized.

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