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GRIDDED ELECTRON TUBE WITH DISPENSER CATHODE HAVING COATED SURFACE PORTIONS

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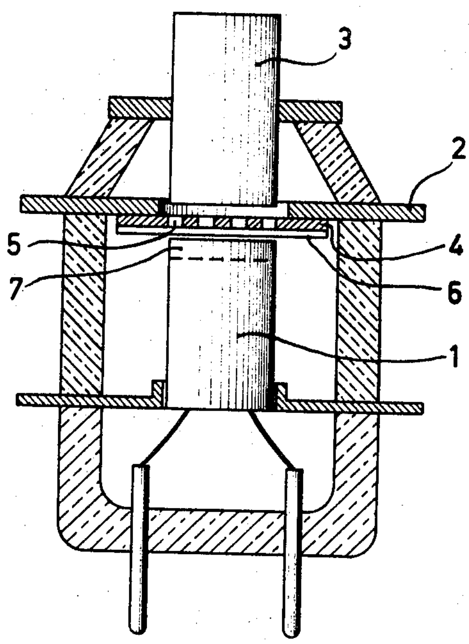

FIG.1

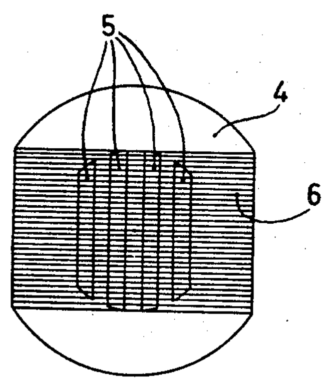

FIG.2

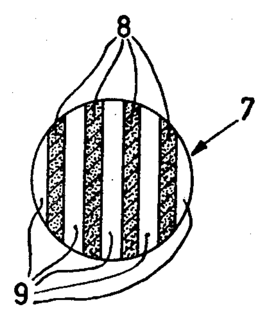

FIG.3

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GRIDDED ELECTRON TUBE WITH DISPENSER CATHODE HAVING COATED SURFACE PORTIONS

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6 Claims. (Cl. 313—348)

ABSTRACT OF THE DISCLOSURE

An electron tube having a grid with plural apertures opposite a dispenser cathode. The cathode surface portions only opposite the grid apertures being coated with Rh, Ir, Ru, or Os to increase their emission relative to the uncoated portions, causing the electrons to be emitted as beams aligned with the grid apertures. This reduces heating of the grid as well as offering other improvements.

The invention relates to an electric discharge tube comprising a cathode having a metallic emissive surface opposite one or more grids, and in particular to a high power tube for use at frequencies in excess of 3000 mc./s.

Tubes operating at such high frequencies entail great difficulties due to excessive heating of the first grid. In order to avoid excessive heating of this first grid, it is known to construct it as a solid disc with apertures across which the grid wires are stretched. In order to minimize grid current, it is also known to shape the cathode, an oxide type, in a form such that only the portions of the cathode surface located opposite the apertures are coated with the oxide emissive material. Such constructions involve the difficulty that the barium of the active cathode portions will migrate over the cathode surface at its operating temperature and ultimately cover also the non-emissive portions, which are thereby rendered emissive as well.

Since such an oxide emissive layer has further disadvantages at very high frequencies, it is preferred to use a so-called dispenser type cathode with a metallic emissive surface. However, the operating temperature of such a dispenser cathode is much higher than that of barium oxide cathodes, e.g., 1050° C., as a result of which the difficulties in connection with the excessively high grid temperature are aggravated, since a dispenser cathode causes increased heating of the grid by radiation, and, moreover, the electron flow is also increased. While it might inhibit emission from those portions of the emissive surface located opposite the closed portions of the grid by coating with a carbide or zirconium, the disadvantage of the higher operating temperature of the dispenser cathode remains and the concommitant difficulties due to the strong heat radiation to the grid. Moreover, the filament wire insulation is more severely taxed due to the higher operating temperature.

In a prior copending application, Ser. No. 410,655, filed Nov. 12, 1964, now U.S. Patent No. 3,373,307, whose contents are hereby incorporated by reference, has been described an improved dispenser cathode containing on its emissive surface a thin porous coating of osmium, iridium, ruthenium or rhenium, which offers the advantage of affording the same emission density but at a substantially lower temperature.

In accordance with the present invention, the difficulties encountered in the construction of a high power, high frequency electron tube, as previously described, are substantially completely avoided, by incorporating in the tube a dispenser cathode whose active portions located opposite the grid apertures are coated with a thin coating of metal of the group of rhenium, iridium, ruthenium or osmium as described in the copending application. As a result, the cathode can be operated at a temperature at least 100° C. lower than the conventional value of 1050° C. for the ordinary dispenser cathode. Owing to the lower operating temperature, the emission of the non-coated portions of the cathode surface is strongly reduced. As a further improvement, the non-coated cathode surface portions may be covered with a substance inhibiting electron emissivity, for example, a carbide as described in U.S. Patent No. 2,972,078, or zirconium as described in U.S. Patent No. 2,895,070. The lower cathode temperature has the advantage of reducing the heating energy required for the cathode and also reducing heating of the grid by cathode radiation; also the insulation of the filament wire is improved. Moreover, the lifetime of the cathode is considerably prolonged.

The invention will now be described more fully with reference to the accompanying drawing, in which:

FIG. 1 is a cross-sectional view of one form of a discharge tube according to the invention;

FIG. 2 is a plan view of the grid of such a tube, and

FIG. 3 is a plan view of the emissive surface of the cathode used in the tube of FIG. 1.

The discharge tube shown in FIG. 1 is a so-called disc-seal triode for very high frequencies and high power. It comprises a dispenser cathode **1**, a grid electrode **2** and an anode **3** separated by the usual insulators forming the tube enevelope. The grid electrode **2**, in the form of a terminal disc, has secured to it a metal plate or disc **4** having elongated apertures or slots **5**, across which grid wires **6** are stretched (FIG. 2). These wires **6** are soldered or welded to the plate **4** so that a satisfactory thermal contact between the wires **6** and the plate **4** is established and the wires **6** are, consequently, cooled satisfactorily.

The dispenser cathode **1** comprises a porous tungsten body **7**, and is constructed as described in the copending application as a cavity-type or impregnated type, with the exception that, instead of the whole emissive surface **9** of the cathode being coated with the high work function metal Rh, Ir, Ru, Os, only the surface areas **8** (FIG. 3) located opposite the slots **5** of the grid plate **4** are coated with the rhenium, irridium, ruthenium or osmium. The work function of the portions **8** of the cathode surface is thus reduced with respect to that of the initial tungsten surface **9** to an extent such that the portions **8** have a satisfactory emission already at a cathode temperature more than 100° C. lower than the conventional value of 1050° C., at which the uncoated cathode surface portions **9** then emit only a small amount of electrons. The electron flow thus travels in the form of beams just through the apertures **5** of the grid plate **4**. Owing to the improved cooling of the grid and to the lower temperature of the grid due to cathode radiation as a result of the lower cathode temperature, the advantages of a dispenser cathode with a metallic, emissive surface in a tube for very high frequencies can thus be utilized to a considerably higher extent without incurring the risk of excessive heating of the grid.

If the emission of the portions **9** of the cathode surface has to be suppressed more completely, these portions may be covered with an inhibitor such as zirconium, which offer the additional advantage that this surface also possesses gas-binding properties. It is found with the use of osmium, rhenium, ruthenium or iridium, that the separation between the portions of good emission and those of poor emission of the cathode surface is maintained during operation, since the osmium, rhenium, ruthenium or iridium do not migrate but remain where deposited, and are not evaporated like barium, while the barium supplied from the cathode interior and which covers both the portions **8** and the portions **9** of the cathode surface is capable of providing a satisfactory electron emission only in cooperation with the osmium, rhenium, ruthenium or iridium coated portions **8**. In a typical impregnated dispenser cathode, the member **7** would be of porous tungsten with a density of the order of 80% with the pores filled by impregnation from the melt with barium-calcium aluminate, as described in the copending application. The high work function coating is provided, also as described in the copending application, by cathode sputtering or spraying through a suitable mask to form the stripe pattern illustrated in FIG. 3.

Although a single embodiment is described above, the invention is also applicable to tubes containing other types of cathodes having a metallic emissive surface.

While we have described our invention in connection with specific embodiments and applications, other modifications thereof will be readily apparent to those skilled in this art without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. An electron tube comprising cathode, grid and anode electrodes, said grid having plural apertures located between the cathode and the anode for allowing electrons to flow from the cathode to the anode, said cathode being a dispenser type cathode having a metallic surface with portions located opposite the grid apertures separated by portions located opposite solid parts of the grid, and a coating of a metal selected from the group consisting of rhenium, iridium, ruthenium and osmium covering only those portions of the cathode surface opposite the grid apertures, whereby said coated portions exhibit an adequate electron emission at a cathode temperature lower than the temperature to which the uncoated portions would have to be raised to generate adequate electron emission.

2. A tube as set forth in claim **1** wherein the cathode is operated at a temperature at least 100° C. lower than 1050° C.

3. An electron tube as set forth in claim **1** wherein the grid comprises a solid disc containing spaced apertures with plural grid wires secured to the disc across the apertures.

4. A tube as set forth in claim **3** wherein the apertures are in the form of parallel slots extending in directions transverse to the grid wires, and the coated cathode surface portions are in the form of stripes substantially matching the grid aperture configurations.

5. An electron tube as set forth in claim **1** wherein the non-coated cathode surface portions are covered with an emission inhibitor selected from the group consisting of carbides and zirconium.

6. A tube as set forth in claim **1** wherein the cathode comprises a porous tungsten stubstrate for the coating and is associated with a barium-calcium-aluminate activator.

No references cited.

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