Sept. 25, 1951 A. H. W. BECK 2,568,705

NONSPUTTERING CATHODE FOR ELECTRON DISCHARGE DEVICES

Filed Oct. 20, 1949

FIG. 1.

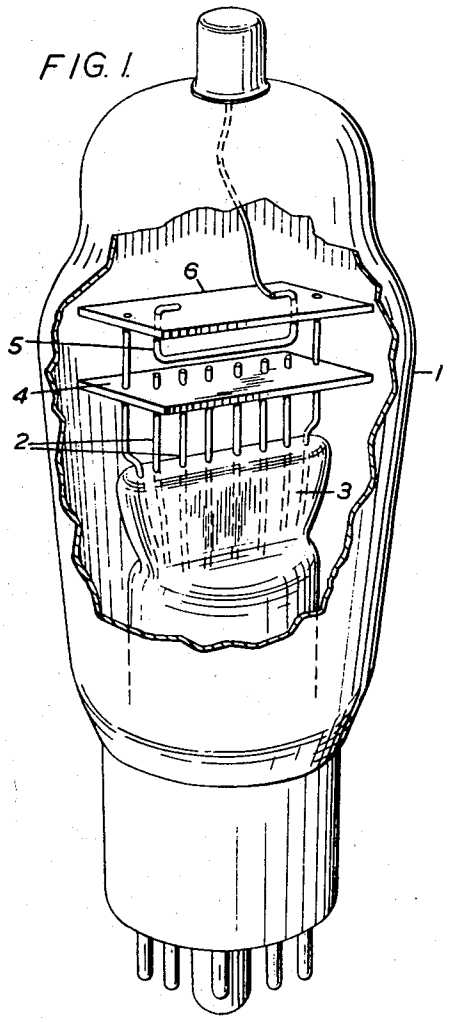


FIG. 2.

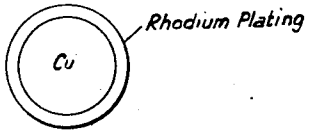
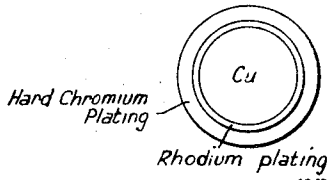


FIG. 3.



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Patented Sept. 25, 1951 2,568,705

UNITED STATES PATENT OFFICE

2,568,705

NONSPUTTERING CATHODE FOR ELECTRON DISCHARGE DEVICES

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Application October 20, 1949, Serial No. 122,381
In Great Britain November 4, 1948

2 Claims. (Cl. 313—218)

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The present invention relates to cold cathode electric discharge tubes and is particularly concerned with means for preventing sputtering of cathode material from the cathode of a discharge gap.

In electric discharge tubes, it is required in many applications that the cathode glow be confined to a specific area of the cathode. This is particularly important in sequence discharge tubes in which an array of discharge gaps is provided, it being arranged that due to ionisation coupling, discharge at one gap may prime the next succeeding gap in the array. In order to control the degree of ionisation coupling between gaps, it is necessary, in general, to limit discharge at any cathode to a specified current. This may readily be done by arranging that the discharge occurs in the region of abnormal glow—when the whole of the available cathode surface is covered with glow. To this end, earlier sequence discharge tubes have had their cathodes shaped in the form of rods coated with alumina leaving only the tips exposed to provide a discharge surface of limited area. This procedure, however, permitted only short life due to sputtering of the cathode material onto the alumina so that eventually the cathode glow spread beyond the desired limit.

Another form of construction has been proposed in which the cathode rods might be left uncoated, the discharge being prevented from spreading beyond the specified area by the provision of a field control plate of metal or of insulating material which surrounds the cathode at a distance less than that of the cathode fall so preventing a discharge from spreading from one side of the plate to the other. This solution has proved very satisfactory from all points of view except ease of manufacture, for if the cathode touches the control plate or is badly off centre in the hole, the tube is either useless or may still have only a short life due to material being sputtered onto the dielectric where it touches the surface of the cathode. From a manufacturing point of view, it would be much easier to be able to assemble the cathode as a push-fit in a mica sheet which may act as a glow defining member while eliminating the difficulty of maintaining small but accurate clearances.

In the accompanying drawings,

Fig. 1 shows an electric glow discharge tube in which the present invention may be embodied.

Figs. 2 and 3 show diagrammatically cathode coating arrangements according to the invention.

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In Fig. 1, the tube envelope 1 encloses a plurality of cathode rod electrodes 2 mounted on a conventional press 3. The cathode electrodes 2 are a close fit in corresponding apertures of a mica sheet 4 so that only the top of the cathode rods protrude therethrough to form the cathode discharge surfaces. A common anode 5 mounted on a further mica sheet 6 is connected to a top cap 7.

In the present invention I provide a cathode having a surface which is hard and has large cohesive forces between molecules, the cathode at the same time having a good value of thermal conductivity to allow heat to be rapidly removed from the surface, whereby sputtering may be considerably reduced below that usual for metals such as copper and nickel.

In one embodiment of the invention, as illustrated in Fig. 2, I use copper as the base metal and coat it with rhodium. As an alternative to rhodium I provide a coating of hard, high current density chromium. In both cases the coating may have a thickness of .001 inch.

In the claims, by a metal of good thermal conductivity I mean one whose thermal conductivity is not less than 12% of that of silver. In practice, I prefer to use copper, but, aluminium is also suitable. Nickel may also be used but, with a conductivity 14% that of silver, this metal is very near the lower limit of what I consider to be practicable. By hard high current density chromium I mean that produced by electroplating at a current density of from 300 to 1000 amperes per square foot.

As an alternative to the single coating of chromium, in order to overcome porosity of the hard chromium and prevent diffusion of the copper I prefer to interpose a flashing of rhodium between the underlying metal and the hard chromium as is indicated in Fig. 3. By a "flash" coating of rhodium I mean one that is continuous but limited in thickness to the order of 10^{-5} inch.

Tests show that in discharge tubes according to the invention, cathode life is increased by a factor of at least four or five from what is obtained with pure nickel, i. e. a satisfactory life of from 800 to 1000 hours working under pulse conditions is now obtainable as compared with 200 hours for a nickel cathode coated with alumina. These figures apply to discharge tubes in which the cathode current density is of the order of one ampere per cm.^{2} and in which the maintaining voltage is a few hundred volts.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What is claimed is:

1. A gas filled cold cathode electric discharge tube comprising a discharge gap electrode formed from a metal of the group consisting of copper, aluminium and nickel and having a layer of rhodium whereby sputtering of the underlying metal during glow discharge operation is prevented.

2. A gas filled cold cathode electric discharge tube comprising a discharge gap electrode formed from a metal of the group consisting of copper, aluminium and nickel and having a rhodium "flash" coating and a surface layer of hard high current density chromium whereby sputtering of the softer underlying metal during glow discharge operation is prevented.

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REFERENCES CITED

The following references are of record in the file of this patent:

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