

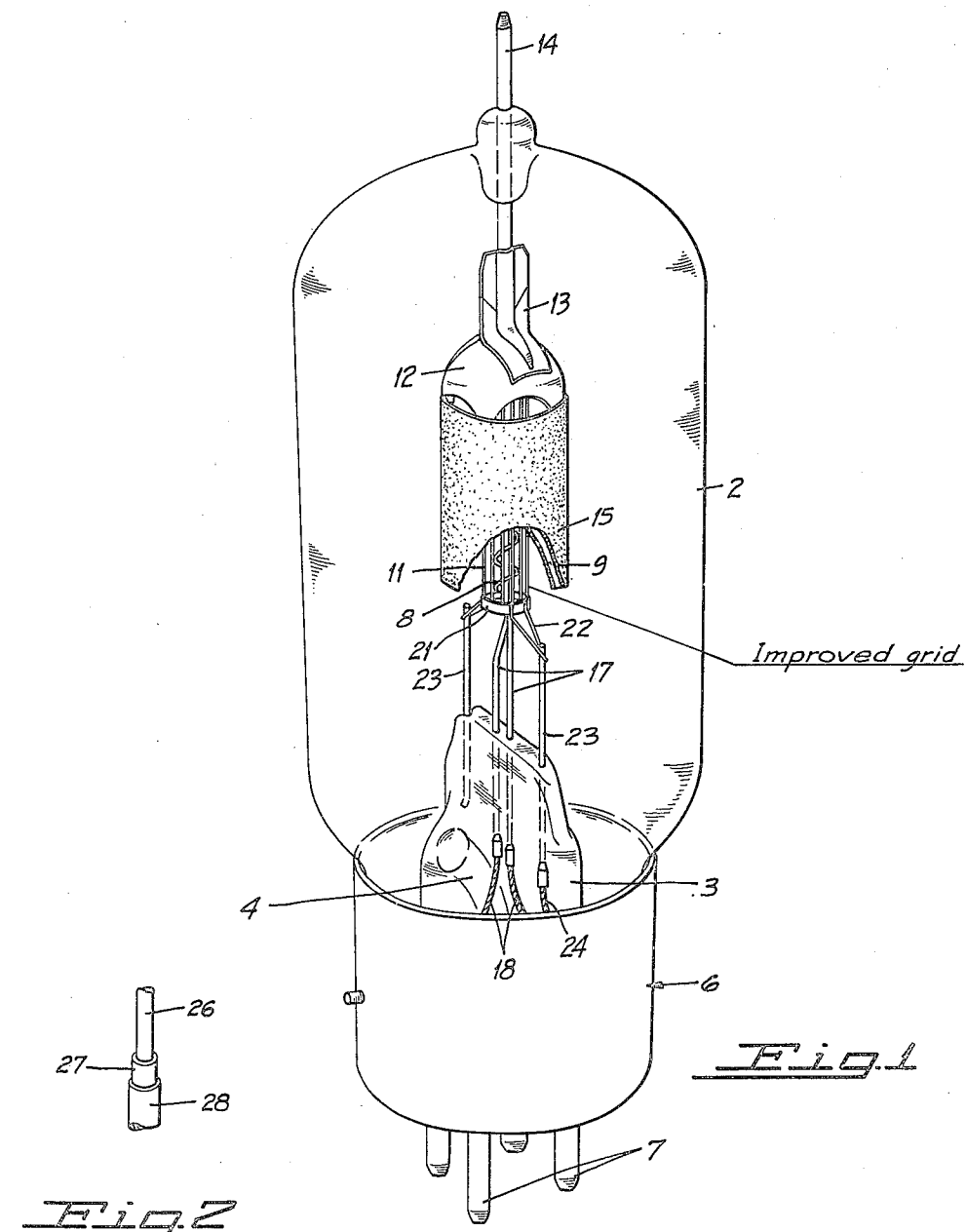
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ELECTRODE FOR ELECTRON TUBES

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ELECTRODE FOR ELECTRON TUBES

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My invention relates to electron tubes, and more particularly to an improved electrode for such tubes.

In electron tubes there are certain electrodes whose operation is seriously affected by their electron emission properties. For example, the proper functioning of a control grid in a triode depends upon the absence of excessive primary emission, namely, thermionic emission of electrons from the grid due to elevated grid temperature. It also depends upon the amount and stability of secondary emission, namely, emission of electrons due to bombardment of the grid by electrons from the cathode. Of these the effects of primary grid emission are most serious, especially in power tubes having thoriated filaments because the grids run quite hot and because thorium from the filament tends to activate the grid.

The broad object of my invention is to provide an electrode which exhibits negligible primary emission and has stable secondary emission.

Another object is to provide an electrode whose emission properties are not appreciably influenced by thorium contamination from a cathode.

Further objects includes the provision of an electrode of the character described which is strong mechanically, inexpensive, and easy to manufacture.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of my invention. It is to be understood that I do not limit myself to this disclosure of species of my invention as I may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawing:

Figure 1 is an elevational view of a tube embodying the improvements of my invention, portions of the anode being broken away to show the inner electrodes; and

Figure 2 is an enlarged view of portions of one of the grid wires.

In terms of broad inclusion, my improved electrode comprises a metallic core, an outer layer of a primary electron emission inhibiting material, and an intermediate layer of a metallic compound isolating the outer layer from the core. In my preferred electrode the outer layer includes a metal in group 8 of the periodic table, and the intermediate layer comprises a metallic carbide. The method of making the electrode preferably comprises the steps of fabricating the electrode of metal, carburizing the electrode, and

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then applying the outer layer by electrodeposition and sintering.

In greater detail, and referring to the drawing, my improvements are illustrated by a triode tube structure comprising an envelope 2 having a stem 3 carrying an exhaust tubulation 4 and provided with a base 6 having prongs 7. The envelope encloses a filamentary cathode 8, tubular anode 9 and grid 11. Anode 9 has a cap 12 supported by bracket 13 on a lead 14 sealed to the upper end of the envelope. If desired, a coating 15 may be provided on the anode to improve its heat dissipation properties.

Cathode 8 comprises a helix of thoriated tungsten wire welded to a pair of leads 17 sealed to stem 3, these leads being connected to a pair of base prongs 7 by conductors 18. Structurally speaking, grid 11 is of the cage type comprising vertical wire bars terminating at a base ring 21 supported by brackets 22 on a pair of rods 23 sealed to stem 3. One of these rods functions as a grid lead and is connected by a conductor 24 to a base prong.

This tube structure is merely for purposes of illustration and may be varied within wide limits, it being understood that my improvements may be incorporated in many other tube designs.

The improved grid electrode 11 comprises a core 26 of a metal having a high melting point and low vapor pressure such as molybdenum, tantalum or tungsten, these metals being generally classified in the art as refractory metals. Molybdenum is especially well suited as a core material and is preferred. The usual procedure in fabricating grids of the cage type is to wind a wire on a mandrel and fasten it to the base ring 21. This same procedure is followed in making my grid, the wire thus wound comprising the core 26 of my electrode as is shown in Figure 2. After fabrication the grid is cleaned in a suitable manner, as by electrolyzing in a sulfuric acid bath.

The grid is next treated to form an intermediate barrier layer 27 of a metallic compound for isolating the core from the surface portions of the grid. I have used a metallic carbide in layer 27 with excellent results. This layer is prepared by carburizing the outer portions of the core metal, thus forming a layer of molybdenum carbide in the preferred electrode. Carburizing may be done in several ways, as by heating the electrode in a hydrocarbon atmosphere or by heating it in a pot containing powdered carbon. For convenience, however, and to establish better control over the carburizing step, I prefer to apply carbon as a coating and then heat the coated electrode. This

is done by depositing a thin coating of finely divided carbon particles on the grid, the particles being preferably electrodeposited from a bath containing the particles in suspension. The coated grid is then heated to say 1850° C. for about five minutes in an oxygen free atmosphere of an inert gas or in vacuum. During this heating the carbon combines with the core metal to form a metallic carbide, as will be readily understood. The resulting grid at this stage has a layer 27 of the metallic carbide, the nature of the carbide depending upon the core metal used.

The carburized grid is next treated to form an outer layer 28 of a material having the desired electron emission properties. I prefer to use an outer layer composed mainly of a metal in group 8 of the periodic table, such as iridium, ruthenium or platinum, the latter being preferred. Layer 28 is formed by depositing on the electrode a thin coating of finely divided platinum particles, and then heating the electrode to fuse or sinter the particles together and to the underlying layer. The platinum particles are preferably electrodeposited from a chlorplatinic acid solution, and the grid thus coated is preferably heated to say 1650° C. for about five minutes in an oxygen free atmosphere of an inert gas or in vacuum. Heating in vacuum is preferred because it also serves to outgass the electrode. This heating step sinters the particles into a continuous sheath and fuses the outer layer to intermediate layer 27. Also, a certain amount of metallic carbide from the underlying layer becomes mixed with the platinum during the sintering operation, so that the final layer 28 comprises a mixture of a major proportion of platinum and a minor proportion of the metallic carbide.

A grid electrode prepared in the manner above described has excellent properties from the standpoint of both primary and secondary emission. The grid exhibits an initial low order of primary emission, and the amount of primary emission does not increase upon contamination of the grid with thorium. The suppression of primary emission is due to the composition of outer layer 28 and also to the fact that this layer is isolated by the barrier layer 27.

Furthermore, the amount of secondary emission from my improved grid is subject to control and, once established, is stable. The composition of outer layer 28 and its surface texture determine its secondary emission properties. The fact that the platinum is deposited as discrete particles, subsequently fused together, enables one to achieve a predetermined surface texture, either rough or smooth, depending upon the size of particles deposited and upon the temperature of sintering. If fewer secondary electrons are desired a rougher surface is produced. I have heated the grids to temperatures of from 1400° C. to 1700° C. to produce surfaces ranging from very rough to quite smooth, depending upon the amount of secondary grid emission desired in a given tube design. As the grid is heated to higher temperatures in the final firing step there apparently is a greater inclusion of the metallic carbide into the outer layer 28, which increased carbide content also modifies the secondary emission properties. In any event, once a desired secondary emission property is established, I have found that such emission from my grid is a stable and dependable characteristic.

After the final firing step the grid is ready for assembly in a tube. The processed grid is very rugged and no special care in handling is re-

quired prior to mounting in the tube. Thoriated tungsten filament 8 is carburized in the usual manner, and the tube is evacuated in accordance with common practice.

While I have described my improvements in connection with the control grid of a triode, it is understood that the improvements may be incorporated in other electrodes where electron emission is a problem. For example, I have had good results in a tetrode where both the control and screen grids were made in accordance with the teachings of my invention.

My improvements are not to be confused with grids made in the past having a coating of platinum on a wire core. Such grids have been used with some measure of success, but eventually develop a high order of primary grid emission due to an interaction that takes place between the platinum and core metal. I have eliminated this difficulty by the interposed barrier layer 27. Also, the inclusion of a metallic carbide in my outer layer 28 helps to control the emission properties. Furthermore, the smooth surface coatings of pure platinum heretofore used do not have the advantage of regulating secondary emission as is possible in my improved electrode. A still further advantage of my electrode is that very little of the expensive platinum is required since only a very thin outer layer 28 is needed to obtain the desired emission properties. This small platinum requirement, compared to platinum coated grids used in the past, is due to the presence of barrier layer 27 and also to the fact that part of outer layer 28 is made up of the metallic carbide.

I claim:

1. An electrode for an electron tube comprising a metallic core, an outer layer of a primary electron emission inhibiting material, and an intermediate layer of a metallic carbide isolating the outer layer from said core.

2. An electrode for an electron tube comprising a metallic core, an outer layer including a metal selected from the group consisting of platinum, iridium, and ruthenium, and an intermediate layer of metallic carbide.

3. An electrode for an electron tube comprising a metallic core, an outer layer comprising a mixture of a metallic carbide and a metal selected from the group consisting of platinum, iridium, and ruthenium, and an intermediate layer of metallic carbide.

4. An electrode for an electron tube comprising a metallic core, an outer layer including platinum, and an intermediate layer of metallic carbide.

5. An electrode for an electron tube comprising a core of molybdenum, an outer layer including platinum, and an intermediate layer of molybdenum carbide.

6. An electron tube having a thoriated cathode and a grid, said grid comprising a metallic core, an outer layer including a metal selected from the group consisting of platinum, iridium, and ruthenium, and an intermediate layer of metallic carbide.

7. A grid material for an electron tube comprising an inner layer of metallic carbide, and an outer layer overlying said carbide layer and including a metal selected from the group consisting of platinum, iridium, and ruthenium.

8. A grid material for an electron tube comprising an inner layer of metallic carbide, and an outer layer overlying said carbide layer and comprising finely divided particles of a metal selected from the group consisting of platinum, iridium,

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and ruthenium fused together and to said carbide layer.

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