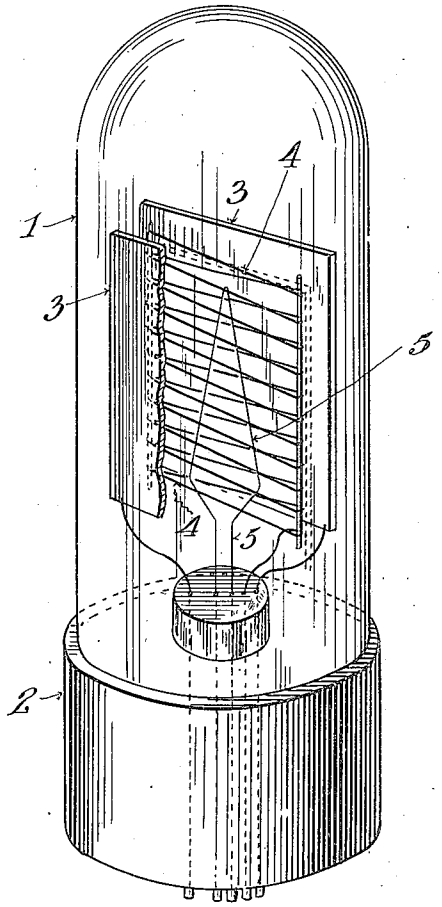
May 1, 1923. 1,453,267

J. L. BRADFORD

ELECTRON EMITTING CATHODE AND METHOD OF MAKING THE SAME

Filed Nov. 29, 1918



INVENTOR
James L. Bradford
BY
Howard C. Hayes
ATTORNEY

Patented May 1, 1923. 1,453,267

UNITED STATES PATENT OFFICE.

JAMES LLEWELLYN BRADFORD, OF NEW YORK, N. Y., ASSIGNOR TO DE FOREST RADIO TELEPHONE & TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

ELECTRON-EMITTING CATHODE AND METHOD OF MAKING THE SAME.

Application filed November 29, 1918. Serial No. 264,504.

To all whom it may concern:

Be it known that I, JAMES L. BRADFORD, a citizen of the United States, residing at New York, in the county of Bronx, State of New York, have made a certain new and useful Invention in Electron-Emitting Cathode and Method of Making the Same, of which the following is a specification.

This invention relates to the manufacture of the heated element, such as the filament, or electron-emitting cathode member of an audion or vacuum tube, and particularly to the element referred to, as an article, as well as to the method of making the same.

The object of the invention is to provide a filament or electron-emitting cathode of greatly increased durability and constancy of activity, for use in audions or vacuum tubes.

A further object is to reduce the cost of manufacture of such devices while securing greater length of life thereof, and increased efficiency.

A further object is to provide an element of the nature and for the use referred to which requires less current in the use thereof, thereby reducing the cost of operation of audions or vacuum tubes in connection with which the element is employed.

Other objects of the invention will appear more fully hereinafter.

The invention consists substantially in the structure and mode of operation hereinafter to be more fully set forth and described, as illustrated in the accompanying drawing, and finally defined in the appended claims.

In the construction of audions or vacuum tubes it is customary to employ one or more cold electrodes and a hot electrode, the latter being called a filament or electron-emitting cathode, and customarily heated by means of an electric current traversing the same. Ordinarily, in the use of the device, the filament or electron-emitting element is heated to a state of incandescence in order to secure the highest degree of activity or electron-emission. This high degree of heat causes rapid deterioration of the heated element and a consequent decrease in its activity. Various expedients have been proposed for increasing the activity in the electron-emission and for increasing the life of such elements. One method heretofore proposed is to coat the element with an oxide. This resulted in an initially high degree of activity of the element, but, in use, these oxide coated elements deteriorate rapidly and the activity thereof becomes less and less. Another method proposes to apply a coating of an organic compound of a metal of the alkaline earth group, such, for example, as barium resinate to platinum for use as the heated element of an audion or vacuum tube. This expedient has not proved to be entirely satisfactory and besides is quite expensive because of the use of a platinum base for the coating.

I have found that all methods which involve the application of coatings are undesirable for the reason that filaments or cathodes so made are not sufficiently stable or permanent and gradually deteriorate, some more rapidly than others, depending somewhat upon the nature of the base employed, the more expensive bases, such as platinum, being the best but open to the objection of greater cost. In carrying out my invention I propose to discard the idea of coatings, and, instead, to incorporate the necessary ingredients into the body of the material out of which the filament or cathode is made. I have discovered that by combining certain suitable substances into an homogeneous mass with certain suitable base materials, such mass can be worked into form to produce a filament or electron-emitting cathode which is more stable and durable than any heretofore proposed, which possesses a high degree of activity of electron emission, which possesses longer life in use than any heretofore employed, which requires only cheap material in its composition, and which requires reduced current for heating the same to the desired degree for the desired extent of activity.

In carrying out my invention I employ a suitable base material, and I have found that tungsten and molybdenum are well suited for this purpose. I also employ suitable oxides and chlorides, preferably of metals of the alkali earth group, that is, including those falling under the second group and including the rare earth class of the eighth group according to Mendelejeff's

periodic law. I have found that, for illustration, the oxides of strontium or calcium, or peroxides, such as barium peroxide are well suited for the purpose. For the chloride constituent I have found that palladium chloride, platinum-ammonium chloride, and calcium chloride afford suitable examples.

I prefer to employ the various ingredients,—base, oxide and chloride—in powdered form, and the best results are secured when the ingredients are employed in the chemically pure state. The base may be wholly tungsten, or molybdenum, or other equivalent material, or a mixture of two or more of these substances. In like manner the oxides and the chlorides may be of separate elements or a mixture of two or more of them of the alkali earth group.

The oxide and chloride constituents, whether consisting of single oxide and chloride elements, or mixtures of oxides and of chlorides or their equivalents, in powder form, are thoroughly mixed together, and the mixture is then added to the base material and the whole composition is then thoroughly mixed. Care should be taken in the mixing operation to avoid as much as possible abrasion or breaking up of the particles of the base material as that would tend to prevent the composition, in the subsequent operations, from being drawn or formed into wire or filament dimensions.

Without intending to be limited or restricted thereto the following relative proportions of the ingredients is given as illustrative of a composition which I have found sufficient and satisfactory for the purpose:

Example: Oxides and chlorides are mixed together in powdered form in about the proportions as follows,—

60% of strontium oxide,
30% of barium peroxide,
10% of palladium chloride.

This mixture is then added to the base material in about the proportion as follows,—

5% by weight of the mixture of oxides and chlorides,
95% by weight of the base material.

For convenience, I will call the mixture of the oxids and chlorids "diluents," or the radio-active element.

After thoroughly mixing the ingredients together, but without undue abrasion of the base material, as above explained, the mass, in the dry state, is pressed into bar form in molds under a high degree of hydraulic or other pressure. The pressed and formed bar is then subjected to heat to nearly, but not quite, the melting point of the base material. This may be conveniently accomplished in an electric or other suitable furnace. In the course of about an hour during which the material is maintained at the temperature specified, the ingredients of the mass or pressed bar seem to amalgamate and form into an homogeneous body, the time required in the heating operation varying somewhat according to the nature and composition of the base material employed.

The homogeneous bar is then suitably swaged or drawn into the proper dimensions to form a filament or cathode element for the purpose set forth.

The use of the chloride constituent increases the activity of the filament or cathode as to its electron-emission properties.

I have found that when a filament or cathode, constructed in accordance with my invention, is heated only to a dull red condition, an electron emission is secured to a degree of efficiency comparable with the best filaments heretofore employed in audions or vacuum tubes which are heated to incandescence to secure maximum activity. This means that less heating current is required, and consequently there is less deterioration of the filament or cathode through oxidation or otherwise, thereby greatly prolonging the life of the filament or cathode without decrease of its activity. I have also found that the electron-emission activity of the filament or cathode embodying my invention is more constant and uniform, and that the physical structure of the filament or cathode is more stable and stronger than those heretofore employed.

It will be observed that I avoid the use of platinum which is very expensive and adds materially to the cost of manufacture of filaments or cathodes, and, instead, I employ comparatively cheap materials and still secure greater longevity as well as advantageous results in the way of more stable and uniform emission, greater strength of filament or cathode, therefore less liability to become injured or broken in handling or transporting the audions or vacuum tubes, less current for heating the element in use, and consequently securing economy not only in manufacture and upkeep, but also in operation of the audions or vacuum tubes employing the filament or cathode.

In the drawing I have shown a form of audion or vacuum tube as illustrative of the manner of use of an electrode, filament or cathode embodying my invention, and wherein 1 is an evacuated vessel, 2 the base thereof, 3, 3 the plate or wing, and 4 the grid electrodes or elements, and 5 the hot member or element produced in accordance with my invention. The leads of the various elements or electrodes extend through the base 2, and the arrangement as shown of the electrodes is the usual arrangement of these parts in use in one form of audion.

Having now set forth the objects and nature of my invention, and the method of carrying the same into operation, what I claim as new and useful and of my own in-

vention, and desire to secure by Letters Patent, is,—

1. The process of manufacturing an electron emitting cathode which consists in mixing together a base material containing tungsten, an oxide and a chloride of metals of the alkali earth group, and then amalgamating the mixture into an homogeneous body.

2. The process of manufacturing electron-emitting cathodes, which consists in mixing together a tungsten containing a base material, with a diluent including oxides and a chlorid of metals of the alkali earth group, and then amalgamating the mixture into an homogeneous body.

3. The process of manufacturing electron-emitting cathodes, which consists in mixing together in powdered form a base material and a diluent including metallic oxides of the second group, and chlorids of the rare earth class of the eighth group of the periodic law, and then amalgamating the mixture into an homogeneous body.

4. The process of manufacturing electron-emitting cathodes, which consists in mixing together tungsten and a diluent including metallic oxides and a chloride of the alkali earth group, and then amalgamating the mixture into an homogeneous body.

5. The process of manufacturing electron-emitting cathodes, which consists in mixing together powdered tungsten and a diluent including metallic oxides and a chlorid of the alkali earth group, and then amalgamating the mixture into an homogeneous body.

6. The process of manufacturing electron-emitting cathodes, which consists in mixing together a base material and a mixture of oxides and a chloride of the alkali earth group, and finally amalgamating the mixture into an homogeneous body.

7. The process of manufacturing electron-emitting cathodes, which consists in mixing together a mixture of base materials including tungsten, an oxide and a chloride of the alkali earth group, and then amalgamating the mixture into an homogeneous body.

8. The process of manufacturing electron-emitting cathodes, which consists in mixing together tungsten and molybdenum as a base material, and an oxide and a chloride of metals of the alkali earth group, and then amalgamating the mixture into an homogeneous body.

9. The process of manufacturing electron-emitting cathodes, which consists in mixing together tungsten, and a diluent including strontium oxide, barium peroxide and palladium chloride, and then amalgamating the mixture into an homogeneous body.

10. The process of manufacturing electron-emitting cathodes, which consists in mixing together a base material, and a diluent including oxides and a chloride of metals falling under the second and eighth groups respectively of the periodic law, and heating the mixture to cause the ingredients thereof to form an homogeneous body.

11. The process of manufacturing electron-emitting cathodes which consists in mixing together a base material, including tungsten, and a diluent including an oxide and a chloride of metals falling under the second and eighth groups respectively of the periodic law, and then compressing the mixture and subjecting the compressed mass to heat to amalgamate the same into an homogeneous body.

12. The process of manufacturing electron-emitting cathodes which consists in mixing together a base material, and a diluent including oxides and a chloride of metals falling under the second and eighth groups respectively of the periodic law, and heating the mixture to a degree below the melting point of the base material to amalgamate the mass into an homogeneous body.

13. The process of manufacturing electron-emitting cathodes which consists in mixing together a base material, and a diluent including an oxide and a chloride of metals falling under the second and eighth groups respectively of the periodic law, and then compressing the mixture and subjecting the compressed mass to heat to a degree below that of the melting point of the base material to amalgamate the mass into an homogeneous body.

14. The process of manufacturing electron-emitting cathodes which consists in mixing together a base material, and a diluent including an oxide and a chloride of metals falling under the second and eighth group respectively of the periodic law, and then compressing the mixture and subjecting the compressed mass to heat to amalgamate the same into an homogeneous body, and finally drawing the heated body into the dimensions to form the cathode.

15. The process of manufacturing electron-emitting cathodes, which consists in mixing together a base material, and a diluent including an oxide and a chloride of metals falling under the second and eighth groups respectively of the periodic law, and compressing the mixture under a high degree of pressure, and finally subjecting the compressed mass to a temperature slightly below the melting point of the base material to amalgamate the same into an homogeneous body.

16. The process of manufacturing electron-emitting cathodes which consists in mixing together a base material, a diluent including an oxide of a metal of the alkali earths and palladium chloride, and then amalgamating the mixture into an homogeneous body.

17. The process of manufacturing elec-

tron-emitting cathodes which consists in mixing together a base material, a diluent including an oxide of a metal of the alkali earths and palladium chloride, and then heating the mixture.

18. The process of manufacturing electron-emitting cathodes which consists in mixing together a base material, a diluent including an oxide of a metal of the alkali earths and palladium chloride, and then compressing the mixture and heating the compressed mass.

19. An electron-emitting cathode consisting of an homogeneous body containing a base material, an oxide, and a chloride.

20. An electron-emitting cathode consisting of an homogeneous body containing a base material, and a diluent including an oxide and a chloride of metals of the alkali earth group.

21. An electron-emitting cathode consisting of an homogeneous body containing tungsten as a base material, and a diluent including oxids and a chloride of metals falling under the second and eighth respectively groups of the periodic law.

22. An electron-emitting cathode consisting of an homogeneous body containing tungsten and molybdenum as a base material, and a diluent including oxids and a chloride of metals falling under the second and eighth respectively groups of the periodic law.

23. An electron-emitting cathode consisting of an homogeneous body containing a base material, a metallic oxide and palladium chloride.

24. An electron-emitting cathode consisting of an homogeneous body containing a base material, strontium oxide and a metallic chloride.

25. An electron-emitting cathode consisting of an homogeneous body containing tungsten, and a diluent including strontium oxide, barium peroxide and palladium chloride.

26. An electron-emitting cathode consisting of an homogeneous body containing a base material, strontium oxide, barium peroxide and a metallic chloride.

In testimony whereof I have hereunto set my hand on this 23rd day of November A. D., 1918.

JAMES LLEWELLYN BRADFORD.