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CATHODE HEATER FOR ELECTRON DISCHARGE DEVICES

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8 Claims. (Cl. 250—27.5)

My invention relates to electron discharge devices, more particularly to improvements in the cathode heaters for such devices.

For indirectly heated cathodes, in order to be able to utilize the entire line voltage for cathode heating and at the same time avoid series resistors and transformers, it has been necessary to use heaters having a very high resistance. Since for a cathode of given dimensions and prescribed working temperature, there is always required a definite number of watts for the heating, it is necessary to decrease the intensity of the heating current when the heating voltage is increased. If a metal wire is chosen for the heater, it must be very long and thin. Difficulties are encountered in accommodating such wires within the insulating member of the cathode either in the form of smooth wires or in the form of a helix, and at the same time insuring at high temperatures a sufficient insulation between the cathode sleeve and filament heater. In view of the fact that by decreasing the length of the heating element, fewer difficulties are encountered in accommodating it in the cathode, it is desirable to use materials having a high specific resistance. Mixtures of metal or carbon powder and insulating oxides have been suggested. However, heating elements formed of such substances were found to be unsuitable, since their resistance values vary considerably.

It is an object of my invention to provide a cathode heater which can be used with relatively high heating voltages and which is free from the difficulties encountered when the conventional type of metal wire cathode heater supported in an insulating sleeve is used.

I have found that suitable heating elements for indirectly heated cathodes can be obtained by a ceramic process from mixtures of current conducting oxides, and oxides which are non-conductors even at high temperature. The oxides which are suitable must have a high melting point and must retain their chemical composition at given operating conditions. The favorable properties of such oxides are probably due to the fact that they dissolve each other to a greater or lesser degree. As a result thereof, the influence of the initial grain size of the conducting and non-conducting constituents are rendered indistinct, so that the resistance elements formed of oxide mixtures, will, at equal proportions by weight of the components of the mixture, and equal conditions of heat treatment, have equal resistance values independent of the initial grain size. Especially favorable results are obtained with such oxide mixtures whose constituents form compounds during heat treatment in an oxidizing space in the manner of the titanates, vanadates, or uranates.

Apparently by the formation of these compounds there is produced an especially fine, molecular distribution of the constituents. Suitable heating resistances are obtained for instance from a mixture of a conductor, a titanium oxide mixture of titanium oxide TiO and titanium dioxide TiO_2, and the non-conductors beryllium-oxide BeO, or calcium-oxide CaO, or particularly magnesium-oxide MgO, or a mixture of the conductor vanadium-oxide V_2O_3 or Niobium-oxide Nb_2O_3 and the non-conductors aluminum-oxide Al_2O_3 or chromium-oxide Cr_2O_3, or a mixture of the conductor uranium-dioxide UO_2 and the non-conductors thorium-oxide ThO_2, or zirconium-oxide ZrO_2, or hafnium-oxide RfO_2 or silic acid SiO_2. The mixture of titanium-oxide and magnesium-oxide was found to be especially suitable. It is obvious that several substances of the type mentioned can be used at the same time, for instance, aluminum-oxide, and magnesium-oxide together with titanium-oxide, or a mixture of aluminum-oxide and magnesium-oxide together with titanium-oxide and vanadium-oxide, or a composition different from those above mentioned may be chosen.

As insulating constituents there may further be used tantalum-oxide Ta_2O_5. Additions of silicon-oxide or other fluxes cause an increase of the mechanical strength. The resistance of the heating elements may be chosen at will by correspondingly apportioning the amount of conducting and non-conducting constituents. The ceramic body may for instance have the shape of a rod, tube, or also of a helix.

The conducting lower metal oxides are easily transformed into the non-conducting higher oxides by burning in air. In order to obtain conducting bodies, it will therefore be necessary to carry out the burning in a reducing atmosphere. It is also possible to start with the non-conducting or poorly conducting higher oxides, for instance U_3O_8, and to transform the same, during burning, into conducting lower metal oxides. The extensive distribution of the conducting substance within the non-conducting substance will be further promoted if the burning is successively carried out in an oxidizing and then in a reducing surrounding. The various polarities of the constituents of the mixture, such as magnesium-oxide and titanium-oxide produce in an oxidizing atmosphere at high temperature an entirely different body for instance magnesium-

titanate of favorable insulating property. In treating this body subsequently in a reducing atmosphere, the reducible oxide, for instance the finely distributed titanium-oxide or the magnesium-titanate, will be reduced to the conducting, lower oxide for instance titanium-oxide which is distributed in an extremely fine state, within the insulating oxide. By choosing a corresponding temperature during burning in the reducing atmosphere, the resistance value of the finished resistance body can still be varied within small limits.

While I have indicated the preferred embodiment of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:

1. An indirectly heated cathode for use with high heating voltages and having a heating resistor in the form of a ceramic body consisting of two components in equal proportions, one component selected from the group vanadium-oxide and niobium-oxide and the other component from the group aluminum-oxide and chromium-oxide.

2. An indirectly heated cathode for use with high heating voltages and having a heating resistor in the form of a ceramic body consisting in equal proportions of uranium-dioxide and one oxide from the group thorium-oxide, zircon-oxide, hafnium-oxide and silicon-dioxide.

3. An indirectly heated cathode for use with high heating voltages and having a heating resistor in the form of a ceramic body consisting of an alkaline earth and a titanium oxide mixture of TiO and TiO_2, said alkaline earth and said titanium oxide mixture being in equal proportions.

4. An indirectly heated cathode for use with high heating voltages and having a heating resistor in the form of a ceramic body consisting of equal parts of magnesium oxide and a titanium oxide mixture of TiO and TiO_2.

5. An indirectly heated cathode for use with high heating voltages and having a heating resistor in the form of a ceramic body consisting of equal proportions by weight of beryllium oxide and of a titanium oxide mixture of TiO and TiO_2.

6. An indirectly heated cathode for use with high heating voltages and having a heating resistor in the form of a ceramic body consisting of equal parts by weight of a titanium oxide mixture of TiO and TiO_2, and one oxide selected from the group of beryllium oxide, calcium oxide and magnesium oxide.

7. An indirectly heated cathode for use with high heating voltages and having a heating resistor in the form of a ceramic body consisting of two components of equal proportions, one component composed of one or more conducting oxides from the group of vanadium oxide, niobium oxide, and uranium oxide and a titanium oxide mixture of TiO and TiO_2, and the other component composed of one or more non-conducting oxides from the group of beryllium oxide, calcium oxide, magnesium oxide, aluminum oxide, chromium oxide, thorium oxide, zirconium oxide, hafnium oxide, silicon dioxide and tantalum oxide.

8. An indirectly heated cathode for use with high heating voltages and having a heater resistor in the form of a ceramic body consisting of equal parts of one of the group of conducting oxides comprising vanadium oxide, niobium oxide, uranium oxide and a titanium oxide mixture of TiO and TiO_2 and one of the group of non-conducting oxides of beryllium oxide, calcium oxide, magnesium oxide, aluminum oxide, chromium oxide, thorium oxide, zirconium oxide, hafnium oxide, silicon dioxide and tantalum oxide.

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