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COMPLETE SPECIFICATION.

Improvements in or relating to Heater Elements for Electric Discharge Devices and to Methods of making such Elements.

We, ARCTURUS RADIO TUBE COMPANY, a corporation of the State of Delaware, United States of America, of 260, Sherman Avenue, Newark, New Jersey, United States of America, Assignees of
5 SAMUEL RUBEN, a citizen of the United States of America, of 801, Riverside Drive, and 83, Fourth Avenue, both in the City and State of New York, United
10 States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

15 This invention relates to heater element, and to the method of making it, for indirectly heating cathodes in electron emission tubes. An object of
20 this invention is the provision of a heater element that will afford long life and a high degree of thermal conduction and radiation to the cathode heater elements in electron emission tubes operating from
25 an alternating current circuit.

30 The problem of suitable insulation for the member used for indirectly heating cathodes in electron emission tubes involves several important factors; they are, the vapor pressure of the insulation, which should be a minimum, so as not
35 to affect the pure electron discharge from the cathode surface; the thermal conductivity of the insulation, which should be as high as possible to maintain at a minimum the temperature gradient
40 between the base heater surface and the exterior radiating or contacting surface; the thermal emissivity of the insulation which should be high in order to obtain maximum radiation; and the insulation
45 resistance which should be as high as practicable, especially at the maximum operating temperatures. The insulation element should be of uniform thickness and should be closely and firmly adherent to the heater base.

50 In order to insulate the heater element from the cathode, it has hitherto been the practice to employ an insulating tube or other rigid body having spaces provided in it through which the heater wire is extended. In practice this has been usually in the form of a quartz or porce-

[Price 1/-]

55 lain tube having bores of small cross section extending through it, for containing the heater wire of such refractory material as tungsten. The inherent
60 drawback to this type of heater is that as the current is initially applied there is an excessive current flow, due to the contact of the heater wire with this relatively large mass of the insulating
65 body; and as the wire contacts with the insulating member only in spots, those parts of the heater wire not so in contact are excessively heated, causing rapid deterioration.

70 The primary object of our invention is to provide a heater element, preferably flexible, with an electrical insulation of the desired properties, by which the heat is uniformly distributed over its length to the cathode; this insures a long life for that member.

75 The heater element for heating a cathode in an electrical discharge device according to the invention comprises a body composed of a refractory metal and a coating of corundum.

80 The method of making the heater according to the invention comprises coating a refractory metal body such as tungsten with a mixture of calcined aluminium oxide and a small percentage of sodium silicate, and heating the coating
85 until the aluminium oxide crystallises and forms corundum. The coating is preferably heated in a reducing atmosphere of hydrogen to about 1000° C., all of the undesirable binder material,
90 viz. the sodium silicate, being then volatilized, and the aluminium oxide forming a crystalline layer of corundum. The resultant crystalline layer shows a high thermal conductivity and electrical
95 insulation. We have found that amorphous aluminium oxide or fused aluminium oxide, such as alundum, does not have the proper composition, and especially it does not adhere sufficiently to the base
100 to withstand vibration or thermo-mechanical action.

105 The coating is preferably prepared by grinding one part of the calcined aluminium oxide with one part of a sodium silicate solution having a specific gravity

of 1.05 until the proper fineness of material is obtained. The surface of the resistance wire base should be previously oxidized by heating for a short period in air, after which the oxide mixture is applied in three evenly distributed coatings, each being allowed to dry before the next is added. The completely coated wire is then slowly passed through a chamber maintained at 1000° C., and then slowly cooled. The final coating is very tough and has a density of about double its initial density.

We have found that when this insulation is used in a high vacuum device there is a negligible evolution of gas or vapor from it; this permits the application of the heater to uses in which high voltages between the elements are employed.

In a preferred form of construction, the coated heater wire is suspended in and in close surface contact with a nickel cylinder as the cathode, the exterior surface of which latter member is coated with an alkaline earth oxide for efficient thermo-electronic emission. So employed it has been found that the average insulation resistance between the cathode and the heater element is in the order of 3 megohms. This value varies with the extent and degree of pressure of contact and the size of the crystals of the coating.

Reference is made to the accompanying drawing representing a tungsten wire having an electrical insulation coating; a tungsten wire is represented at 1 and the coating of corundum is indicated at 2. Having now particularly described and

ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A heater element for indirectly heating a cathode in an electrical discharge device, comprising a body composed of a refractory metal and a coating of corundum. 45

2. A method of making a heater element for an electrical discharge device having an indirectly heated cathode element which comprises coating a refractory metal body with a mixture of calcined aluminium oxide and a small amount of sodium silicate and heating the coating until the aluminium oxide crystallizes and forms corundum. 50

3. A method as claimed in claim 2, in which the coating of the refractory metal is heated in a reducing atmosphere. 60

4. The improved heater element for indirectly heating a cathode in an electrical discharge device, substantially as hereinbefore described and illustrated. 65

5. The improved method of making a heater element for an electrical discharge device having an indirectly heated cathode element, substantially as hereinbefore described. 70

Dated the 10th day of October, 1929.
For ARCTURUS RADIO TUBE CO.

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[This Drawing is a full-size reproduction of the Original.]

