May 4, 1954 F. E. GEHRKE ET AL 2,677,782

VACUUM TUBE HEATER

Filed Oct. 27, 1950

Fig. 1

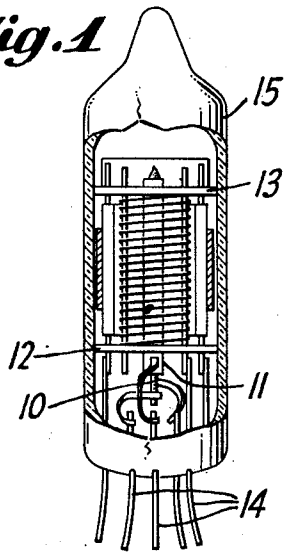


Fig. 2

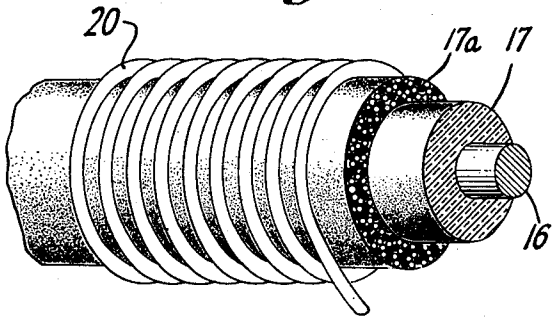


Fig. 5

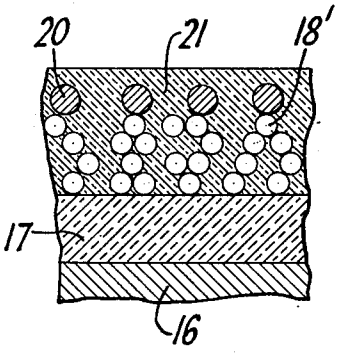


Fig. 3

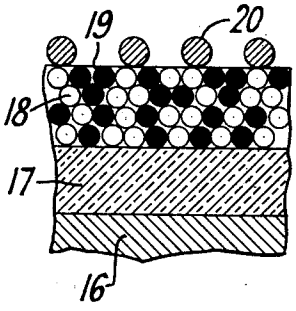
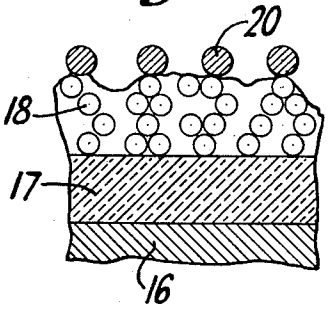


Fig. 4



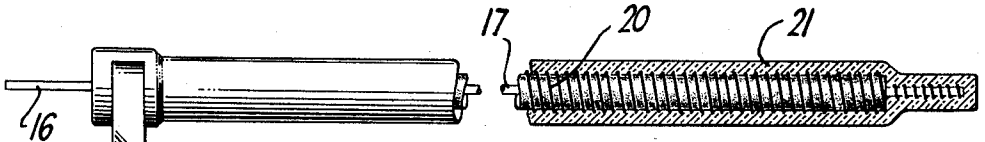
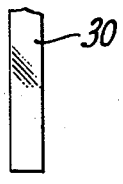


Fig. 6



INVENTORS
FORREST E. GEHRKE
WILLIAM T. GRANGER
BY
J. Albert Hallquist
ATTORNEY

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VACUUM TUBE HEATER

Forrest E. Gehrke, Huntington, and William T. Granger, Floral Park, N. Y., assignors to Sylvania Electric Products Inc., a corporation of Massachusetts

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7 Claims. (Cl. 313—340)

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This invention relates to heaters for vacuum tubes.

In the manufacture of heaters for vacuum tubes, it has been known to wind the heater wire in the form of a coil around a heavier mandrel wire, the latter being first coated with insulation to avoid short-circuiting the heater turns. Difficulties have been experienced with such heaters, these commonly being burnouts of the heater during exhausting and aging of the tubes.

While we do not wish to be bound to our theory as to the probable causes of these burnouts, it was concluded that they may be due to the development of pressure between the heater and mandrel due to differences in expansion of the heater and mandrel respectively, and/or due to the migration during processing and operation of the tube, of metal into the body of insulator between the heater and mandrel rod to an extent sufficient to cause the formation of a conductive path between the heater winding and the mandrel core. This would in effect short circuit a portion of the heater and overheat the remainder. It was considered that these difficulties could be reduced if some way could be found to wind the heater on the mandrel so as to leave at least some open space between the mandrel and the heater wire.

By following the method hereinafter described, applicants found it possible to produce a mandrel-supported heater with a space between the mandrel and heater wires.

It is an object of this invention to provide a mandrel-supported heater which is less subject to burnouts than the conventional mandrel-supported heaters.

It is a further object of this invention to provide a mandrel-supported heater with a space between the mandrel and the heater.

It is a further object of this invention to provide a method for producing such a mandrel-supported heater.

Still other objects and advantages of our invention will be apparent from the following specification.

The features of novelty which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention itself, however, both as to its fundamental principles and as to its particular embodiments will best be understood by reference to the specification and accompanying drawing in which

Figure 1 is a view of a vacuum tube with a heater according to our invention, parts of the tube being broken away in the drawing for simplicity.

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Figure 2 is a perspective view of an insulated mandrel at one stage of the practice of our invention.

Figure 3 is a greatly enlarged longitudinal section of a portion of the arrangement of Figure 2 after it has been coated according to our invention and the heater wire wound in position.

Figure 4 is a similar view after part of the coating has been removed in accordance with our invention, and

Figure 5 is a similar view of the heater and mandrel after completion and

Figure 6 is a completed heater.

Referring now more particularly to Figure 1, 10 represents the mandrel supported heater as frequently used in a vacuum tube, the heater being supported within a hollow, tubular cathode 11 mounted in a central aperture in mica supporting discs 12 and 13. The ends of the heater wire are connected to leads 14 which pass out through the base of the tube. The electrode assembly or mount is positioned in envelope 15. The cathode 11 is surrounded by a suitable arrangement of grids and an anode which are here not specifically identified since they form no part of the present invention.

The connections from the ends of the heater wire may go directly to the lead-in wires 14 or the upper end of the heater wire may be connected to the mandrel and it is used for one connection, the other being made to the other end of the heater wire. Such construction is described in more detail in a Wheeler application Serial Number 50,946 filed September 24, 1948, and assigned to the assignee of the present application.

Referring now more particularly to Figures 2 to 5, the mandrel wire 16 is first coated with a suitable insulating agent 17, such as aluminum oxide and sintered to fix it into a hard coat. Because such insulated mandrels are commonly available and because in the practice of our invention we start with conventional insulated mandrels, the same are not described in detail.

In accordance with our invention, we apply a special coating 17a to the insulated mandrel. This coating consists of an intimate mixture, emulsion or solution of two different substances having different solubility characteristics uniformly dispersed in a liquid carrier vehicle. As an example, we may use a mixture of cellulose acetate and methyl methacrylate (commonly called "Lucite") in acetone. The mandrel is coated with this and allowed to dry and the heater wire wound about it. This is the state of the heater shown in Figure 2. While we do not wish

to be bound by any theory, we believe this forms a coating with fine particles of cellulose acetate and "Lucite" intimately mixed in the manner shown in Figure 3 in which 18 represents finely divided particles of cellulose acetate, and 19 similar particles of "Lucite."

After the heater has been wound and tabbed with suitable connection pieces the assembly is placed in benzene for several hours. Because "Lucite" is soluble in benzene and cellulose acetate is not, a selective dissolving action occurs removing the "Lucite" particles and leaving the cellulose acetate particles. Microscopic examination of the assembly at this point shows the coating to be in the form of mounds of adherent particles such as shown in Figure 4, with the heater wire resting on the peaks of these mounds thereby preventing the shifting of the wire and maintaining control of turn spacing.

The assembly is then coated with its final insulation which tends to fill in the spaces left by the removal of the "Lucite" particles. It is then fired which burns out the cellulose acetate as well as sintering the final insulation into a dense unitary coating. The cellulose acetate, being slow burning, does not cause the insulation to chip as fast burning material would. The burning out of the cellulose acetate leaves voids 18' where the acetate particles were, as indicated in Figure 5, but the turns of the wire are prevented from axial shifting by the outer insulating coating which extends inwardly between the wire turns into the valleys between the mounds and to some extent, into the voids left by dissolving out the "Lucite."

The layer of insulation between wire 20 and mandrel 17 in its final state may be characterized as being spongy, that is, as an open porous body with substantial voids and cavities therein.

The result of this is a mandrel-supported heater in which the heater turns are held in their proper space relation while at the same time there is sufficient spacing between the heater turns and the mandrel to prevent the development of pressure between them due to differences in expansion of the mandrel and heater coil. The general appearance of a completed heater is as indicated in Figure 6, one end of the heater wire being internally connected to mandrel wire 13 and the other to tab 35 whereby both heater connections may be made at the same end of the assembly. However our invention is not limited to the particular physical arrangement shown.

While we have given as an example the use of a coating of cellulose acetate and "Lucite" in acetone, it will be clear that we are not limited thereto, but may use other plastics provided they have different solubility characteristics so that one may be dissolved out by selective action, leaving the other.

While we have shown and described certain preferred embodiments of our invention, it will be apparent that modifications and changes may be made without departing from the spirit and scope of our invention as will be clear to those skilled in the art.

What we claim is:

1. A new article of manufacture, comprising a mandrel-supported heater having a core, a coating of insulation thereon, a heater surrounding said mandrel and having substantially open space between said heater and said coating of insulation and a coating of refractory insulation surrounding said heater.

2. A new article of manufacture comprising a mandrel-supported heater having a core, a coating of insulation thereon, a heater wound around said coating and spaced radially from said coating and a coating of insulation surrounding said heater and projecting inwardly between the turns thereof.

3. A new article of manufacture comprising a vacuum tube having a heater element including an insulated mandrel, a heater wound helically around said mandrel in spaced relation thereto and a coating of refractory insulation surrounding said heater and projecting inwardly between the turns thereof.

4. A new article of manufacture comprising a mandrel-supported heater having a wire core, a coating of insulation thereon, a heater coiled around said mandrel and spaced therefrom, an outer coating of insulation surrounding said heater, the space between said mandrel and said heater containing a substantial amount of open space.

5. A heater for electron discharge devices including a refractory insulating core, a helical heater surrounding said core in spaced relation with respect to said core and a coating of refractory insulation surrounding said heater winding and projecting inwardly between the turns thereof.

6. A heater for electron discharge devices including a refractory insulating core, a heater helically wound in a spaced away relationship with said core and a coating of refractory insulation surrounding said heater winding and projecting inwardly between the turns thereof and resting against said refractory insulating core.

7. A heater for electron discharge devices including an inner refractory core, a spongy coating of refractory material over said core, a heater wire wound helically around said porous coating and an outer coating of refractory insulation surrounding said heater.

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