July 1, 1941. J. R. BEERS 2,247,869

HEATER ELEMENT FOR CATHODES USED IN RADIO TUBES AND METHOD OF MAKING THE SAME

Filed Feb. 28, 1940

Fig. 1

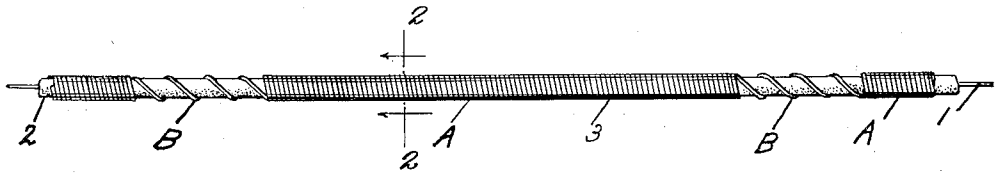
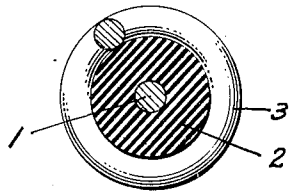


Fig. 2



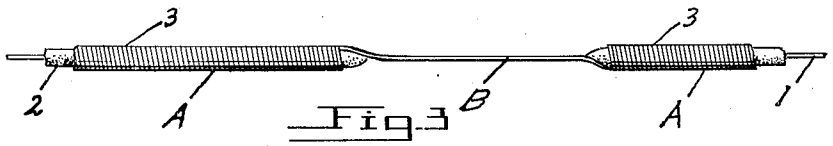


Fig. 3

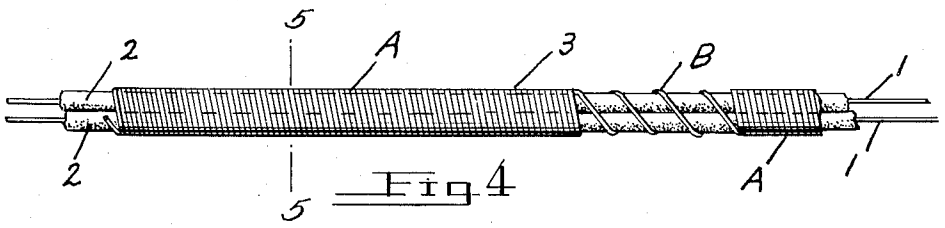
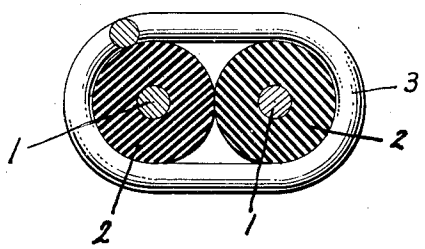


Fig. 4

Fig. 5



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HEATER ELEMENT FOR CATHODES USED IN RADIO TUBES AND METHOD OF MAKING THE SAME

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Application February 28, 1940, Serial No. 321,308

6 Claims. (Cl. 250—27.5)

This invention relates to heater elements and method of producing the same for cathodes used in the conventional type of radio tubes.

There has been a tendency recently to have tubes in which the cathode heaters operate at from 25 to 117 volts as compared to the older types operating at 2.5 to 6 volts. Using the higher voltage presents a problem since sometimes as much as six feet of very fine tungsten wire are required for each heating element.

According to prior practice the fine heating wire has been wound upon a metal mandrel in a coil winding machine and after the coil has been wound the mandrel has been dissolved out with an acid. By using a flexible metal mandrel one was enabled to use a conventional coil winding machine to produce the heating elements.

It is also old in the art to provide heating coils of the type under consideration with a rigid core of insulating material and in some cases the insulation surrounds a wire core which may itself be used as a return lead for the heating coil. In the case where the coil has been wound upon a metal mandrel and the mandrel has been dissolved out, an insulating sleeve or core has been inserted in the coil to form a support therefor.

The problem which I have solved involves the feature of providing a heating coil with a ceramic core or mandrel which is of sufficient flexibility to enable it to be used as a mandrel in a coil winding machine and on which the heating coil is wound.

In carrying out this process I employ a tungsten or molybdenum wire of any desired length and coat it throughout its length with a suitable high temperature ceramic type insulation to a predetermined diameter. The insulating core thus produced is placed in a coil winding machine in the same way as the metal mandrel referred to above and the heating coil is wound thereon throughout the length of the core. The insulated core is of sufficient flexibility to enable it to be wound upon a spool and to be used in a coil winding machine without breaking the insulation. The heating element is wound on the insulation core in alternate sections of closely wound turns and coarsely wound turns and after completion of the winding the coils are separated by cutting midway of the coarsely wound turns. This provides short sections of heating filaments terminating at each end in a few coarse turns, which turns may be used as connecting leads for the heating element. The core of ceramic insulation which, of course, retains its flexibility is maintained in the completed heating coil during normal operation and is not dissolved out or dispensed with as in the case of a metal core.

As indicated above an object of the invention is to provide a heating coil mounted upon a flexible core of ceramic insulation and the invention also resides in the method of producing, continuously, heating elements for radio tubes in a conventional coil winding machine, which I am enabled to do by reason of my development of the core of ceramic insulation which is of sufficient flexibility to enable it to be used in such machines.

The invention is illustrated in the accompanying drawing, in which—

Figure 1 shows a short section of the wound core as it comes from the winding machine;

Fig. 2 is a section on line 2—2 of Fig. 1;

Fig. 3 is similar to Fig. 1 with the core separated and the coarse turns straightened;

Fig. 4 shows a construction using two insulated cores as a mandrel; and

Fig. 5 is a section on line 5—5 of Fig. 4.

In the drawing the core wire 1 has thereon a flexible coating of ceramic insulation 2. On this coating 2 the resistance or heating wire 3 has been coiled. The heating wire is coiled in closely wound turns as indicated at A and coarsely wound turns as indicated at B. The closely wound sections A form the heating elements while the sections B are cut in the middle and serve to form connecting leads for the sections A.

The method of construction employed is as follows: a length of tungsten or molybdenum wire is coated with a high temperature resistant ceramic insulation to a predetermined diameter. The coated wire is sufficiently flexible to admit of being wound on a spool and used as a mandrel in a conventional coil winding machine. The flexible coated core or mandrel is then placed in a coil winding machine and the heating wire wound thereon in alternating sections of coarse and fine turns, B and A as a continuous operation. When the product comes from the winding machine it is cut into short lengths for use by cutting through the center of the coarse turns B. Figure 3 shows two heater sections or units in which the core had been cut and the coarse turns of a section B straightened but not cut.

Usually, in carrying out my process, the length of insulated core employed in windings is from 150 to 300 feet and this will accommodate from 1,000 to 2,000 complete heating coils wound from

a single piece of tungsten wire on a continuous coil winding machine.

In my development of this method and product a tungsten wire having a diameter of the order of .007 inch has been employed and this wire is coated with ceramic insulation to a diameter of the order of from .030 to .032 inch. The diameter of the heating coil wire itself is of the same order as that of core wire.

Figures 4 and 5 illustrate a construction in which two coated conductors are employed as a mandrel and the heating wire coiled thereon. The two cores of Fig. 4 are duplicates of the single flexible core of Fig. 1, each comprising a center tungsten or molybdenum wire 1, a coating 2 of ceramic insulation which is flexible enough to be wound on a spool and used in a coil winding machine as a flexible mandrel. The heater wire 3 in Figs. 4 and 5 is wound in alternate sections of fine and coarse turns A and B and these sections are separated into individual units as above described in connection with the description of Figs. 1, 2 and 3.

One, two, or three insulated core mandrels could be used for a single coil. It has been found most satisfactory, however, to employ a single core for the present type of tube in which the high voltages are used.

The heating unit may be finished by connecting one end of the heating coil to the adjacent end of a core wire leaving the other free ends of the coil and core wire for leads. As an alternative method the core wire may be disregarded as a connecting means and light metal caps slipped over the ends of the core or cores and the ends of the coils attached thereto.

In further finishing the coil a spray insulation is applied over the heater coil to indulate it from the metallic cathode sleeve. In this connection, it has been found that, instead of the usual solid spray coating, alternate rings of insulation separated by short gaps of unsprayed coil facilitate the removal of gas, make the spray thickness less critical, and improve the action of the heater.

The usual method of producing ceramics is to mold or extrude suitable materials into the desired form and then subject them to a temperature at which the separate particles flow into each other and form an homogeneous mass. In producting a flexible ceramic in the form of an insulated wire the wire is drawn through suspensions of the ceramic material in water then through baking ovens arranged alternately. The ceramic material usually consists of finely divided aluminum oxide. Binding of the oxide to the wire is accomplished by using a small amount of aluminum nitrate in the water suspension, the nitrate converting to oxide as it passes through the baking ovens. The baking temperatures used are much below the fusion temperature of the aluminum oxide and so the particles retain their original form and are more or less only mechanically united by the converted nitrate.

By the described method of manufacture flexible heating units having a supporting core are produced. By this method the step of dissolving out a metal mandrel is avoided and the completed filaments more readily produced by a continuous process than heretofore known. Coils of any desired length can be easily produced and are flexible enough for manipulation and still have an insulation core which is often desirable.

What is claimed is—

1. A heating unit for radio tubes consisting of a flexible core wire, a flexible coating of ceramic material on said wire and a heating coil having its turns closely wound on said coating.

2. A method of continuously producing heating elements for radio tubes comprising, coating a length of flexible wire with a ceramic to produce a flexible mandrel, winding a heating coil on said mandrel in a coil winding machine and dividing the product into relatively short sections as individual heating units.

3. A manufactured product from which heating elements for radio tubes may be made, comprising a length of flexible core wire having a flexible coating of ceramic material thereon throughout its length and a plurality of coil sections coiled on said coating in continuous alternating sections of closely wound turns and coarsely wound turns.

4. A heating element for radio tubes comprising a core conductor having a diameter of the order of .007 inch, a flexible coating of ceramic insulation on said core having a diameter of the order of .032 inch and a coiled heater wire on said coating, the diameter of the wire of said coil being of substantially the same order as the core conductor.

5. A heating element for cathodes used in radio tubes comprising a flexible core wire of tungsten, a flexible covering of ceramic material on said wire, and a heating coil of tungsten helically wound on said covering.

6. A method of continuously producing heating coils for radio tubes which comprises coating a flexible wire of small diameter and substantial length with a flexible ceramic to form an insulating core, using said core as a flexible mandrel and winding a heating wire thereon in alternate sections of relatively closely wound and relatively coarsely wound turns and dividing the product between the successive closely wound sections.

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