

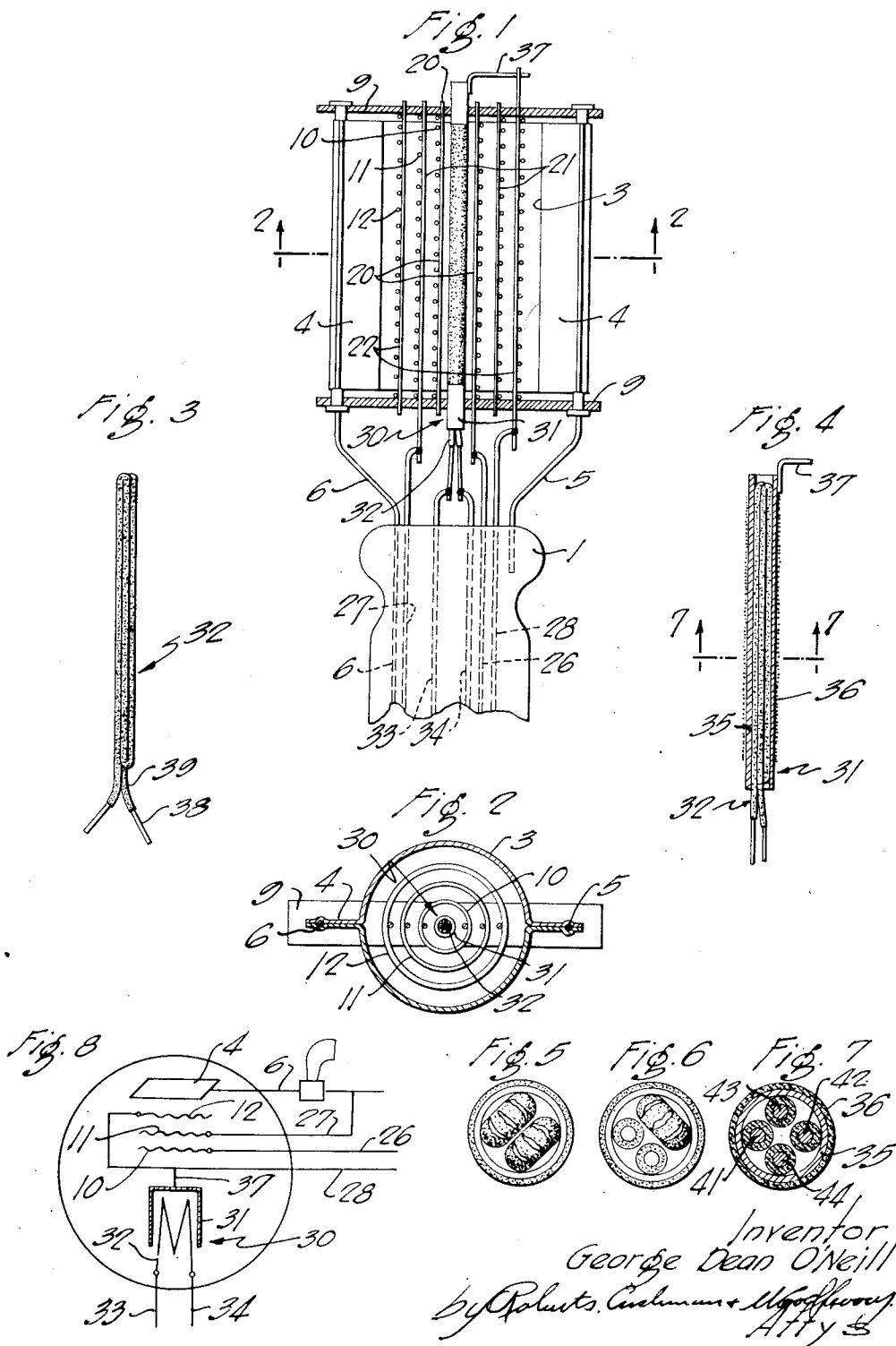
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ELECTRON DISCHARGE DEVICE

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ELECTRON DISCHARGE DEVICE

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Certain electron discharge devices, including independently heated so-called pentode tubes for radio reception equipment, are commonly provided with cathode heating elements for a voltage of approximately 6.3 volts. The use of this comparatively high voltage presents certain difficulties, which are mainly caused by the problems of properly arranging a comparatively long resistance wire within the small tube which ordinarily forms the cathode proper of the electron emitting element, and of properly insulating this wire, especially if it is arranged in the form of a helix. In order to provide the necessary length of wire, such a helix has to be recurrently wound and therefore supported upon a mandrel or post, in order to prevent short-circuiting and generally to preserve the shape of the heating element. Such an arrangement presents certain difficulties and disadvantages, as, for example, the possibility of short-circuiting windings, the necessity of heating the electrically inactive supporting element, which moreover occupies a large part of the available space within the cathode tube, and the comparatively difficult, complicated and therefore expensive manufacturing process of winding and insulating such elements.

The present invention provides an improved radio tube of this type and a process for making it, which avoid these and other disadvantages, and some of its principal objects are to provide an electron discharge device with an independently heated cathode suited for a comparatively high heater element voltage and quickly attaining its operating temperature, to provide a pentode tube with an electrically independent heater element within a cathode tube, to provide a compact emitter unit with a comparatively long but substantially straight resistance wire as heater element within a cathode tube, the unit being substantially free from liability of short-circuit and containing no electrically inactive elements such as insulator rods for support, to provide such a unit which can be exactly and easily manufactured, and generally to provide a satisfactory, durable, yet inexpensive radio tube of the aforementioned type.

In another aspect the invention provides a method for insulating and shaping a heater element for a radio tube of the aforementioned type.

In carrying out my invention I may double a straight resistance wire several times and then insulate the wire portions from each other or, in the preferred form of my invention, I cover a comparatively long, straight resistance wire with an insulating composition which does not split

longitudinally, but rather parts in the form of rings around the wire if the latter is bent, so that it will not chip or break off; in this sense therefore the insulation coating may be termed semi-flexible; then I fold the wire so that it forms a bundle of several serially interconnected, substantially equal lengths of wire with the connection ends extending beyond the bundle, and arrange the wires so that they occupy a cross-sectional area similar in shape and size to that available within the cathode tube. I then insert this wire within the tubular emitter element and connect the ends of the wire to the customary leads or other elements of tubes of this kind, whereby the heater element is preferably kept electrically independent of the other elements of the device.

The various objects and advantages of the invention will be apparent from the following description, by way of example, of a modern pentode power tube incorporating my invention, and of the method for making the same, with reference to the accompanying drawing, in which

Fig. 1 is a central sectional view of the electrodes and related elements of a radio tube constructed in accordance with the invention;

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

Fig. 3 is an elevational detail of the heater element;

Fig. 4 is a vertical section through the emitter element assembly;

Fig. 5 is a top view of the emitter assembly;

Fig. 6 is a bottom view of the emitter assembly;

Fig. 7 is a section on lines 7—7 of Fig. 4; and

Fig. 8 is a connection diagram of the radio tube shown in Figs. 1 and 2.

In Figs. 1 and 2 of the drawing, 1 is a stem of glass or other non-conductive material upon which the various elements of the tube are mounted with the conventional supports and leads secured in a press. The plate or anode 3 may consist in conventional manner of semi-cylindrical elements joined by means of flanges 4 which are supported by vertical wires 5 and 6, wire 6 also serving as a lead. Grid support strips 9 of insulating material extend between wires 5 and 6 and hold several grid structures, each of which comprises supporting and conducting elements and the grid helixes themselves. More particularly, 10 is the control grid supported by 20 and connected with lead 26; 11 is the screen grid supported by 21, wire 27 being the corresponding lead; and 12 is the suppression grid supported by 22 with 28 as a lead.

Centrally within the substantially concentric plate and grid structure is the emitter assembly

30 comprising a cathode element 31 and a heater element 32 attached to two leads 33 and 34. The emitter element consists of a metallic tube 35 with a coating 36, a connection 37 being welded to the upper end of the tube forming an electric joint between the cathode 31 and lead 28 of suppression grid 12.

The filament or heating element consists of a wire 38 which is coated with an insulation layer 39 and twice doubled upon itself, as shown in Fig. 3, whereby the two free ends of the folded wire are left somewhat longer than the two intermediate portions. The four wire portions are retained in close contact, so that they form a bundle of substantially parallel wire portions, with the two ends somewhat protruding. This bundle is then inserted in the cathode tube, whose available cross-section it fills to a considerable degree. The ends of the wire bundle remain outside the tube and are suitably connected to leads 33 and 34, held in the press of the tube.

It should be noted that the heater element may be folded more than two times so that, for example, six wire portions may be contained within the tube.

In its preferred construction, the heating wire is covered with insulating material of peculiar properties, in order to secure proper insulation of the resistance wire. This insulating material must be able to withstand bending without chipping or otherwise loosening from the wire, although a break at the bends, in a plane substantially perpendicular to the wire axis is not harmful. Only if the insulating covering meets this requirement can the wire be doubled after being insulated, which is the preferable manufacturing method, since only a covering of this type secures proper insulation of the portions of the wire bundle from each other and from the cathode tube. An insulation layer meeting these requirements may, when the wire is bent, separate along planes substantially perpendicular to the wire axis, as indicated in Figs. 5 and 6, but must not split longitudinally, which would cause the chipping or loosening referred to above. For making such an insulated wire, I prefer the following procedure. A mixture of approximately

C. P. aluminum oxide-----	grams--	248
C. P. silicon dioxide-----	do----	2.5
Dry 1000-second viscosity nitrocellulose	grams--	40
Ethyl carbonate-----	c. c.	2,500
Amyl acetate-----	c. c.	105
Ethyl oxalate-----	c. c.	80
is prepared and applied to the stretched wire by spraying or dipping in known manner, whereupon a second coat is placed on the wire in similar manner. This second layer consists of a mixture of approximately		
Alundum-----	grams--	248
Talc-----	do----	3
Dry 80-second viscosity nitrocellulose	grams--	40
Ethyl carbonate-----	c. c.	2,500
Amyl acetate-----	c. c.	105
Ethyl oxalate-----	c. c.	80

After drying the coated wire in air at approximately 50° C., it is fired for two to four minutes at approximately 1600° C., in hydrogen atmosphere.

This covering also assures complete insulation of the heating element from the cathode tube so that these two elements can be kept elec-

trically independent, which is preferable in many instances and indicated more particularly in Fig. 8. This figure shows the heater element 32 with its leads 33 and 34 entering independently of the cathode element 31 which is electrically connected through 37 to lead 28 and therefore to suppression grid 12. Screen grid 11 with lead 2 is shown connected to the output circuit in conventional manner.

It is apparent that a heater element of this type may be made of any desirable length, and therefore for any desirable voltage within wide limits, and that its simple construction prevents any short circuits. This construction also utilizes the space available within the cathode tube in the best possible manner, at the same time promoting quick heating of the cathode, due to the small amount of insulating material present, the heating time depending mainly upon the heat capacity of the substance present which absorbs heat before any energy is available to heat the cathode. Rapid heating is also promoted by the absence of any electrically inactive material between longitudinal folds, as for instance mandrels, cores, and similar structures.

It is also apparent that the current in each wire portion flows opposite to the current in adjacent portions. For example, if at a certain moment the current flows upwardly in portion 41 (Fig. 7), it flows in the same direction in portion 42, but in opposite directions in portions 43 and 44. Due to this fact, the variations in potentials and direction of current flow are to some extent neutralized, which tends to reduce hum according to principles well known in the art.

It should be understood that the present disclosure is for the purpose of illustration only, and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A heater element for electron discharge tube comprising a heater wire having an under coat of insulating mixture consisting substantially of aluminum oxide and a small per cent of silica and an outer coat of a different kind of an insulating mixture consisting substantially of Alundum and talc to enable said wire to be bent back upon itself without destroying the insulating properties of said coatings.

2. A heater element for an electron discharge tube comprising a wire having an under coat of insulating material consisting substantially of aluminum oxide and a small per cent of silicon oxide, and an outer coat consisting substantially of Alundum and talc.

3. A heating element for an indirectly heated cathode comprising a bundle formed of the folds of a multiply doubled resistance wire having a first coating comprising aluminum oxide and a small per cent of silica, and a second coating consisting substantially of Alundum.

4. In combination, a heater element in the form of a single length of wire doubled upon itself intermediate its free ends with the doubled portion bent back upon itself to form a four-strand bundle, said wire carrying a continuous unitary coating, said coating being of a first layer of insulating mixture consisting substantially of aluminum oxide and a small per cent of silica and a second layer of a different insulating mixture consisting substantially of Alundum and talc.

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