March 18, 1952 W. WHEELER 2,589,522

CATHODE HEATER STRUCTURE

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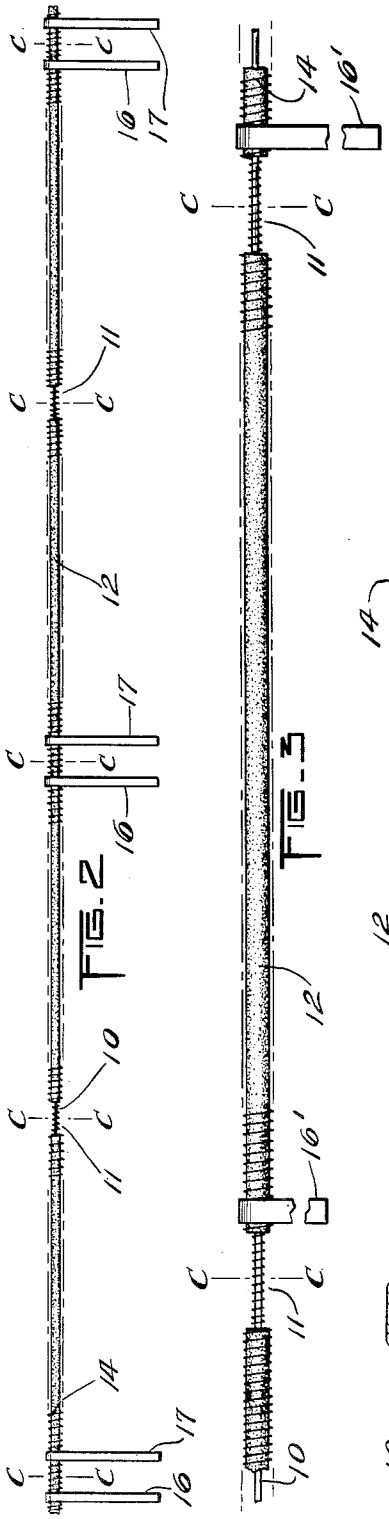


FIG. 2

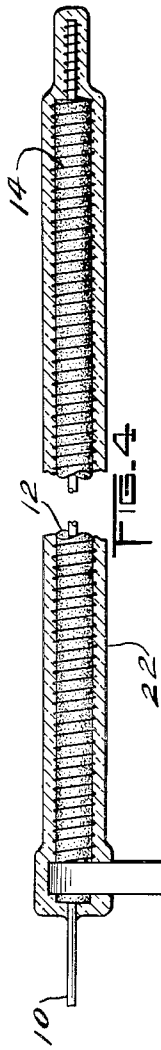


FIG. 4

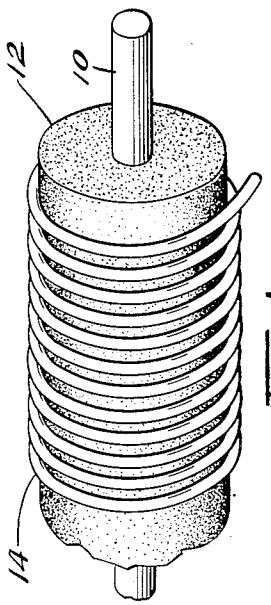


FIG. 1

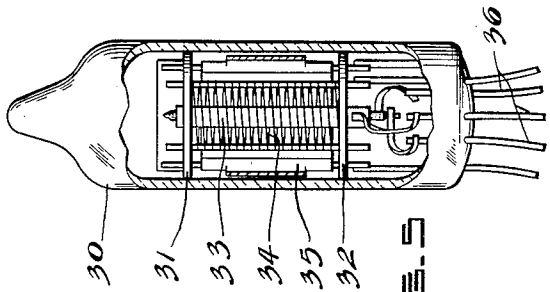


FIG. 5

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CATHODE HEATER STRUCTURE

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7 Claims. (Cl. 313—337)

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The present invention relates to electron discharge tubes and more particularly to heater structures for indirectly heated cathodes forming a part of such electron discharge tubes.

An object of the present invention is the provision of a heater element of extremely small size and one which is adapted to be used with high energizing voltages.

Another object of the present invention is the provision of a novel method of constructing heater elements for use in electron discharge devices.

Still another object of the present invention is the development of a production process for heaters adapted to be used in electron discharge devices in which no delicate operations or tedious manipulations are involved.

A further object of the present invention is the provision of a heater element which will have longer life when used in conventional tubes, and which, furthermore, will present a lessened drain on the heater power supply.

Still a further object of the present invention is the manufacture of a high-voltage low-wattage heater particularly for use in rugged tubes.

The foregoing objects, and others which may appear from the following detailed description are attained in one example of the present invention by coating a mandrel wire with a refractory material. At spaced intervals along the length of the mandrel wire, the spacing being slightly greater than twice the length of the desired completed heaters, the refractory material is removed leaving small bare spots on the mandrel wire. The coated and treated wire is then used as a mandrel on which is helically wound light tungsten resistance wire at the desired number of turns per inch. In the regions where the refractory material has been removed, the heater wire is wound directly on the mandrel wire, thus making electrical contact therewith. Connection tabs of a special alloy are then welded in place in a paired relationship at points intermediate the bare spots on the mandrel wire. The long wound mandrel is then severed between each of the pairs of connection tabs, and at the middle of each of the bared places along the mandrel wire, thus forming a number of separate heater units, each with a connection tab near one end, and a connection to the central mandrel at the other end. In an alternate form of construction, the mandrel wire may be bared before winding at spaced points, the spacing between the points being slightly greater than the length of the completed heater. A single connection tab of a special alloy is then welded in place near and at one side of each of the bared spots. The completed wound mandrel in the second modification is then severed into a number of separate heater units by cutting the mandrel wire and wound resistance wire in the middle of each bared place. In either form of construction the helically wound resistance wire is then stripped off between the connection tab and the adjacent end of the bared area.

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If desired, especially when using heavy gauges of heater wire, the connection tab may be eliminated, the stripped off portion of resistance wire being left connected and used for a terminal lead. Each separate heater is again coated with a refractory material, and sintered to form a dense hard outer coat. One connection to the resistance wire is then made by the tab near one end, and the other connection is made to the central mandrel at the same end. It has been found that the close winding of the resistance wire on the bared portion of the mandrel wire provides a reliable contact between the resistance wire and the mandrel rod without requiring any welding operation. The heater thus constructed may be directly inserted into a cathode sleeve, which is to form a part of a complete electron discharge tube. Since the heater wire is rigidly supported over its entire length, a much more rugged form of construction than that known in the prior art is obtained. Furthermore, a high voltage heater is obtained which may be used in extremely small size indirectly heated cathodes.

The present invention will be more fully understood by reference to the following detailed description, which is accompanied by a drawing in which

Fig. 1 illustrates in greatly enlarged perspective view, a portion of the heater element of the present invention during the course of manufacture,

Fig. 2 illustrates a string of a number of heater elements of the present invention during a later step of the process of manufacture,

Fig. 3 illustrates a string of a number of heater elements according to a modified form of the present invention during a step in process of manufacture, while

Fig. 4 is a partial sectional view of a typical heater element constructed according to the principles of said invention, and

Fig. 5 illustrates a thermionic discharge tube utilizing an indirectly heated cathode constructed according to the present invention.

In Fig. 1, there is shown a mandrel wire 10. This wire, which may be a three mil tungsten

wire, is coated with aluminum oxide to form an insulating and refractory coating 12. A preferred manner of providing the refractory insulating coating over mandrel 10 is by continuously coating a length of mandrel wire cataphoretically with aluminum oxide which is then sintered to produce a smooth hard surface. The outside diameter of the insulating coating may have a diameter of from ten to twenty thousandths of an inch. In the modification shown in Fig. 2, the refractory coating is removed from the mandrel wire 10 at spaced points along the length of the wire as indicated at 11. In this modification, the spacing of points 11 is somewhat greater than twice the desired length of the completed heater, while in the modification in Fig. 3, the spacing between points 11 is slightly greater than the desired length of the completed heater. The mandrel thus produced, is wound at a desired number of turns per inch with a light tungsten resistance wire 14. The winding is continuous over the outside refractory coating 12 and, at the bared portions 11, directly over the mandrel wire 10. As one specific example, wire 14 having a diameter of nine ten thousandths of an inch may be wound on mandrel 12 at a winding pitch of the order of between 600 and 700 per inch. With these dimensions, a heater element having a length of the order of 28 mm. may draw about 1 watt when connected to a 26 volt supply.

The resistance wire 14 having been wound in place on a long length of prepared mandrel, connection tabs 16 and 17 are welded in place in a paired relationship at points intermediate the bared spots 11, as snown in Fig. 2. In Fig. 3 a single connection tab 16' is welded in place to the resistance wire at one side of each of the bared places 11. I have found that a platinum tungsten alloy serves as a satisfactory material for the connection tabs 16, 17, and 16'. This alloy permits an efficient weld to the tungsten heater wire 14, and to the later applied connecting wires. The connection tab in addition to serving as a means of making electrical connection to the resistance wire 14, also serves to hold the helical winding securely in place without breaking or cracking the refractory coating 12.

Individual heaters, each having one terminal tab 16 or 17, are produced from the wound length of heater shown in Fig. 2 by cutting through at the points indicated by the dotted lines C, C, at the middle of each bared place 11, and between the connection tabs 16, 17. The heater wire 14 wound directly on the mandrel wire 10 at the bared spots 11 remains in close contact with the mandrel rod or wire even though cut apart at the line C, C.

In the form shown in Fig. 2, the portion of the refractory material and the part of the resistance wire winding between tab 16 for example, and the line of cutting, C, C, between tabs 16 and 17 is removed, thus allowing access to the mandrel rod 10 for connection to one end of the heater. In the modification shown in Fig. 3, the portion of the resistance wire on the mandrel rod adjacent tab 16' is removed up to the point of connection of the wire 14 to tab 16'. If tab 16' is omitted, the unwound portion of resistance wire serves as a terminal lead.

The individual heater elements provided by cutting along line C, C, of Figs. 2 and 3, and with the central mandrel wire 10 appropriately bared at the end of the heater adjacent the connection tab are again cataphoretically coated with a refractory material such as aluminum oxide, and sintered to produce a smooth, hard, final coat. The sintering may, for example, be accomplished by firing the heaters in a hydrogen furnace at 1600° C. for one-half of a minute to one minute.

The resultant heater element produced by either method is shown in partial section in Fig. 4, wherein reference numeral 22 indicates in section the second coat of refractory material. It will be seen that the resistance wire 14 is rigidly held in place over its entire length. There is no possibility of the wire shifting to produce interturn shorts nor is there any possibility of intermittent contacts occurring between the connection tab 16 and the heater wire 14, or between the heater wire 14 and central mandrel wire 10.

The completed heater element may be inserted into a hollow tubular cathode sleeve for use in a conventional electron discharge tube. In Fig. 5 I have shown an electron discharge tube having a hermetically sealed outer casing 30, which may be evacuated or contain gas under some preferred degree of reduced pressure. Within the casing 30, supported by insulating spacers 31 and 32, are arranged an indirectly heated cathode 33, one or more grid structures as indicated by grid 34, and an anode 35. Within the cathode 33 is placed the heater element shown in Fig. 4 and described above. Connection tab 16 or 16' and the lower end of the mandrel wire 10 are connected to chosen ones of lead-in wires 36 whereby current may be supplied to the heater.

It will be seen that a heater element as constructed according to my invention may be conveniently placed in a small circular cross-section heater sleeve, and may be arranged to substantially fill the space within the heater sleeve, thus assuring intimate contact with the sleeve over its entire length, whereby an efficient heat transfer from the heater to the cathode sleeve is attained.

While I have shown and particularly described several embodiments of the present invention, it will be clearly understood that the present invention is not limited thereto, but that modifications within the scope of the invention may be made.

What is claimed is:

1. The process of manufacturing small high voltage heaters which comprises coating a length of mandrel wire with a refractory material, removing said refractory material from spaced points along the length of said wire, helically winding heater wire on said refractory material and in contact with said mandrel wire at said spaced points, conductively connecting connection tabs to said heater wire in spaced pairs intermediate the bared portions of said mandrel wire, cutting said wound coated mandrel between each of said pairs of connection tabs and at each of said bared portions to provide a number of separate heater units, removing said heater wire winding and refractory material between each of said connection tabs and the most closely adjacent cut, and coating each of said heater units with a final coating of refractory material.

2. The process of manufacturing small high voltage heaters which comprises coating a mandrel wire with a refractory material, removing said refractory material from said mandrel wire at spaced points along the length of said wire, the spacing between said points being slightly greater than the desired final length of said heat-

ers, helically winding heater wire on said refractory material and in contact with said mandrel wire at said spaced points, cutting said mandrel apart at each of said spaced bare points, unwinding from said mandrel a portion of heater wire adjacent one of said cutting points to provide space for making a connection to said mandrel and coating each of said heater units with a refractory material.

3. The process of manufacturing small high voltage heaters which comprises coating a length of mandrel wire with a refractory material, removing said refractory material from spaced points along the length of said wire, applying a continuous spaced helical winding of heater wire on said refractory material and in conductive contact with said mandrel wire at said spaced points, conductively connecting connection tabs to said heater wire at spaced points along said winding, cutting said wound coated mandrel to provide a number of individual heater elements each having one connection tab and one bared portion of mandrel wire with heater wire wound upon it, removing said heater wire winding at the end of each heater element adjacent said tab and coating each of said heater units with a final coating of refractory material.

4. A small high voltage heater including a central conductive mandrel wire, a refractory coating over the major portion of said mandrel wire, a helical winding of resistance wire over said refractory coating, and over one end of said mandrel wire in contacting relationship therewith, a connection tab conductively connected to said resistance wire at one end of said winding, and an outer coating of refractory material over said heater wire leaving said connection tab and one end of said mandrel wire bare.

5. An electron tube including an indirectly heated cathode, said indirectly heated cathode comprising a hollow metallic sleeve, having electron emissive material on its exterior surface, and a heater element within said sleeve, said heater element including a central conductive mandrel wire, said mandrel wire extending beyond said coating, a refractory coating over said mandrel wire, a helical winding of resistance wire over said refractory coating and over one end of said mandrel wire, a connection tab welded to said resistance wire at one end of said winding, the connection between the other end of said winding and said mandrel wire being constituted by the resistance wire being wound in direct contact with said mandrel, and an outer coating of refractory material over said resistance wire.

6. An electron discharge tube including indirectly heated cathode, a number of grids and an anode, said indirectly heated cathode including a hollow, metallic sleeve, having electron emissive material on its exterior surface, and a heater element within said sleeve, said heater element including a central conductive mandrel wire, a refractory coating over said mandrel wire, said mandrel extending beyond the ends of said refractory coating, a continuous helical winding of resistance wire over said refractory coating and over one end of said mandrel in conductive contact therewith, lead-in conductors of said tube being connected to the other end of said mandrel wire and the adjacent end of said resistance wire.

7. A small, high voltage heater including a central conductive mandrel wire, a refractory coating over the major portion of said mandrel wire, said mandrel wire extending beyond the ends of said refractory coating, a continuous helical winding of resistance wire over said refractory coating and over one end of said mandrel wire, the other end of said mandrel wire in direct contact therewith and the end of said resistance wire adjacent said other end being adapted for connection to a source of electrical power.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,459,412	Nicolson	June 19, 1923
1,678,145	Kelly	July 24, 1928
1,881,644	Jones	Oct. 11, 1932
1,991,197	Denzler	Feb. 12, 1935
2,014,787	Smithells et al.	Sept. 17, 1935
2,112,969	Mavrogenis	April 5, 1938
2,247,869	Beers	July 1, 1941

FOREIGN PATENTS

Number	Country	Date
401,638	Great Britain	Feb. 8, 1932