March 18, 1952 W. WHEELER ET AL 2,589,521

HEATER

Filed Sept. 15, 1948

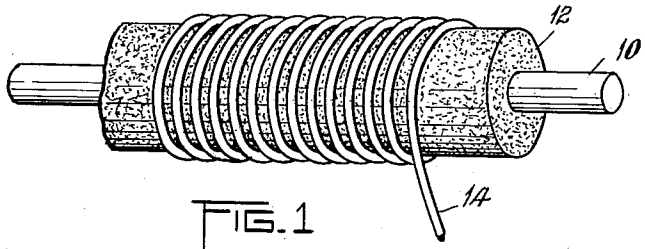


FIG. 1

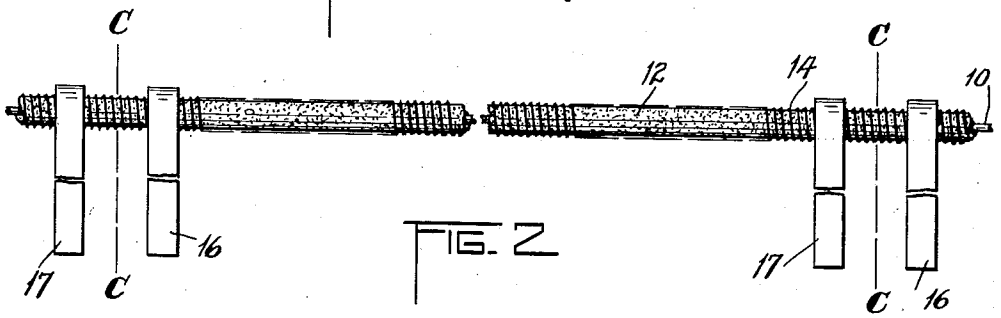


FIG. 2

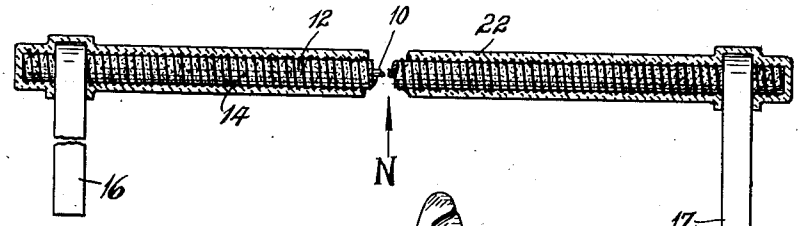


FIG. 3

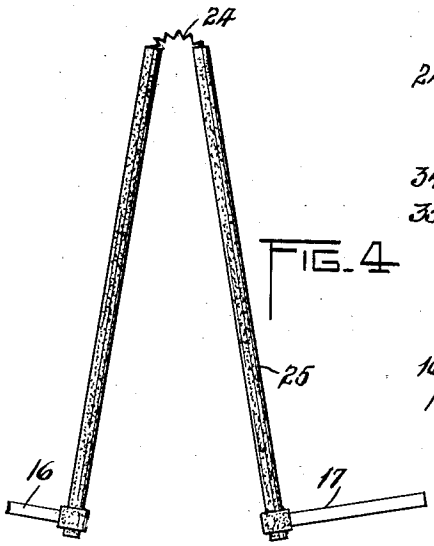


FIG. 4

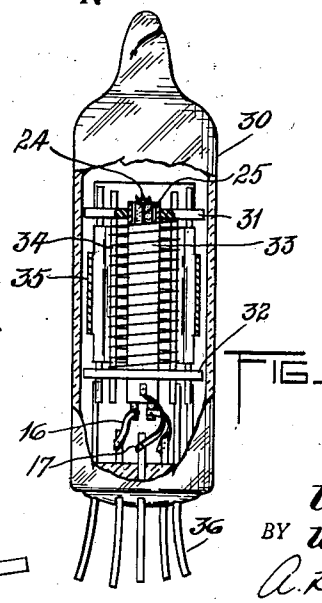


FIG. 5

INVENTOR.
William Wheeler
BY Warner Wicke
A. L. B. Richardson
Attorney

Patented Mar. 18, 1952 2,589,521

UNITED STATES PATENT OFFICE

2,589,521

HEATER

William Wheeler, St. Albans, and Warner C. Wicke, Amsterdam, N. Y., assignors to Sylvania Electric Products, Inc., a corporation of Massachusetts

Application September 15, 1948, Serial No. 49,448

9 Claims. (Cl. 313—337)

1

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 adapted to be used with high input 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 further will present a less strain on the heater power supply.

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

The foregoing object, and others which may appear from the following detailed description, are obtained in one example of the present invention by coating a mandrel wire with a refractory material. The outside surface of the coating is used as a mandrel, on which is helically wound light tungsten resistance wire at the desired number of turns per inch. Connection tabs of a special alloy are then welded in place in a paired relationship at spaced intervals along the length of the wire. The long wound mandrel is then severed between each of the pairs of tabs, thus forming a number of separate heater units, each with a connection tab near each end. Each separate heater is again coated with a refractory material. Before the heater is inserted into a cathode sleeve, the heater element is nicked or scored with a sharp blade at a point half way between the connection tabs and broken at that point. The refractory material and the central mandrel wire break more or less sharply, leaving a short coiled portion of the heater wire connecting the two sections of the heater. Since the heater wire is rigidly supported over substantially its entire length, a much more rugged form of construction than that known to the prior art is obtained by this means. A high voltage heater is obtained for use in extremely small size directly 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

2

Fig. 1 illustrates in a 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 is a partial sectional view of a typical heater element constructed according to the principles of the present invention,

Fig. 4 shows the heater element as it is prepared for insertion into a cathode sleeve, 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 the mandrel wire cataphoretically with aluminum oxide which is then sintered to produce a smooth, hard surface. The outside diameter of the insulating coating 12 may have a diameter of the order of ten thousandths of an inch. The mandrel thus produced is wound at the desired number of turns per inch with a light tungsten resistance wire 14. In one specific arrangement tested, wire 14, having a diameter of nine ten-thousandths of an inch, was wound on a ten thousandths inch support at a winding pitch per inch of the order of between 600 and 700. With these dimensions, a heater element having a length of the order of 28 mm. drew about one watt when connected to a 26 volt supply. The resistance wire 14, having been wound in place, connection tabs 16 and 17 are welded in place in a paired relationship as shown in Fig. 2. Each pair of connection tabs is spaced apart a distance slightly greater than twice the length of the cathode sleeve with which it is designed to be used. We have found that a platinum tungsten alloy serves as a satisfactory material for the connection tabs 16 and 17, permitting an efficient weld to the heater wire 14 and to the later applied connecting wires.

The connection tabs, in addition to serving as a means of making electrical connection to the resistance wire 14, also serve to hold the helical winding securely in place without breaking or cracking the refractory coating 12. Individual heaters, each having one terminal tab 16, and one terminal tab 17 are produced by cutting through at the points indicated by the dotted lines C, C.

The individual elements are again cataphoretically coated with a refractory material such as aluminum oxide, and sintered to produce a smooth, hard final coat. They may, for example, be fired in a hydrogen furnace at 1600° C. for one-half minute to one minute. The resultant heater element is shown in partial section in Fig. 3, wherein reference numeral 22 indicates in section the second coat of refractory material.

Before the heater is inserted into a cathode sleeve, for use in a conventional electron discharge tube, the heater is nicked lightly with a knife blade or similar instrument at a point intermediate the tabs 16 and 17, as indicated by the arrow labeled N. The heater is next bent sharply at the point of nicking N. The nicking process causes a sharp clean break of the coatings of refractory material, and of the central mandrel wire without damaging the coiled heater wire contained between the two successive coatings of refractory material. The heater element then appears as shown in Fig. 4, and is indicated generally by reference character 25. The only even slightly fragile part of the completed heater, is the small bare coil 24 of uncoated heated wire resulting from the nicking, breaking process. However, this is not subject to strain once the completed heater has been inserted in the cathode sleeve.

In Fig. 5 we have shown an electron discharge tube having a hermetically sealed casing 30, which may be evacuated or contain gas under some preferred degree of reduced pressure. Within the casing, supported by spacers 31 and 32, are arranged an indirectly heated cathode 33, one or more grid structures indicated by grid 34, and an anode 35.

Within cathode 33 is placed the heater element 25 described above, connection tabs 16 and 17 being connected to chosen ones of the lead in wires 36, whereby current may be supplied to said heater. While it is preferred to use a cathode which is oval or oblong in cross-section, in order to obtain more efficient heat transfer between the heater element and the cathode sleeve, other forms, such as circular, may be used if desired.

While we have shown and particularly described a preferred embodiment 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; thus, for example, the connection tabs per se may be omitted, and connections made directly to the ends of the heater wire, or the heater wire may be unwound to extend away from the heater itself to form connections.

What is claimed is:

1. The process of manufacturing small high voltage heaters which comprises coating a mandrel wire with a refractory material, helically winding on said refractory material a desired length of heater wire, conductively connecting connection tabs to said heater wire in spaced pairs, cutting said wound, coated mandrel between each of said pairs of connection tabs to provide a number of separate heater units, coating each of said heater units with a refractory material, and nicking and breaking the mandrel and refractory coatings only at a point substantially midway between the ends of each of the heater units.

2. The process of manufacturing small high voltage heaters which comprises coating a mandrel wire with a refractory material, winding resistance wire on said refractory material, conductively connecting connection tabs to said heater wire in spaced pairs, cutting said wound, coated mandrel between each of said pairs of connection tabs to provide a number of separate heater units, coating each of said heater units with a refractory material, and nicking and breaking the mandrel and refractory coatings only at a point substantially midway between the ends of each of the heater units.

3. A small high voltage heater including a central conductive mandrel wire, a refractory coating over said mandrel wire, a helical winding of heater wire over said refractory coating, connection tabs encircling said winding and welded to said heater wire at each end of said winding, and an outer coating of refractory material over said heater wire, leaving said connection tabs bare at their ends.

4. A small high voltage heater including a central conductive mandrel wire, a refractory coating over said mandrel wire, a helical winding of heater wire over said refractory coating, connection tabs encircling said winding and welded to said heater wire at each end of said winding, and an outer coating of refractory material over said heater wire, leaving said connection tabs bare at their ends, said heater being nicked at a point midway between its ends, and doubled back on itself, said refractory coatings and central mandrel being broken without breaking said heater wire.

5. A small high voltage heater including a central conductive mandrel wire, a refractory coating over said mandrel wire, a helical winding of resistance wire over said refractory coating, connection tabs welded to said resistance wire near each end of said winding, and an outer coating of refractory material over said resistance wire, leaving said connection tabs bare at their ends, said heater being nicked and doubled back on itself at a point intermediate its ends, and said refractory coatings and central mandrel being broken without breaking said resistance wire.

6. An electron discharge tube including a cathode comprising a hollow metallic sleeve and a small high voltage heater within said sleeve, said heater including a central conductive mandrel wire, a refractory coating over said mandrel wire rod, a helical winding of heater wire over said refractory coating, connection tabs welded to said heater wire at each end of said winding, and an outer coating of refractory material over said heater wire, leaving said connection tabs bare at their ends, said heater being doubled back on itself at a point intermediate its end.

7. An electron discharge tube including a cathode comprising a hollow metallic sleeve and a small high voltage heater within said sleeve, said heater including a central conductive mandrel wire, a refractory coating over said mandrel wire rod, a helical winding of heater wire over said refractory coating, connection tabs welded to said heater wire at each end of said winding, and an outer coating of refractory material over said heater wire, leaving said connection tabs bare at their ends, said heater being nicked at a point midway between its ends, and said refractory coatings and central mandrel being broken without breaking said heater wire, whereby said heater may be arranged within said sleeve in the form of two parallel rod-like portions, both of said connection tabs extending at one end of said sleeve.

8. An electron discharge device including a cathode structure having a metallic sleeve and a multiple leg heater within said sleeve, each leg of said heater including a central conductive mandrel wire, a refractory coating over said mandrel wire rod, a helical winding of heater wire over said refractory coating, connection tabs welded to said heater wire near each extreme end of said heater, and an outer coating of refractory material over each leg of said heater over said heater wire, leaving said connection tabs bare at their ends.

9. An electron discharge device including a cathode structure having a metallic sleeve and a small high voltage heater within said sleeve, and including a central conductive mandrel wire, a refractory coating over said mandrel wire rod, a helical winding of heater wire over said refractory coating, connection tabs welded to said heater wire near each end of said winding, and an outer coating of refractory material over said heater wire, leaving said connection tabs bare at their ends, said heater being nicked at a point midway between its ends, and doubled back on itself at said point, said refractory coatings and central mandrel being broken without breaking said heater wire, whereby the two halves of said heater may lie parallel to one another within said sleeve.

WILLIAM WHEELER.
WARNER C. WICKE.

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
1,638,499	Mavrogenis	Aug. 9, 1927
1,678,145	Kelly	July 24, 1928
1,791,140	McCullough	Feb. 3, 1931
1,932,077	Kimmell	Oct. 24, 1933
2,014,787	Smithells et al.	Sept. 17, 1935
2,041,286	Eber et al.	May 19, 1936
2,094,657	Kapteyn	Oct. 5, 1937
2,247,869	Beers	July 1, 1941
2,269,081	Felsner	Jan. 6, 1942
2,286,478	Farnsworth	June 16, 1942
2,477,601	Hanson	Aug. 2, 1949
2,479,192	Zabel	Aug. 16, 1949
2,482,826	Bender et al.	Sept. 27, 1949