Feb. 15, 1944. A. G. FOOTE 2,342,044

ELECTRIC RADIANT ENERGY DEVICE

Filed July 24, 1942

Fig. 1.

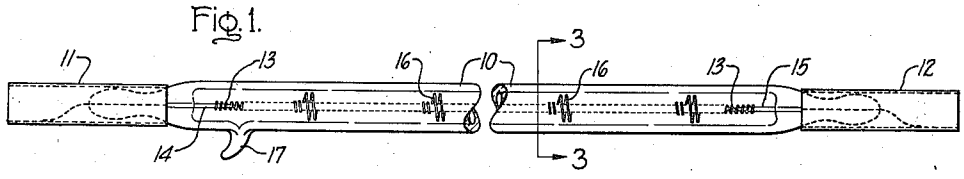


Fig. 2.

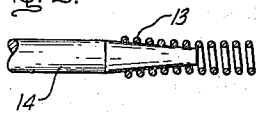
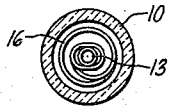


Fig. 3.



Inventor:
Alton G. Foote,
by John H. Anderson
His Attorney.

Patented Feb. 15, 1944

2,342,044

UNITED STATES PATENT OFFICE

2,342,044

ELECTRIC RADIANT ENERGY DEVICE

Alton G. Foote, Wickliffe, Ohio, assignor to General Electric Company, a corporation of New York

Application July 24, 1942, Serial No. 452,234

1 Claim. (Cl. 176—39)

My invention relates to electric devices capable of transforming electric energy into radiant energy, such as electric lamps and similar devices, and comprising a sealed envelope enclosing an electric energy translation element, such as a filament.

The principal object of my invention is to provide such a device of simple, compact, rugged structure which may be easily and economically manufactured and assembled and which may be used as a source of radiant heat, visible light, or as an immersion heater for liquids. Another object of my invention is to provide a method for mounting a coiled filament in such devices.

Another object of my invention is to provide a compact, firm, physical and electrical connection between a filament and a current inlead wire useful in such a device. A further object of my invention is to provide readily attachable, flexible supports for an elongated filament mounted in an elongated, tubular envelope. Further objects and advantages of my invention will appear from the following detailed description and the accompanying drawing, in which Fig. 1 is a side elevational view of a species of device embodying my invention; Fig. 2 is a side elevational, partly sectional view of a connected inlead and filament; and Fig. 3 is a sectional view along the line 3—3 of Fig. 1 showing the filament and one of the supports therefor in detail.

Referring to Fig. 1 of the drawing, the device illustrated is eminently satisfactory for use as a radiant heater and comprises an elongated tubular envelope 10 of vitreous material, such as quartz, having bases 11 and 12 of electrically conducting material, such as brass, secured thereto. A coiled filament 13, such as a tungsten filament, is mounted in said envelope 10 and is electrically connected to the bases 11 and 12 by the inlead wires 14 and 15, respectively, which are preferably of tungsten and which pass through the ends of the envelope 10. The gas-tight joints between said envelope 10 and said inleads 14 and 15 may be of the kind disclosed in the U. S. Patent 2,177,685, issued October 31, 1939.

The filament 13 is helically coiled and is provided with a multiplicity of flexible spiral wire supports 16 which are spaced along and secured to said filament 13.

The filament 13 and the inlead wires 14 and 15 are physically and electrically connected by a frictional joint. The inner end portions of the inleads 14 and 15 are tapered as shown in Fig. 2. The largest diameter of the tapered ends of the inleads 14 and 15 is larger than the inner diameter of the coiled filament 13, while the smallest diameter thereof is slightly smaller than the inner diameter of said filament 13. The tapered ends of the inleads 14 and 15 are inserted a sufficient distance into the ends of the filament 13 to cause the coils of the filament to expand. Tension is exerted on the filament 13 and the leads 14 and 15 when these are mounted in envelope 10. The filament 13 then tends to decrease in diameter and thus firmly grips the tapered ends of the inleads 14 and 15. Of course, when electrical energy is passed through the filament 13, its temperature increases and it expands. Since the inleads 14 and 15 are stationary in the envelope 10, such expansion would normally cause the filament to deviate from a straight line in the envelope 10 and its connections with the inleads 14 and 15 to loosen. This is avoided in accordance with my invention by placing the filament under sufficient tension to compensate for its thermal expansion when it is heated. This not only keeps the axis of the filament straight and aligned with that of the envelope 10 but also insures a good, firm physical and electrical connection between the tapered ends of the inleads 14 and 15 and the filament 13 at all times.

The small, compact connection described above is of particular utility in devices of the type providing limited space for accommodating the connection, such as that shown in Fig. 1 of the drawing. The inlead wire and the filament being in the same straight line occupy a space equal to the diameter of these elements at the overlapping portions thereof.

When the filament 13 consists of tungsten wire of the kind which is changed from a ductile to a non-ductile or non-sag condition by heating, the manufacture of the device is as follows: The filament is helically coiled by winding it on a mandrel. The mandrel is then removed and the coiled filament cleaned in the usual manner. The spiral supports 16, which have been formed by winding a similar wire about a step mandrel, are then placed in spaced relation on the coiled filament and are held in place thereon by squeezing the small turns to make them elliptical to grip the filament. The supports 16 comprise one or more turns having an outer diameter slightly smaller than that of the bore of the envelope 10. The assembled filament and supports are then placed on a mandrel, preferably of tungsten, in an inert atmosphere, such as hydrogen, and heated to a temperature high enough to change the tungsten wire from a ductile to a non-ductile condition. The treating mandrel is then removed.

The heat-treated non-ductile tungsten filament and supports are then ready for mounting in the envelope 10. This may be accomplished by first inserting the inleads, which have been provided with a bead of sealing glass, into the ends of the coiled filament as described above and then passing one end of the filament together with the inlead secured thereto through the bore of the envelope 10. The glass bead on the inlead passing through the envelope is, of course, smaller in diameter than the bore of the envelope 10. The usual steps of sealing inlead wires into envelopes of quartz or hard glass are then performed, that is, a reducing or non-oxidizing gas is flowed through the envelope, the glass beads and the ends of the quartz are heated and then fused together to form a gas-tight joint therebetween. In order to place the filament 13 under sufficient tension to keep it taut and straight in the envelope 10 even when hot, I prefer to first apply sufficient tension thereto during fabrication of the device, when the filament is cold, to keep the axis thereof straight and then to further separate the inleads 14 and 15 before making the fused joints at the ends of the envelope 10. The spirals 16 afford yielding support to the filament 13 to minimize the effect of physical shocks. The bases 11 and 12 are secured to the envelope 10 by filling the space therebetween with lead after the inleads 14 and 15 have been electrically connected thereto by nickel wires welded to said bases and said inleads. After the seals at the ends of the envelope have been made, the envelope is exhausted in the usual manner through a side tube and filled with inert gas, such as argon, at approximately 700 mm. pressure. The side tube is then sealed to leave the tip 17.

Instead of passing one of the glass beaded inleads through the envelope 10 during manufacture of the device, the filament 13 may be secured to one of the inleads and the free end of the filament passed through and pulled beyond the open end of the envelope. The other inlead is inserted in the end of the filament outside the envelope 10 and then moved into the envelope until the glass bead is juxtaposed to the open end of the envelope. The device is then completed as described above.

In devices having the above described structure made by me, the filament consisted of tungsten wire having a diameter of .00598 inch wound on a mandrel having a diameter of .025 inch at 130 turns per inch. The spiral supports 16 consisted of tungsten wire having a diameter of .007 inch wound on a step mandrel and had two small turns, the inside diameters of which were .037 to .038 inch and 1½ large turns having an outside diameter of .140 to .150 inch. The filament and the supports 16 when assembled were placed on a tungsten mandrel in a hydrogen atmosphere and heated to approximately 2800° C. to change the structure of the tungsten from a ductile to a non-ductile or non-sag condition. The quartz tube 10 had an outer diameter of .235 to .275 inch and a wall thickness of .03 to .045 inch. The inleads 14 and 15 consisted of tungsten and had a diameter of .028 inch to .03 inch. The inleads were tapered for approximately ¼ of an inch so that the end diameter was about .023 to .025 inch.

Electric devices having the above described structure are mechanically rugged, have a low heat capacity, are easily constructed to successfully operate on different voltages, and may be adapted either by shaping the envelope or by utilizing simple types of reflectors to obtain a wide variety of radiant energy distribution patterns useful in the paint drying field or as room heaters, for example.

What I claim as new and desire to secure by Letters Patent of the United States is:

A device capable of transforming electric energy into radiant energy comprising a vitreous envelope having a filament and current leading-in wires sealed therein, said filament having coiled end portions and said wires having tapered ends engageable with and extending into the end portions of said filament, the inner diameter of said filament end portions being smaller than the maximum diameter of the tapered ends of said wires, said wires being so spaced in said envelope that said filament is under physical tension at all times to firmly grip the tapered ends of said wires.

ALTON G. FOOTE.