Dec. 24, 1940. E. C. EWING, JR 2,226,281

VACUUM TUBE FILAMENT

Filed Dec. 9, 1939

Fig. 1.

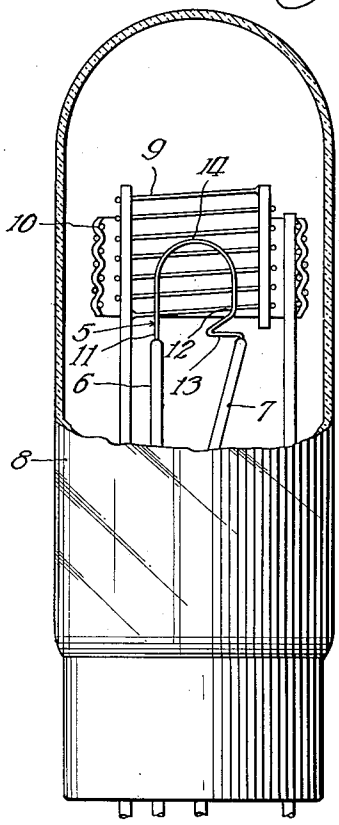


Fig. 4

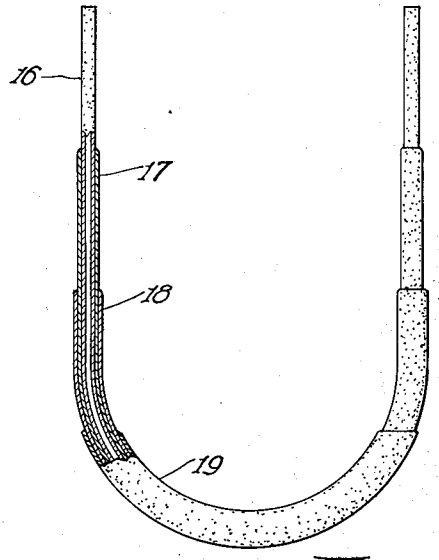


Fig. 5.

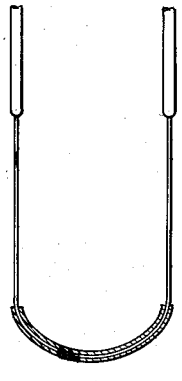


Fig. 2

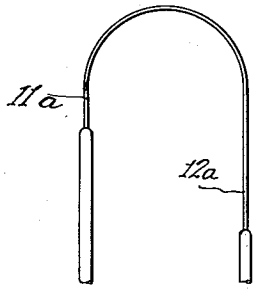
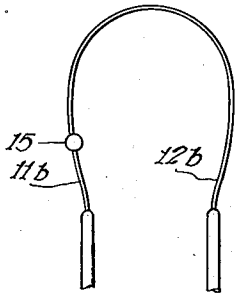


Fig. 3.



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VACUUM TUBE FILAMENT

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Application December 9, 1939, Serial No. 308,415

7 Claims. (Cl. 250—27.5)

The present invention relates to filament emitters for vacuum tubes. The principal purpose of the invention is to improve the life, emission, and microphonic characteristics of the filament by certain modifications in the structure and coating thereof.

One particular purpose of the invention is to provide a novel coating of the filament whereby emitter coatings such as are commercially used are applied to the filament to a greater degree toward the points of greatest heat in the filament. I find that in this fashion I am able to get improved emitter life by cooling what otherwise would be an overheated section of emitter. This improvement is of particular advantage where the filament used is operated with extremely low voltages, such as those around three-fourths of a volt. In such devices, a short filament is necessary because of the low voltage. Furthermore, the leads to the filament are necessarily large in comparison with the filament, and thus heat conduction from the ends of the filament maintains a sharp gradient in the temperature of the filament between the mid-portion and the ends thereof. With the present invention, advantage is taken of the higher radiating capacity at the mid-point of the filament so as to get improved emission without destroying the life of the emitter material coated on the filament.

The present invention contemplates also a further improvement in the filament structure whereby noise characteristics of the filament are lessened or eliminated. This improvement comprises varying the period of vibration in one leg with respect to the other leg of a U-shaped filament supported by its ends.

I have found that an extremely short filament supported entirely by its ends without tension does avoid vibration noises to a great degree. The present invention enables me to further overcome objectionable vibration which is noticeable when a comparatively heavy mass of emitter is applied to the filament at a remote point from its fastenings. The elimination of vibration noises is of vital importance in extremely small tubes for low voltages, such tubes being used in hearing aids and similar classes of service. Extremely fine filaments are prone to microphonic vibration.

The features and advantages of the present invention will appear more fully as the description proceeds, reference being had to the accompanying drawing wherein a preferred form of the invention is shown. It is to be understood, however, that the drawing and description are illustrative only, and are not to be taken as limiting the invention except insofar as it is limited by the claims.

In the drawing,

Fig. 1 is a view partly in side elevation and partly in section of a three electrode vacuum tube, showing a filament embodying the present invention;

Fig. 2 and Fig. 3 are fragmentary views illustrating filament of a modified construction;

Fig. 4 is a sectional view illustrating the filament coating, and

Fig. 5 shows another type of coating which can be applied by continuous processes or otherwise over the entire filament and then removed from the ends thereof.

Referring now to the drawing, the present invention is shown as embodied in a filament 5 which is mounted upon suitable supports 6 and 7 in the glass envelope 8 of a three electrode vacuum tube. The grid of the tube is indicated at 9, and the plate is shown at 10. The tube shown is preferably like that illustrated in my prior application Serial No. 233,041, filed October 3, 1938. The filament construction, while maintaining the loop form shown in the prior application, is modified in certain respects as hereinbefore mentioned. A filament of this character is useful primarily in an extremely small tube with a filament potential of the order of three-fourths of one volt. Hearing aids and similar devices operated by batteries of the 1½ volt dry cell type can heat the filaments of two of these tubes by connecting them in series across one battery.

The present filament is so designed that the period of vibration of one leg 11 is different from that of the other leg 12. In the form shown in Fig. 1, this difference is obtained by providing a bent portion 13 in the leg 12. Natural shocks imparted to the tube will thus tend to vibrate the leg 11 at one rate and to vibrate the leg 12 at a different rate. The result is that the mid-portion 14 of the filament, which is the hottest portion, is deprived of its tendency to set up sustained vibration of a certain frequency.

In Fig. 2 of the drawing, the leg 11*a* is considerably shorter than the leg 12*a*. This results again in giving the leg 11*a* a different natural period of vibration than that of the leg 12*a*.

In Fig. 3, the leg 11*b* is given a different period of vibration from that of the leg 12*b* by the application of a small mass 15 thereto. There are several ways of obtaining different periods of vibration in the two legs of the filament. The

present invention contemplates all such modifications as would occur to those skilled in the art.

Referring now to Fig. 4, there is shown the application of emissive coatings 16, 17, 18 and 19 to a filament wire. The coating is applied in the following fashion: First, the entire filament 5 is given a first coating 16 of a suitable emitter material, for example, a barium or strontium carbonate. This can be done by dipping the wire in a bath of the emitter and a suitable carrier. The first coating may be terminated short of the ends of the filament, if desired. The second coating 17 is then applied in the same manner but it is not applied to the full length of the filament loop. A portion of each end is kept out of the solution. The third coating 18 is applied in the same fashion but this also is stepped down from the ends of the loop, and the final coating 19 is applied just on the bent or mid-portion of the loop. The coatings may be of different emitter materials. For example, the outer coating may be of a material having higher emission for a given temperature than the inner coatings. The inner coating may be applied merely to the mid-portion of the loop, and subsequent coating extended farther toward the ends to thus build up a coating thicker at the mid-point and tapering toward the ends. The showing in Fig. 4 is, of course, considerably exaggerated as to the thickness of the coatings. It will be evident, however, that in this fashion it is possible to increase the thickness of the emitter material from the ends of the filament loop toward the center thereof. When the loop is mounted with the ends in the supports 6 and 7, the mid-portion of the loop will be subjected to the least amount of cooling by end conduction and it will be the greatest source of emission.

The coating material is a relatively poor thermal conductor. Therefore, it requires an appreciably increased amount at the mid-point in order that the entire emitting section shall be of uniform temperature. Otherwise, the excessive heat generated at the mid-point of these short filaments, if not adequately radiated, would prematurely destroy the activity of the emitter. It is apparent that the coating material reduces the temperature of the wire below the temperature of an uncoated wire under the same surrounding conditions. By increasing the thickness and amount of emitter at the mid-point of the filaments, a normal emission life is had.

In the modified form of Fig. 5, the end portions of the filament may have the emitter coating partially or completely removed. It is better to graduate the coating as shown in the preferred form, but this modification does obtain the result of giving that portion of the filament which provides the major part of the emission a higher operating temperature without raising the voltage or changing the filament length, than would be obtained from a filament with a like coating throughout its length.

From the foregoing description it is believed that the construction and advantages of the present invention will be readily apparent to those skilled in this art. Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a thermionic vacuum tube, a filament comprising a generally U-shaped wire loop the ends of which are conductively connected to supporting leads, said filament having an emissive coating thereon the amount of which increases toward the mid-point of the loop.

2. In a thermionic vacuum tube adapted to operate on a filament voltage of about three-fourths volt or less, an inverted U-shaped filament supported entirely by its ends, said filament having an emissive coating which is thickest at the mid-point of the filament and diminishes toward the ends thereof.

3. In a thermionic vacuum tube adapted to operate on a filament voltage of about three-fourths volt or less, an inverted U-shaped filament supported entirely by its ends, said filament having a different natural period of vibration in one leg thereof than the natural period of vibration of the other leg, said filament having an emissive coating which is thickest at the mid-point of the filament and diminishes toward the ends thereof.

4. In a thermionic vacuum tube adapted to operate on a filament voltage of about three-fourths volt, a filament supported entirely by its ends, said filament having an emissive coating thereon which increases in thickness from the ends of the filament toward the center thereof.

5. In a thermionic vacuum tube, a filament emitter, supports for said emitter at the opposite ends thereof, said emitter having a high emissive coating at the central portion thereof, said coating being reduced in thickness adjacent to the ends of the filament.

6. In a thermionic vacuum tube, an inverted U-shaped filament supported entirely by its ends in the form of a readily yielding loop, said filament having one leg thereof bent to provide a substantially V-shaped portion therein.

7. In a thermionic vacuum tube, an inverted U-shaped filament supported entirely by its ends in the form of a readily yielding loop, one leg of said filament being substantially longer than the other.

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