

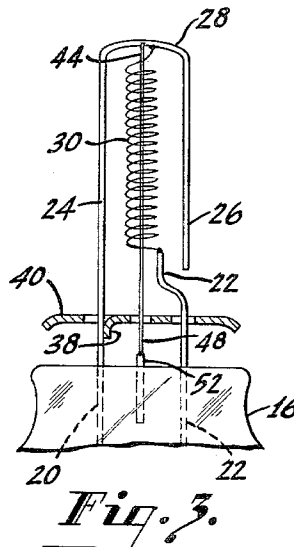
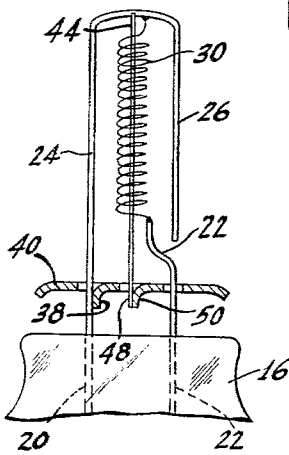
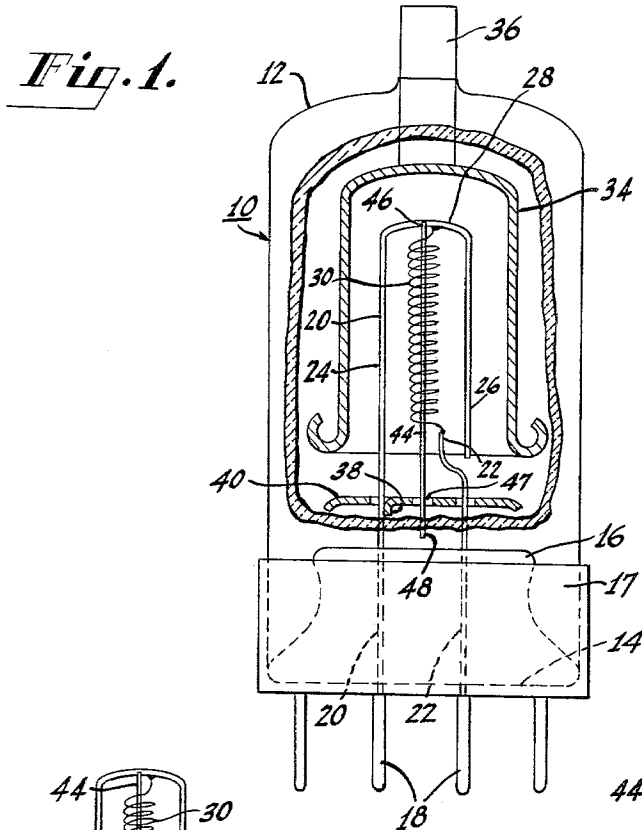
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HIGH VOLTAGE ELECTRON DISCHARGE TUBE

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HIGH VOLTAGE ELECTRON DISCHARGE TUBE
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This invention relates to electron discharge tubes and particularly to high voltage diode-type tubes.

Certain high voltage diode tubes, such as the commercially available type known as the 1K3, comprise a coiled filamentary cathode mounted between a pair of supports and a tubular anode surrounding the filament in coaxial relation therewith. In the application of such tubes an A.C. (alternating current) voltage of the order of 20,000 volts may be applied to the anode.

A problem encountered with this type of tube is that the high A.C. potential between the coiled filament and the surrounding tubular anode creates large radial electrostatic forces tending to alternately attract and repel the filament with respect to the anode. If the filament were perfectly coaxial with respect to the tubular anode, the various radial forces on the filament would be symmetrical and would cancel one another. Due to manufacturing variations, however, it often occurs that the filament is not perfectly coaxial with respect to the anode and non-symmetrical electrostatic forces are applied to the filament. The effect of the alternating electrostatic fields acting on the filament is that the filament vibrates at the frequency of the A.C. voltage applied to the anode. Failure of such electron tubes often results due to flaking of the electron emission coating from the vibrating filament. Further, since the electrostatic forces on the filament are increased as the filament is moved further off-center and closer to the anode, the amplitude of vibration of the filament tends to become greater and greater. In some cases the filament may be pulled off-center to the extent that the filament contacts and shorts with the anode thereby causing the filament to be burned out.

Various means have been devised for shielding the filament from the anode for the purpose of reducing the electrostatic forces acting on the filament. Such shielding, however, is relatively expensive and is further undesirable since it tends to reduce to an undesirable extent the electron emission from the cathode.

Other means have been provided which engage the filament for the purpose of restraining excessive movement of the filament and for damping the vibration of the filament produced by the electrostatic forces. Such means have generally added undesirable cost to the tubes, and are further undesirable because the engagement of these restraining means with the filament causes heat loss by conduction from the filament to the restraining means and a corresponding loss of thermal efficiency of the electron tube.

It is an object of this invention, therefore, to provide a new and novel high voltage electron tube of the type described, including means for damping and preventing excessive vibration of the electron tube filament, said means adding little cost to the tube and having little effect on the efficiency of the tube. This and further objects of the invention will become more fully apparent from the reading of the description which follows.

For achieving the objects of the invention, in an electron tube wherein a coiled filament is suspended between a pair of filament supports, and a tubular anode is disposed in coaxial surrounding relation with the filament, there is secured to one of the filament supports, and extending coaxially through the filament, an insulated rod. The rod is smaller in diameter than the inside diameter of the filament coil and is substantially out of contact

with the surrounding filament. During operation of the tube, the central rod dampens the vibrations of the filament by contact therewith and thereby prevents build-up of the amplitude of vibration of the filament. This, in turn, avoids flaking of the emissive coating from the filament and prevents pull-out and shorting of the filament against the anode.

Advantages of the invention are its simplicity and inexpensiveness, its effectiveness in solving the problems described, and its minor effect on the tube efficiency.

In the drawing:

FIG. 1 is a side elevation partially in section of an electron tube which may be made according to this invention;

FIGS. 2 and 3 show modifications of a portion of the tube shown in FIG. 1.

An electron tube 10 (FIG. 1) comprises a glass envelope 12 closed at one end by a stem 14 having an inwardly extending glass press 16. Surrounding the stem end of the tube is a base 17 having socketing terminal pins 18. Extending through stem 14 and press 16 and sealed vacuum tight therewith are a pair of leads 20 and 22. The outer ends of leads 20 and 22 are received within and soldered to the socketing pins 18, and the inner ends of the leads extend into the glass envelope 12. Within the glass envelope 12 lead 20 is formed into an inverted U and lead 22 is bent to extend upwardly between the legs 24 and 26 of the U and spaced therefrom. Suspended between the connecting portion 28 between the legs of the U and the upper end of lead 22 is a coiled filamentary cathode 30. The cathode may be made from tungsten wire coated with any suitable electron emitting material and is welded to the support leads 20 and 22. The downwardly extending legs 24 and 26 of lead 20 are provided to reduce, to some extent, the magnitude of the electrostatic field at the filament 30.

Surrounding cathode 30 is a tubular anode 34 having a tubular conductive support lead 36 secured to the top end of the anode. The support lead 36 is sealed vacuum tight through the top end of the glass envelope 12 and thus provides support as well as an electrical terminal for anode 34.

Welded to lead 20 by means of a downwardly extending tab 38 is a circular corona shield 40. Shield 40 is disposed between anode 34 and stem 14 for shielding the stem from the electrostatic field created by the anode.

For preventing the build-up of high amplitude vibration of the filament coil 30, a central rod 44 is disposed through the filament coil. For ease of mounting, and for reasons of cost, rod 44 is preferably of a refractory metal, such as tungsten, coated with a suitable insulating material such as aluminum oxide. The insulating coating or exterior of the rod 44 prevents shorting of the turns of the filament coil 30 through the rod. The top end 46 of rod 44 may be conveniently welded to support lead 20 adjacent the point where the top end of filament 30 is welded to the support lead.

Rod 44 is preferably relatively stiff and self-supporting and has a smaller diameter than the inside diameter of filament coil 30. In one embodiment, for example, rod 44 is made from 4 mil tungsten wire coated with aluminum oxide to a diameter of 8 mils, and the inside diameter of the filament coil 30 is 16 mils. The rod 44 extends substantially coaxially through the filament coil 30 and substantially out of contact therewith, through an opening 47 in corona shield 40, and terminates freely at the rod's lower end 48 in the region between shield 40 and stem 14. Opening 47 may be substantially greater in size than the diameter of rod 44 to facilitate threading of the rod therethrough.

Generally, it is not necessary to fasten the lower end 48 of rod 44 to any support means. Rod 44 is relatively

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stiff, and once welded in place tends to remain in position. Further, the wall of opening 47 aids in the original positioning of the rod 44 because the operator in making the tube initially threads the rod 44 into the opening 47. The wall of opening 47 protects against any possible shorting of the rod lower end 48 with filament lead 22.

In some instances it may be desired to secure both ends of rod 44. One arrangement for securing the lower end 48 of rod 44 is shown in FIG. 2 wherein the lower end 48 of rod 44 is welded to a downwardly extending tab 50 of corona shield 40. In another arrangement (FIG. 3) the lower end 48 of rod 44 is secured to a stud 52 mounted on and extending outwardly of press 16. If rod 44 is made from an aluminum oxide coated tungsten wire, it is not possible to secure the lower end 48 of rod 44 to the filament support lead 22 as this would short out the filament 30. However, by providing support rod 44 with an intermediate ceramic or other insulating portion, or the like, lower end 48 thereof may be secured to lead 22.

As mentioned, the diameter of rod 44 is smaller than the inside diameter of filament coil 30, and the central rod 44 is disposed so as to be substantially coaxial with the filament 30. In this arrangement there is substantially no engagement of the central rod 44 with the filament 30, hence, little heat transfer by conduction therebetween. During operation of the tube, the central rod 44 operates to prevent excessive vibration of the filament by contacting the inside surface of the filament coil 30 and damping the vibration thereof. It has been found, however, that because of the insulative coating on the center rod 44 and the intermittent contact between the filament 30 and the rod, and the fact that generally only small portions of the vibrating filament will engage the rod, little heat is lost from the filament to the damping rod 44 by conduction. Thus, the efficiency of the tube is not significantly affected by the use of the damping center rod 44.

What is claimed is:

1. An electron discharge tube particularly suitable for use at high voltages comprising a stem, a pair of leads extending through said stem and providing a pair of spaced filament supports within the tube, an elongated coiled filamentary cathode secured to and between said supports, an anode disposed around said cathode, a shield secured to one of said leads and disposed between said anode and said stem, said shield having an opening therethrough, and an insulated damping rod, said rod being secured at one end thereof to one of said supports and extending through said cathode and adjacent to the other of said supports, the other end of said rod extending through said opening in said shield.

2. An electron discharge tube comprising a stem, a pair of leads extending through said stem, said leads being formed to provide a cathode support, an elongated coiled filamentary cathode secured between said formed leads, a tubular anode surrounding and coaxial with said cathode, a shield secured to one of said leads and disposed between

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said anode and said stem, said shield having an opening therethrough, an insulating damping rod extending through said cathode, the upper end of said rod being secured to one of said formed leads, and the lower end of said rod extending through said cathode, adjacent to the other of said formed leads and through said opening in said shield and terminating freely in the region between said stem and said shield, and said rod having a diameter smaller than the inside diameter of said filamentary cathode.

3. An electron discharge tube comprising a stem, a plurality of leads supported by said stem, two of said leads providing upper and lower cathode supports, an elongated coiled filamentary cathode having a longitudinal axis secured to and between said supports, said lower support being spaced from said axis, a tubular anode surrounding and coaxial with said cathode, a plate-like shield secured to one of said leads and disposed between said anode and said stem transversely of said axis, said shield having an opening therethrough and a lip portion adjacent to said opening and extending toward said stem, an insulated damping rod, the upper end of said rod being secured to said upper support, said rod extending coaxially with and through said cathode and through said opening, the lower end of said rod being secured to said lip portion, and said rod having a diameter smaller than the inside diameter of said filamentary cathode.

4. An electron discharge tube comprising a stem, a plurality of leads supported by said stem, two of said leads being formed to provide upper and lower cathode supports, an elongated coiled filamentary cathode having a longitudinal axis secured between said formed leads, said lower support being spaced from said axis, a tubular anode surrounding and coaxial with said cathode, a shield secured to one of said supports and disposed between said anode and said stem, said shield having an opening therethrough in line with said axis, an insulating damping rod extending axially through said cathode, the upper end of said rod being secured to said upper support, and the lower end of said rod extending through said opening in said shield and being secured to another one of said leads in the region between said stem and said shield, said rod having a diameter smaller than the inside diameter of said filamentary cathode.

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