Jan. 11, 1949. P. SCHWERIN 2,458,534

VIBRATION SUPPRESSING SUSPENSION FOR TENSIONED FILAMENTS OF ELECTRON SPACE CHARGE DEVICES

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Fig. 2.

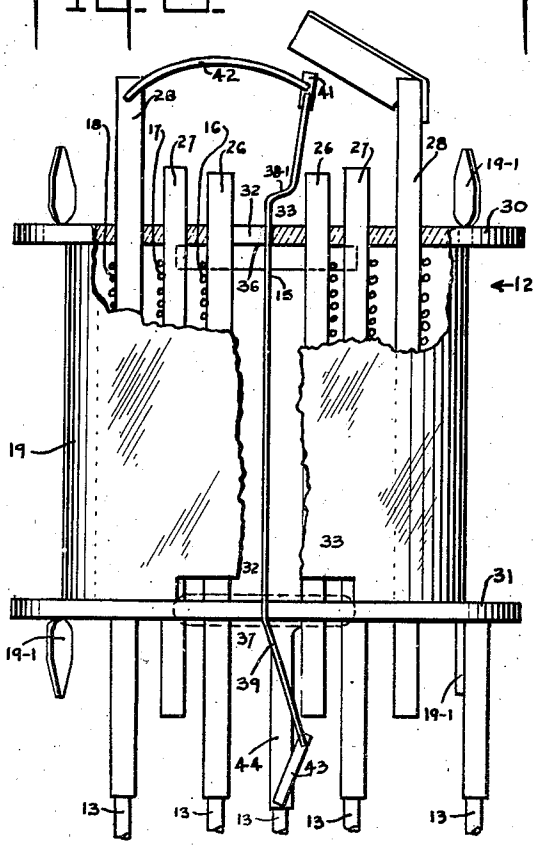
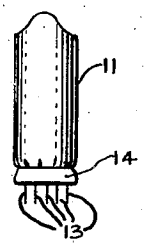


Fig. 1.



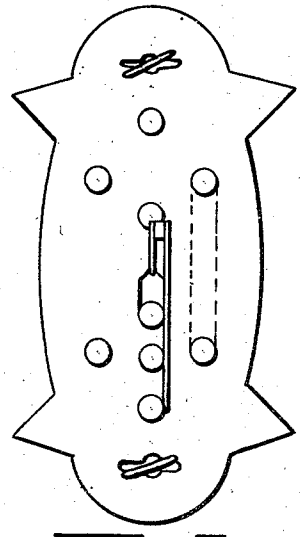
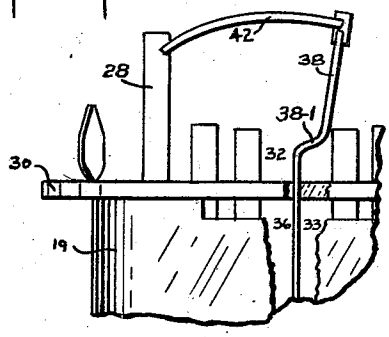


Fig. 3.

Fig. 5.



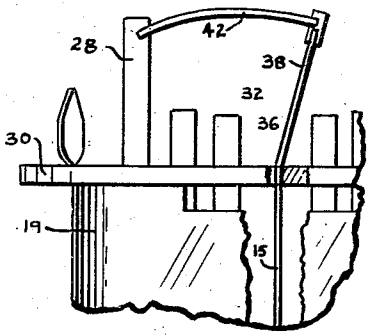


Fig. 4.

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VIBRATION SUPPRESSING SUSPENSION FOR TENSIONED FILAMENTS OF ELECTRON SPACE CHARGE DEVICES

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1 Claim. (Cl. 250—27.5)

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This invention relates to electron space discharge devices in which an electrode assembly comprising a cathode, an anode and at least one grid electrode interposed between the cathode and anode are enclosed in a hermetically sealed envelope and more particularly to such electron discharge devices which are known commercially as miniature and subminiature electron tubes and which utilize a thermionic filamentary element as the cathode.

Among the objects of the invention is a tube of the foregoing type in which the filamentary cathode is held in its operative position by a resilient tensioning member engaging an end part of the mounting portion of the cathode filament for biasing a seating portion of the filament mounting element against a border edge of a spacer member of the electrode assembly, a part of the mounting portion of the cathode filament projecting beyond the edge of the spacer member being offset in a direction transverse to the direction of the seating element facing the edge, so that substantially the entire length of the seating element facing the spacer edge is held in engagement therewith for producing a damping action which suppresses microphonic vibrations of the filament.

The foregoing and other objects of the invention will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawings wherein

Fig. 1 is a side elevational view of a typical subminiature tube, the tube being shown on an enlarged scale, such tubes having a length of only one inch or less;

Fig. 2 is an elevational view of the electrode assembly mounted in the interior of the tube with parts of the structure broken away;

Fig. 3 is a top view of Fig. 2; and

Figs. 4 and 5 are views similar to Fig. 2 showing successive stages of the process of tensioning and shaping the filament suspension elements.

There are many applications requiring multi-electrode electron amplifier tubes of the miniature and subminiature type having extremely small dimensions and able to operate with a high degree of uniformity and efficiency. Among such applications are hearing aid amplifiers and radio broadcast receivers of a size small enough to be worn hidden in a pocket of the user and other applications, such as the field of proximity fuses in which space is at a premium.

Although the principles of the invention are applicable to other types of tubes, their application will be described in connection with a pentode-type tube shown in Figs. 1 to 3. It comprises a hermetically-sealed, evacuated tubular envelope 11 of material, such as glass, which encloses an electrode assembly, generally designated 12, provided with a plurality of leads 13 which are hermetically sealed in the terminal wall portion 14 of the envelope to provide external circuit connection to the enclosed electrodes.

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The cathode assembly 12 comprises a cathode shown in the form of a single longitudinally-extending filament 15, a control grid 16, a screen grid 17, a spacer grid 18 and an anode structure 19. The several grid electrodes 16, 17, 18 and the anode 19 are of the conventional type and form internested electrode elements which extend longitudinally in directions generally parallel to the common longitudinal axis of the electrode assembly and of the tubular envelope 11. The cathode 15 forms the central element of the electrode assembly and is formed of an oxide-coated metal filament.

The several grids 16, 17, 18 are made of very fine metal wire about .001" to .004" in diameter. The inner wire grid 16 is supported on two grid posts 26, the similar grid 17 is supported on two grid posts 27 and the grid 18 is supported on two grid posts 28. The several grid posts 26, 27, 28 of such tubes are usually formed of metal wires about .012" to .025" in diameter. The electrodes and their posts are held supported in their operative position by two similar generally-flat sheet-like insulating spacer elements 30, 31, commonly made of a material having a high dielectric constant, such as mica, the spacer elements being provided with openings or holes in which the grid posts and the anchoring elements 19—1 of the anodes are anchored.

In the tube shown, each of the two spacer elements 30, 31 has formed in its center an elongated hole 32 provided at one of its narrow ends with a V-shaped edge or border portion 33 against the corner portion of which an upper seating portion 36 and a lower seating portion 37 of the mounting portions 38, 39, respectively, of the filament are held for stably supporting in its operative position the principal part of the filamentary cathode 15 extending between the two spacer members 30, 31 and facing the operative parts of the other electrodes.

The upper mounting portion of the cathode filament 15 is provided with a tab 41 which is secured in a conventional way, as by welding, to one end of a tensioning member 42 shown in the form of a spring wire, the other end of which is

secured, as by welding, to the upwardly projecting end of one of the grid posts 28 which supports the spacer grid 18. The lower mounting portion 39 of the cathode filament 15 is shown held in its operative position by one end of a tab 43 which is, in turn, held secured to a supporting projection 44 mounted on and projecting outwardly from the lower insulating support member 32 of the electrode assembly.

The tab support 44 is of the conventional type and, as indicated in Figs. 2 and 3, it is formed by threading a thin strip of a metal, such as nickel, through two holes underlying the holes of the lower supporting member 31 and folding the strip along the outwardly facing surfaces of the supporting sheet member 31, the end portions of the strip being folded over each other and formed into the downwardly projecting tab projection 44.

For the satisfactory operation of such tubes, it is important that the effective portion of the filamentary cathode 15 facing the other electrodes and extending between the two spacer supports 30, 31 shall be held stretched in a definite operative position with respect to the other electrodes. To this end, the tensioning wire 42 is made of a material having sufficient stiffness and it is so arranged as to apply to the mounting portion 38 of the cathode filament connected thereto a biasing force which maintains the effective filamentary portion 15 extending between the two spacer supports 30, 31 in stretched condition and at the same time holds the seating portions 36, 37 biased against the sharp corner of the V-shaped notch forming the seat against which the seating portions 36, 37 of the thin filament are held.

Prior art subminiature tubes provided with a filamentary cathode held in its operative position by two spaced insulating supports, such as the mica supports 30, 31 of the electrode assembly described above, presented serious manufacturing difficulties because the cathode filaments of a great many of the tubes manufactured in accordance with long-established prior-art practice exhibited a tendency to vibrate, thus becoming the cause of disturbing microphonics. In all such prior tubes, the mounting portion of the filament was held against the border edge of the support opening 32 in the manner indicated in Fig. 4, the mounting portion of the filament was held against the border edge of the support opening 32 in the manner indicated in Fig. 4, the mounting portion of the filament passing through the support opening 32 coming into engagement only with a relatively sharp edge of the border region of the support opening facing the seating portion 36 of the filament. The critical nature of the microphonic difficulties referred to above became even more aggravating in tubes in which a material, such as tungsten, was used as a filament core in lieu of the conventional nickel filament cores.

The invention is based on the discovery that the difficulties encountered with prior-art tubes by reason of cathode filament microphonics are overcome and microphonic vibrations of the cathode filament are suppressed by providing at least one of the two mounting supports of the filamentary cathode with an offset portion of the type indicated on the mounting portion 38 at 38—1 extending in a direction transverse to the direction of the adjacent seating element 36 thereof, so as to assure that the forces applied by the tensioning spring member 42 to the mounting portion of the filament and transmitted thereby to the seating portion 36 of the filament are of such character as to cause substantially the entire length of the seating element 36 of the filament to cling and remain in contact engagement with the entire width of the support seat 33 formed by the relatively wide edge surface of the spacer element 30 for damping and dissipating vibratory energy imparted to the filament, while at the same time maintaining the forces transmitted to the effective portion of the cathode filament 15 extending between the two spacers 30, 31 sufficient to hold it in stretched condition.

In particular, it was found that when using cathode filaments of a refractory material, such as tungsten, which notwithstanding its small thickness of only .0005" in diameter, exhibits relatively great stiffness, the tensioning forces applied thereto by the tensioning wire 42 in order to maintain it stretched along the intermediate portion extending between the two spacer members 30, 31 will cause it to become curved along its seating portion 36 passing through the opening 32 of the spacer and maintain contact engagement with the seating surface 33 only along its upper edge, in the manner indicated in Fig. 4, unless a lateral offset, such as indicated at 38—1 in Figs. 2 and 5 was formed in the mounting portion 38 of the filament.

In other words, the invention is based on the discovery that providing a lateral offset in the filament mounting portion extending between the seating portion of the filament and its point of connection to the tensioning member 42 makes it possible to limit the forces applied to the seating region of the filament mounting portion to a value at which the effective portion of the cathode filament extending between its two supports 30, 31 holds it stretched while at the same time assuring that the forces transmitted by the tensioning means 42 to the seating portion 36 of the filament leave it in a straight condition and cause it to cling along its entire length against the facing relatively wide edge surface forming the seat 33 of the filament.

As indicated in Fig. 2, the offset portion 38—1 is formed on the part of the filament mounting portion adjoining its seating portion 36 in order to assure that the biasing force transmitted from the tensioning spring 42 to the seating portion 36 of the filament mounting portion exerts on the seating portion a force which causes the entire length of the seating element 36 of the filament mounting portion to hug the relatively full width of the facing border edge 33 of the supporting sheet member 30. In other words, in the filament mounting arrangement of the invention, the forces which are imparted to the seating portion 36 of the filament mounting portion are of such nature as to cause substantially the entire length of the filament seating portion 36 to extend straight and substantially parallel to the facing seat border portion 33 of the spacer member 30. In this respect, the filament mounting arrangement of the invention differs from the prior art mounting arrangement in which the seating portion 36 of the filament was held positioned in the manner indicated in Fig. 4 and the forces exerted thereon caused the seating portion 36 to assume a curved configuration, only an extremely short portion of the overall length of the seating element 36 being brought into engagement with a short element

of the width of the facing border portion 33 of the supporting sheet member 30.

It has been found in practice that it is sufficient to provide only one of the filament mounting portions with a laterally offset portion, such as indicated in Fig. 2 at 38—1, in order to effectively suppress microphonics encountered in a large fraction of the tubes heretofore manufactured and which had to be discarded. However, it may also be desirable to provide the lower mounting portion of the filament, such as indicated at 39 with a similar offset region in order to assure that the lower seating portion 37 of the filament mounting portion 39 has exerted thereon at the point at which it emerges from its contact engagement with the border edge of the filament support 32 a biasing force in a direction substantially perpendicular to the length of its seating portion 37.

In manufacturing tubes provided with a filament mount of the invention described above, one may proceed as follows:

After first assembling all electrodes, except the filamentary cathode electrode, into an electrode assembly including the support and spacer sheet members 30, 31, as indicated in Fig. 2, the cathode filament 15 with its two tabs 41, 43 previously secured to the ends of its mounting portion is threaded through the two holes 32 of the two spacer members 30, 31. Thereupon, the lower tab 43 is secured as by electric spot welding to the supporting projection 44 extending from the lower spacer support 31. Thereafter, the upper tab of the filament is secured to the tensioning spring 42 as by welding, while they are held in the position shown in Fig. 4. It is then merely necessary to bring a suitable deforming tool against the mounting portion 38 of the filament emerging beyond the border of the support opening 32 and impart thereto the offset deformation 38—1 in the manner indicated in Fig. 5.

In order to enable those skilled in the art to readily practice the invention and without in any way limiting its scope, there are given below structural data of a subminiature tube of the invention.

The cathode filament was made of a wire of tungsten .0005" in diameter.

The upper tensioning spring 42 was formed of a spring wire .002" in diameter.

The thickness of the mica spacer was about .005".

The distance between the insulating spacers was 5/8 of an inch.

It was found that by making the offset or kink 38—1 only one millimeter long, substantially the entire length of the seating surface 36 of the filament mounting portion was held in contact engagement with substantially the entire width of the mica spacer in good vibration damping engagement therewith.

It will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific exemplifications thereof will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the appended claim it shall not be limited to the specific exemplifications of the invention described above.

I claim:

In an electrode assembly for an electron space-discharge device: a set of electrodes including at least one control electrode; said electrodes extending longitudinally generally parallel to a common axis; said electrode assembly including a generally-flat sheet-like insulating spacer extending transverse to said axis and supporting the projecting end portions of said electrodes in their spaced operative positions; a metallic filament constituting the cathode and having a mounting portion extending from one end of said filament; said spacer having a spacer perforation through which said mounting portion extends and the border edge of said spacer perforation being of a width which is a multiple of the thickness of said filament; said electrode assembly including a resilient tensioning element connected to said mounting portion for stretching the portion of the filament facing the other electrodes and for biasing a seating element of said mounting portion toward a seat portion of said border edge; the major part of the length of said mounting portion extending in a direction generally parallel to said common axis; a part of said mounting portion projecting through the perforation toward said tensioning element being offset in a direction transverse to the direction of its length for limiting and controlling the direction of the tensioning forces exerted thereby on said seating element whereby substantially the entire length of said seating element is held in engagement with the facing border edge of the spacer for imparting to the filament a vibration suppressing damping action.

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