

Filed Dec. 31, 1956

2,933,636

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FIG. 1

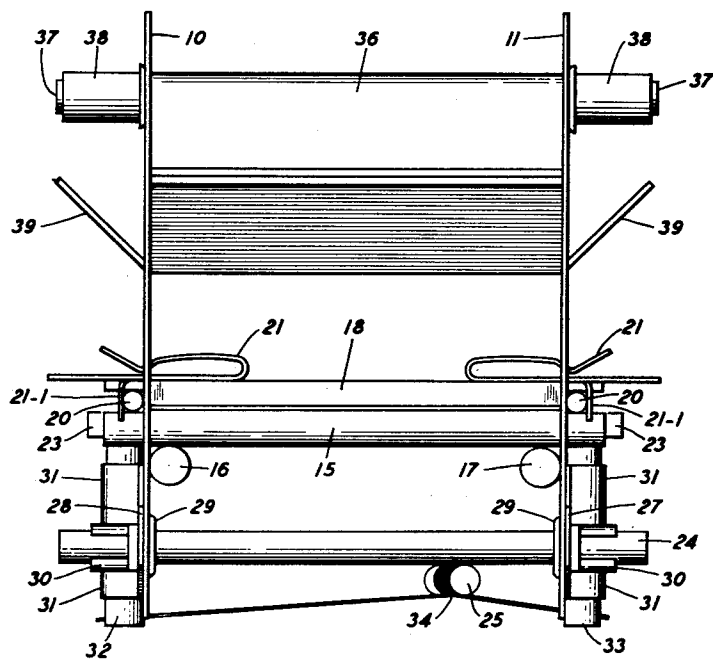
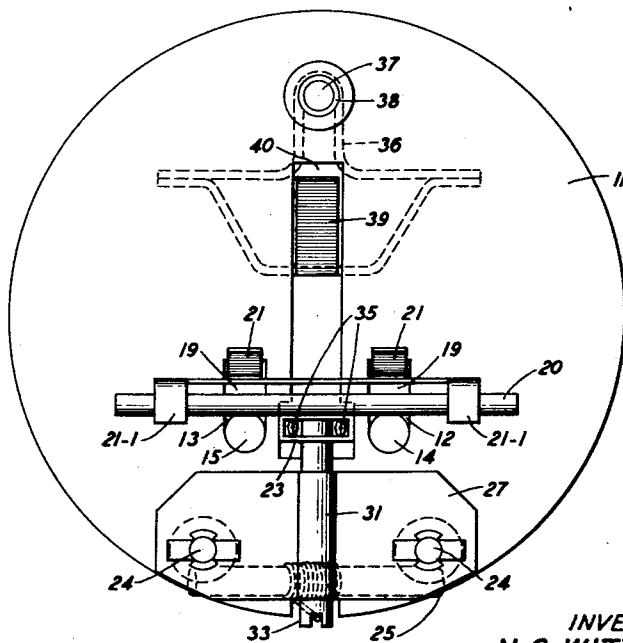


FIG. 2



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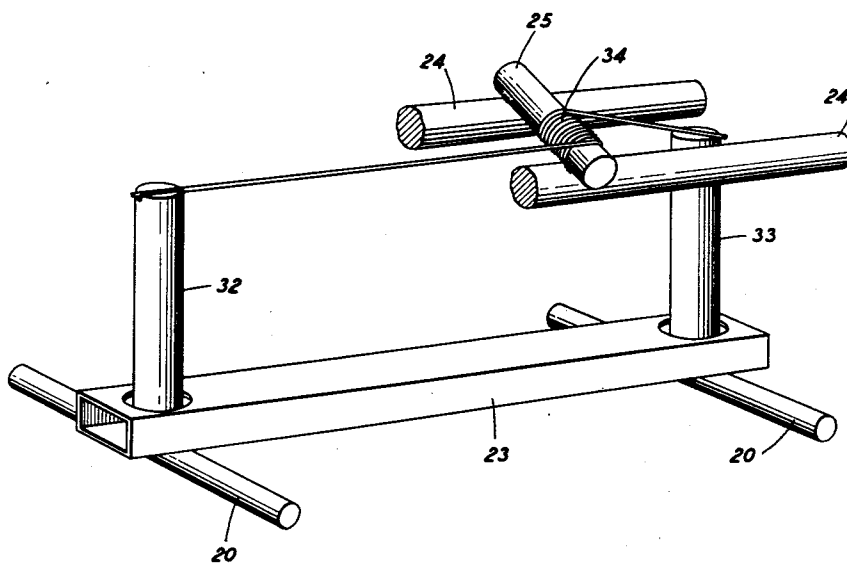
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ELECTRODE SUPPORT AND SPACING STRUCTURE FOR
ELECTRON DISCHARGE DEVICES

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FIG. 3



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ELECTRODE SUPPORT AND SPACING STRUCTURE FOR ELECTRON DISCHARGE DEVICES

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Application December 31, 1956, Serial No. 631,611

6 Claims. (Cl. 313—357)

This invention relates to electron discharge devices and, more particularly, to electrode assemblies for electron discharge devices.

In planar electrode devices having inter-electrode spacings of the order of 0.001 inch, the problem of attaining the desired spacings is a difficult one. Another difficult problem, the desired spacings having been attained, is that of preventing permanent distortion of the electrodes when the assembly of which they are a part is subjected to shock, physical impact, severe vibration, or temperature change.

With a control grid to cathode spacing in an electron discharge device of the magnitude of 0.001 inch, a change in the spacing or a variation in the spacings of the different areas of the electrodes of only 0.0001 inch may cause a pronounced change in the transconductance of the device and a consequent failure to meet the required performance characteristics.

To minimize inter-electrode spacing changes due to permanent distortion resulting from shock, impact and vibration, the electrodes must be as rugged and stable as possible. However, it is not practicable to mount the electrodes in an absolutely rigid support structure because of the tendency of the electrodes to expand when heated. Rigid mounting and thermal expansion could combine to cause buckling and/or bowing of the cathode and, as a result, spacing changes and variations. Thus, while a planar electrode mounting structure must provide secure electrode support, it must also, in many applications, allow for longitudinal movement of portions of the cathode in response to temperature changes.

An object of this invention is to improve electrode mounting structures.

More specifically, an object of the present invention is to maintain accurately determined electrode spacings during the entire life of an electron discharge device.

A further object of this invention is to allow substantially unrestricted expansion and contraction of portions of a planar electrode in an electron discharge device, thereby accurately maintaining the spacings between it and other electrodes.

Another object of this invention is an electrode supporting structure which, while allowing substantially unrestricted expansion and contraction of portions of a planar electrode, securely anchors other portions thereof so as to prevent longitudinal displacement of the entire cathode.

A still further object of the present invention is an electrode supporting structure which is sturdy and readily assembled.

These and other objects are attained in one specific illustrative embodiment of this invention wherein in an electron discharge device the spacings between a planar cathode and two grids associated therewith are accurately maintained. The planar cathode assembly, the grid assemblies, and a plate assembly are mounted between and supported by apertured mica members. The effective

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surfaces of the electrodes lie in planes which are parallel to each other and which are perpendicular to the planes in which the micas are positioned.

The control grid assembly, which is located directly adjacent to the cathode, comprises a grid frame upon which are wound a plurality of turns of fine wire. The grid frame extends through apertures in the mica assemblies and provides projecting portions against which to position spacer pins. The spacer pins are loaded or biased against the projecting portions of the control grid frame by the assembly of the second grid or screen grid which includes loading springs. The control grid frame projecting portions are stepped or ground flat an amount equal to the desired cathode to control grid spacing, the cathode being biased against the spacer pins, which rest against the stepped portions, and the wires of the control grid being wound over unstepped portions of the control grid frame assembly.

The cathode biasing arrangement includes a connection rod assembly which is securely mounted between the mica members. The connection rod assembly comprises a support rod and a coil spring wound thereon, the spring and support rod being positioned closer to one mica member than to the other. Each end of the coil spring bears against a cathode loading pin, a slot in each loading pin receiving a spring end and providing for secure pin engagement therewith.

The cathode loading pins bear against the cathode and, thus, resiliently load it against the spacer pins. Because of the off-center positioning of the support rod and coil spring, the cathode loading pins exert unequal forces against different portions of the cathode. Accordingly, when the cathode is heated and forced to expand, only its more lightly loaded end will move with respect to the spacer pins. Thus, secure longitudinal positioning of the entire cathode is attained.

Furthermore, the sticking force between the cathode and the lightly loaded pin is less than the sticking forces present in a cathode assembly having a centrally positioned support rod and coil spring. Thus, the minimum force that must be overcome by portions of the cathode in longitudinally moving in response to temperature changes is less in illustrative embodiments of the present invention than in electrode assemblies as heretofore constructed. As a result, buckling and bowing and spacing changes and variations caused thereby are substantially reduced.

Accordingly, a feature of the present invention is a planar cathode, portions of which are equally and resiliently biased against spacer pins by an off-center coil spring assembly.

A further feature of this invention is an electrode assembly including a connection rod assembly comprising an off-center support rod having wound thereon a coil spring, the ends of which unequally bear against two cathode loading pins, thereby anchoring the more heavily loaded cathode portion to the pin which it contacts and allowing substantially free expansion and contraction of those portions of the cathode which contact the other loading pin.

A complete understanding of this invention and of the various features thereof may be gained from consideration of the following detailed description and the accompanying drawing, in which:

Fig. 1 is an elevational view of an electrode assembly constructed in accordance with the principles of the present invention;

Fig. 2 is an end view of the assembly of Fig. 1; and Fig. 3 is a perspective view of a portion of the assembly of Fig. 1.

Referring now to the drawing, Figs. 1 and 2 show

an electrode assembly illustrative of the principles of this invention and which may be easily arranged, mounted and electrically connected in any one of a great variety of devices by anyone skilled in the art of electron discharge devices.

Identical insulator assemblies 10 and 11, both of which are advantageously of mica, have formed therein a plurality of electrode assembly receiving openings. The openings 12 and 13 have grid frame members or rods, 14 and 15 respectively, extending therethrough, grid cross-frame members 16 and 17 being attached to the members 14 and 15 in any suitable manner thereby forming a rigid grid frame assembly. In one illustrative embodiment of this invention 770 turns per inch of 0.00028 inch diameter tungsten wire were laterally wound on the grid frame members 14 and 15 to form a control grid electrode.

A screen grid assembly is positioned between the micas 10 and 11 and in close proximity to the above-mentioned control grid. The screen grid comprises a screen frame member 18 having 135 turns per inch of 0.001 inch diameter tungsten wire wound thereon. The frame member 18 includes tab elements 19 which extend through the mica assembly openings 12 and 13 and rest on spacer pins 20. The spacer pins 20 are advantageously made of a ceramic material and must be straight within ± 0.001 inch. Loading spring assemblies 21 serve to hold the screen grid securely in place, and also serve to bias the spacer pins 20, the pins 20 resting on the grid frame members 14 and 15. The loading spring assemblies include clip elements 21—1 which are intended to hold the spacer pins 20 against the mica assemblies 10 and 11.

A coated cathode 23 is biased against the spacer pins 20 by an assembly including loading pins 32 and 33. As seen in Fig. 3, the non-emitting face of the cathode 23 contains two openings therethrough for the pins 32 and 33.

As seen in Figs. 1 and 2, the portions of the grid frame members 14 and 15 which project beyond the mica assemblies 10 and 11 are stepped, the steps or flat portions being in contact with the spacer pins 20. Since the lateral grid wires are wound over unstepped portions of the frame members 14 and 15, the amount or depth of the step determines the spacing between the emitting surface of the cathode 23 and the lower surface defined by the lateral grid wires. The depth of the stepped portions, and thus the cathode-control grid spacing, can, of course, be very accurately determined in, for example, a grinding operation. For a more detailed description of this type of spacing means, reference may be made to Patent 2,663,819, C. T. Goddard, December 22, 1953.

The cathode biasing assembly comprises connection rods 24 and a support rod 25. The center of the support rod 25 is positioned closer to the mica assembly 11 than to the assembly 10. The rod 25 is advantageously attached to the connection rods 24 by welding.

The connection rods 24 extend through the micas 10 and 11 and through guide plate members 27 and 28. Each connection rod 24 has two fixed washers 29 thereon. The washers 29 contact the micas 10 and 11 and in combination with eyelets 30 securely position the rods 24 with respect to the micas 10 and 11.

The guide plates 27 and 28 contain connection rod receiving openings therethrough, and are secured in place by the eyelets 30 and the micas 10 and 11. Furthermore, each guide plate contains a generally cylindrically-shaped guide portion 31.

Cathode loading pins 32 and 33 rest in the guide portions 31 and are biased against the cathode 23 by the ends of a coil spring 34 which is wound on the off-center support rod 25. Each cathode loading pin includes a slotted lower portion which is designed to engage one of the coil spring ends. The spring ends can be arranged to impinge upon the slotted ends of the loading pins 32

and 33 by oblique positioning of the support rod 25 on the connection rods 24.

The loading pins 32 and 33 extend through the guide portions 31 of the plates 27 and 28 and resiliently bear against the cathode 23. As seen in Fig. 3, the openings in the non-emitting face of the cathode 23 receive the pins 32 and 33 and allow them to rest against the inside surface of the emitting side of the cathode 23. The openings, in providing passages for the loading pins to extend through the back or non-emitting face of the cathode, eliminate the cathode crushing or squashing which commonly results if the pins are loaded against the non-emitting cathode face. Such crushing causes the cathode to bow toward the grid; the bowing constitutes an undesired inter-electrode spacing change.

A heater member 35 is positioned within the cathode 23 and therein arranged so that its elements are not in contact with the cathode loading pins 32 and 33.

An anode electrode 36 is positioned between the micas 10 and 11 and is supported on an assembly rod 37. The ends of the rod 37 extend through the micas and have fitted thereon tubular eyelets 38, the eyelets being secured to the rod 37 in any suitable manner as, for example, by crimping. Anode tabs 39 fit through openings 40 in the micas and prevent the anode 36 from rotating about the assembly support rod 37.

The illustrated and described electrode assembly, while being mechanically rugged and stable, exhibits sufficient flexibility to maintain accurately determined electrode spacings over a considerable range of temperature during the entire life of an electron discharge device. The lightly loaded cathode pin, i.e., pin 32, offers a minimum constraint or sticking force to the tendency of the cathode portion which it contacts to expand or contract in response to temperature changes, while the other cathode loading pin, i.e., pin 33, bears against the cathode 23 with sufficient force to prevent longitudinal movement of the cathode portion which it contacts. Thus, pin 33 anchors a portion of the cathode 23 and prevents the entire cathode from longitudinally sliding or "walking." On the other hand, the lightly loaded pin 32 is designed so that the small force with which it bears against a portion of the cathode 23 does not significantly interfere with longitudinal shifting of that portion of the cathode in response to temperature changes. Thus, provision is made for substantially free thermal expansion and contraction of the cathode in a direction perpendicular to the mica assemblies so that cathode buckling and bowing and electrode spacing changes caused thereby are markedly reduced.

It is to be understood that the above-described embodiment and arrangement is merely illustrative of the application of the principles of the present invention. Numerous other arrangements may be made by those skilled in the art without departing from the spirit and scope of this invention.

What is claimed is:

1. An electrode assembly comprising a planar cathode, a control grid, said control grid comprising two parallel rods and a plurality of turns of wire wound on said rods, spacer members disposed perpendicular to and in contact with said rods, two pins bearing laterally against respective opposite ends of said cathode, and means for spring-loading said pins such that one is more heavily loaded than the other, said planar cathode being biased against said spacer members by said pins, whereby the portion of said cathode in contact with the more heavily loaded pin remains stationary with respect thereto, while the portion of said cathode in contact with the less heavily loaded pin is free to move longitudinally in response to temperature induced expansions and contractions of said cathode.

2. In combination, an elongated flat cathode, spacer members respectively disposed in contact with end portions of said cathode, and means laterally biasing the end

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portions of said cathode against said spacer members with respectively different forces.

3. In combination, a flat cathode, a spacer member in contact respectively with a portion of each end of said cathode, and means laterally biasing said end portions against said members with respectively different forces, said means comprising biasing pins and spring means, each of said biasing pins being in contact with an end portion of said cathode and said spring means being positioned off-center with relation to said biasing pins and in contact therewith, such that a greater force is exerted on one than on the other of said pins.

4. An electrode assembly for an electron discharge device comprising a flat elongated cathode, a control grid adjacent the emissive surface of said cathode, spacer members at each end of said cathode and defining the spacing between said emissive surface and said control grid, a pin bearing laterally against said cathode at each end thereof, and means spring biasing one of said pins against said cathode more heavily than the other of said pins, said means including a spring having a first portion biasing said one pin and a second portion biasing said other pin and means positioning said spring closer to said one pin than to said other pin.

5. An electrode assembly for an electron discharge

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device comprising a flat elongated cathode, spacer means in contact with opposite ends of one surface of said cathode, and means laterally biasing said opposite ends of said cathode against said spacer means with different forces, said biasing means including loading members bearing against the other surface of said cathode at said opposite ends and spring means more heavily loading one of said loading members than the other of said loading members.

6. An electrode assembly in accordance with claim 5 wherein said spring means includes a spring member having end portions bearing against said loading members and means positioning said spring member closer to said one loading member than said other loading member.

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