

Dec. 13, 1938.

J. P. LAICO

2,139,685

ELECTRON DISCHARGE DEVICE

Filed Jan. 5, 1937

2 Sheets-Sheet 1

FIG. 1

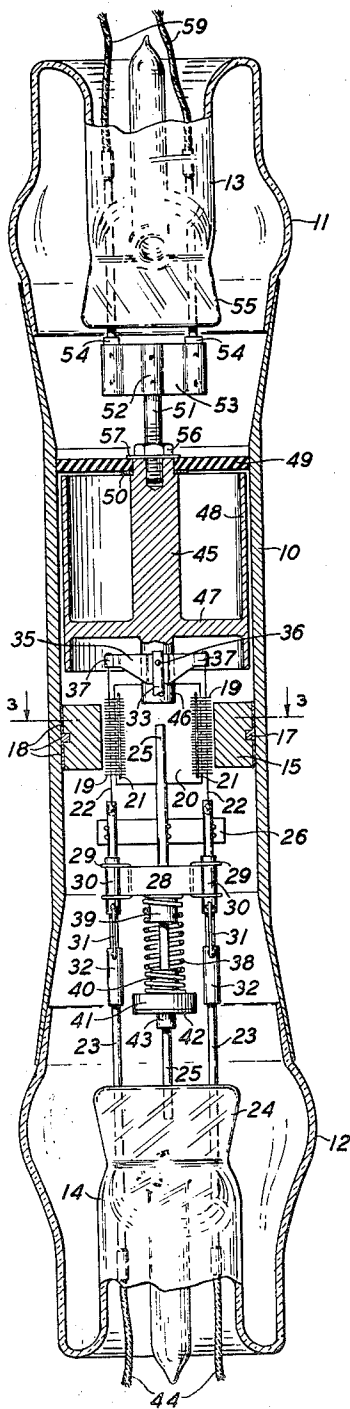


FIG. 2

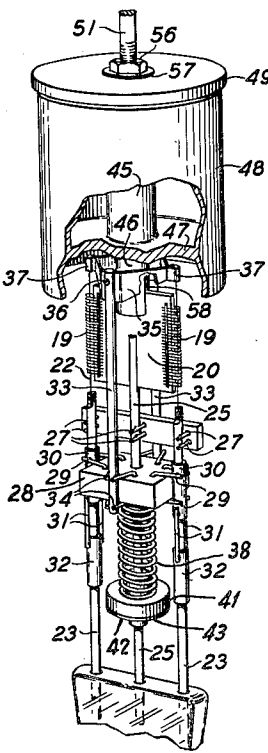
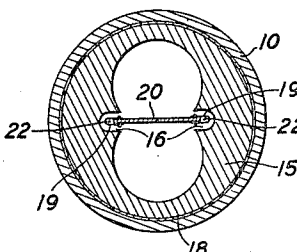


FIG. 3



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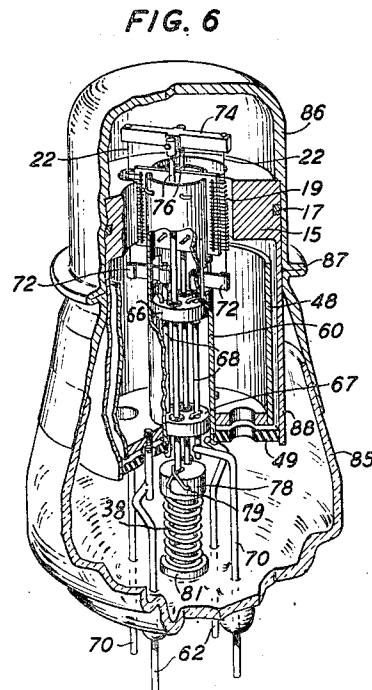
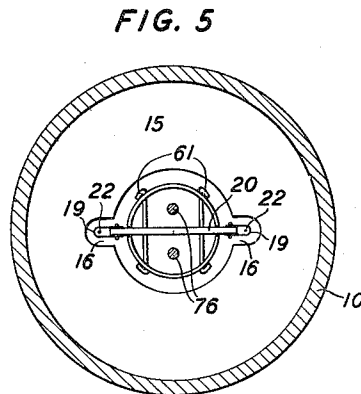
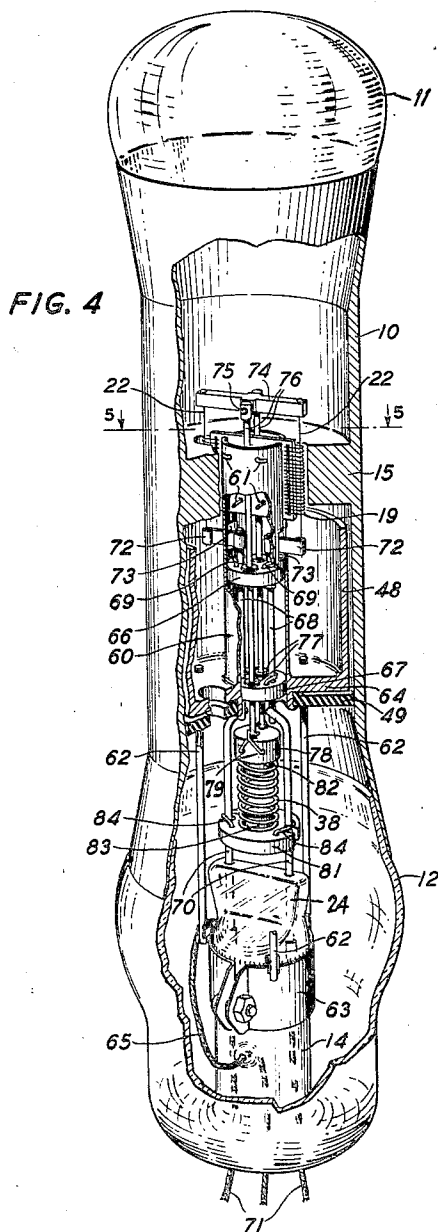
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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

2,139,685

## ELECTRON DISCHARGE DEVICE

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Application January 5, 1937, Serial No. 119,083

14 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices operable at ultra-high frequencies, for example, frequencies corresponding to wave-lengths of one meter or less.

One object of this invention is to maintain accurately the spacing between a plurality of closely adjacent electrodes in electron discharge devices. More specifically, one object of this invention is to allow substantially free longitudinal expansion and contraction of a cathode and a control electrode in ultra-short wave electron discharge devices whereby the form and the proper position thereof relative to each other and to other electrodes is maintained.

Another object of this invention is to expedite the fabrication of electron discharge devices wherein the spacings between electrodes are extremely small.

In one illustrative embodiment of this invention, an electron discharge device, which may be of the general construction disclosed in Patent 2,063,341, granted December 8, 1936, to Arthur L. Samuel, comprises an annular anode having a pair of grooves or channels in its inner wall in each of which a cathode element and a control electrode element are positioned. The control electrode elements may be grids supported upon a common plate or fin and the cathode elements may be linear filaments each disposed in cooperative relation with one of the grids. The filaments and grids may be mounted upon a supporting structure extending from one end of the enclosing vessel and including a plurality of uprights, one of which is affixed to the plate or fin and two of which are secured individually to one end of the filaments, the uprights being accurately spaced laterally with respect to one another. A guiding member is supported from the other end of the enclosing vessel and engages the plate or fin to hold it in position laterally but allowing longitudinal expansion and contraction thereof.

The filaments are engaged at the other end by a rockable member which is supported by a platform or carrier slidably mounted upon the supporting structure for the filaments and grids. Compression means, such as a helical spring, is provided for initially tensioning the filaments, the means serving also to place a substantially constant longitudinal tension upon the filaments during operation of the device. Variations in the expansion and contraction of the two filaments are compensated for by the rockable member so that the linear form of the filaments is preserved

and the position thereof with respect to the grids is maintained.

The invention and the various features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawings, in which:

Fig. 1 is an elevational view partly in cross-section of an electron discharge device illustrative of one embodiment of this invention;

Fig. 2 is a detail view in perspective of the cathode and control electrode assembly in the device shown in Fig. 1, portions of the assembly being broken away to show details thereof more clearly;

Fig. 3 is a view in cross-section along line 3—3 of Fig. 1 showing the configuration of the electrodes and the relative positions thereof;

Fig. 4 is an elevational view in perspective of an electron discharge device illustrative of another embodiment of this invention, portions of the enclosing vessel and of the internal structure being broken away to show details of construction more clearly;

Fig. 5 is an enlarged cross-sectional view along line 5—5 of Fig. 4 showing the form and position of the electrodes; and

Fig. 6 is a perspective view partly in section and partly broken away of an electron discharge device illustrative of still another embodiment of this invention.

Referring now to the drawings, the electron discharge device shown in Figs. 1, 2 and 3 comprises an enclosing vessel including a cylindrical metallic portion 10 and vitreous end portions 11 and 12 hermetically sealed to the metallic portion 10 and provided with aligned stems 13 and 14, respectively. Disposed within the metallic portion 10 and secured thereto, as by a suitable solder, is a metallic annulus 15, which serves as the anode of the device and is provided with diametrically opposite parallel grooves or channels 16. The annulus may be provided also with an annular groove 17 in its outer surface in which the soldering material 18 may be placed prior to the insertion of the annulus within the metallic portion 10. When the material is heated, the solder flows outwardly from the groove 17, between the annulus 15 and the cylindrical portion 10, and upon cooling and setting forms a tight joint between the annulus and the cylindrical portion.

A control electrode element or grid is positioned in each of the grooves or channels 16 and comprises a plurality of parallel U-shaped wires 19 which are spaced uniformly from the walls of

the grooves or channels and are affixed, as by welding, to a large area metallic plate or fin 20 together with locking strips or wires 21. Each of the grids encompasses a cathode element, such, for example, as a linear filament 22, uniformly spaced from the grid wires 19.

In electron discharge devices adapted to operate at ultra-high frequencies, because of the small electron transit times required, it is necessary that the clearances between the electrodes be extremely small. For example, in the device shown in Figs. 1 to 3, the spacing between the grids 19 and the anode may be of the order of 30 mils and the filaments 22 may be spaced from the grids a distance of the order of 12 mils. It is necessary also that these small spacings be maintained accurately during the operation of the device in order that uniform and constant operating characteristics obtain and short-circuiting between electrodes is prevented. These and other results are achieved in accordance with one feature of this invention by mounting the cathodes and grids in such manner that they may expand and contract freely longitudinally without substantially varying the relation thereof to one another and to the anode.

Specifically, each of the filaments 22 is connected at one end to a rigid metallic upright or rod 23 embedded in and extending from a press 24 on the stem 14 and having leading-in conductors 44 connected thereto. The uprights 23 preferably are parallel to each other and to the filaments. The plate or fin 20 is fitted and secured in a slot in another upright or rod 25 also embedded in the press 24 and parallel to the upright 23. The uprights 23 and 25 are held in proper space relation by an insulating brace or cross-piece 26, secured to the uprights by metallic stubs 27 affixed to the uprights and embedded in the insulating brace, so that the filaments 22 are maintained accurately spaced with respect to the corresponding grid 19. An insulating carrier or platform 28 is slidably mounted on the upright or rod 25 and is suitably secured, as by tie wires or stubs 29 to guide sleeves 30 slidably mounted on the uprights 23. The guide sleeves 30 are rigidly coupled, as by tie wires 31, to additional guide sleeves 32 also slidable on the uprights 23, which serve to assure linear movement of the platform 28 along the uprights 23 and 25.

The platform 28 carries a pair of metallic uprights or rods 33 disposed parallel to each other and rigidly secured to the platform as by U-shaped wires 34 welded to the uprights and extending through the platform. The uprights 33 support in turn a metallic cross-piece 35 which is rockable about pivots 36 (only one of which is shown) extending from the uprights. The cross-piece 35 is provided with integral extensions or fingers 37 to which the filaments 22 are fastened.

Bearing against the platform 28 is a helical compression spring 38, one end portion of which encompasses an integral cylindrical sleeve 39 on the platform and the opposite end of which encompasses an insulating sleeve 40 having a flange 41 seated upon a metallic disc 42 in turn seated upon a stop or collar 43 upon the upright or rod 25. During the fabrication of the device, the stop or collar 43 is so positioned and affixed to the rod or upright 25 that a desired tension is applied to the filaments 22 by the spring 38, the tension in the two filaments being equalized automatically by rocking of the cross-piece 35 about the pivots 36. When the filaments 22 expand and

contract in accordance with variations in the temperature thereof during operation of the device, the platform 28 slides along the uprights 23 and 25 to maintain a constant tension upon the filaments. Any differences in the expansion or contraction of the two filaments are compensated for by rocking of the cross-piece 35 about the pivots 36. Consequently, the linear form of the filaments and the desired space relation between the filaments and the grids 19 are accurately maintained.

The anode 15 and grids 19 may be coupled interiorly of the enclosing vessel by an impedance or tuning member comprising a hub 45 having a reduced end portion 46, a disc portion 47, and a cylindrical shell 48. The shell 48 is coaxial with the metallic portion 10 of the enclosing vessel and is maintained in proper space relation therewith by an insulating disc 49 fitted on the hub 45 and seated on a metallic shim 50 in turn seated upon a shoulder on the hub 45. The impedance or tuning member is carried by a stud 51 threaded into the hub 45 and affixed, as by welding, in a socket 52 in a metallic band 53, which is secured to rigid metallic supports or stubs 54 embedded in a press 55 on the stem 13. A lock nut 56 may be provided for locking the tuning member to the stud 51, the nut bearing against a metallic washer 57 seated on the hub 45.

The reduced end portion 46 of the hub 45 is provided with a slot 58, shown in Fig. 2, in which the plate or fin 20 is slidably fitted. Suitable potentials may be applied to the grids 19 through leading-in conductors 59 connected to the supports or stubs 54.

The disc portion 47, reduced end 46, anode 15 and the parts of the metallic portion 10 thereadjacent bound an annular cavity and provide an inductance coupling the grids 19 and the anode 15. This inductance forms, with the interelectrode capacitances, a resonant circuit. The magnitude of the inductance may be fixed during the fabrication of the device, so that the circuit of which it forms a part is tuned to the desired operating frequency of the device, by mounting a tuning member in the proper position on the stud 51 to provide the requisite spacing between the opposed surfaces of the disc 47 and the anode 15. The cylindrical shell 48 and the metallic portion 10 form a blocking condenser in the tuned grid-anode circuit.

As will be apparent, the reduced end portion 46 prevents lateral displacement of the plate or fin 20 but allows the control electrode assembly to expand and contract longitudinally during operation of the device, so that the proper space relation between the grids 19 and the cathodes 22 and anode 15 is maintained and uniform operating characteristics obtain. The large contact surfaces between the walls of the slot 58 and the surfaces of the plate or fin 20 provide an efficient and good electrical connection between the control electrode assembly and the tuning member and through the latter to the conductors 59.

In the embodiment of this invention shown in Figs. 4 and 5, the tuning member is provided with an elongated, central cylindrical shell 60 having at one end a pair of diametrically opposite slots in which the plate or fin 20 carrying the grids 19 is fitted. The plate or fin 20 may be locked in position by a plurality of cross wires 61 tightly fitted in apertures in the plate or fin and extending through and bent against the shell 60. The tuning member is supported from the stem 14 by a plurality, for example three, of rigid sup-

ports or rods 62 affixed to a metallic band or collar 63 clamped about the stem, and threaded into the base 64 of the tuning member. A suitable potential may be applied to the control electrode through a leading-in conductor 65 sealed in the stem 14 and connected to one of the supports or rods 62. The control electrode and tuning member may be centered in the enclosing vessel by an insulating disc 49 fitted within the metallic portion 10.

Fitted within the cylindrical shell 60 are a pair of insulating discs 66 and 67 which are maintained in spaced relation by a pair of metallic rods 68 extending through the discs and secured thereto by wire stubs 69 embedded in the discs and welded to the rods. The rods 68 are secured at one end to metallic supports or uprights 70 embedded in the press 24 and having leading-in conductors 71 connected thereto. At the other end, the rods 68 have affixed thereto metallic bands 72, which extend through oversize apertures 73 in the shell 60 and are secured to one end of the filaments 22.

The filaments 22 are secured at their other end to opposite ends of a metallic rocker member 74 which is mounted pivotally on a pin 75 extending between uprights 76. The uprights 76 extend slidably through guide bushings 77 in the insulating discs 66 and 67 and are affixed to a floating insulating platform or block 78, as by wires 79 embedded in the block 78 and welded to the uprights 76. The insulating block or platform 78 is supported by a compression spring 38 which bears against this block and a platform 81 and is positioned by tubular projections 82 and 83, respectively, thereon. The platform 81 is rigidly mounted on the uprights or supports 70 as by wires 84 embedded in the platform and welded to the uprights or supports.

In the fabrication of the device, the platform 81 is so positioned that the spring 38 places a desired tension upon the filaments 22, the tension in the two filaments being equalized by movement of the rocker member 74 on the pin 75. The linear form of the filaments 22 and hence the proper relation of the filaments with respect to the grids 19 is maintained during operation of the device, by the spring 38 and the rocker member 74.

In the embodiment of the invention illustrated in Fig. 6, the enclosing vessel comprises a truncated, pear-shaped vitreous portion 85 and a cup-shaped metallic portion 86 provided with an external flange 87 through which the device may be mounted upon a suitable support, such as a cooling jacket. The cathode, control electrode and tuning member assembly is substantially identical with that shown in Figs. 4 and 5 and described hereinabove. The lower insulating platform 81, however, is seated and fitted in a suitable recess or socket in the end wall of the vitreous portion 85 and the supports or uprights 62 and 70 are sealed directly in this end wall. The anode member 15 is provided with an integral cylindrical sleeve 88 which encompasses the cylindrical portion 48 of the tuning member and is maintained in coaxial relation therewith by the insulating spacer 49.

The construction shown in Fig. 6 enables large reductions in the overall length of the electron discharge device and, furthermore, enables the use of relatively short leading-in conductors to the cathode and control electrode so that low lead impedances, which are of particular importance at ultra-high frequencies, are obtained.

Although specific embodiments of the invention have been shown and described, it will be understood, of course, that these embodiments are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising a plurality of filamentary electrodes, supporting members secured to one end of said electrodes, a carrier slidably mounted on said supporting members, a rockable member supported by said carrier and engaging the other ends of said electrodes, and resilient means for tensioning said electrodes engaging said carrier.

2. An electrode assembly for electron discharge devices, comprising a stem, a plurality of cathodes, a plurality of uprights extending from said stem and secured to one end of said cathodes, a platform slidably supported on said uprights, supports carried by said platform, supporting means connected to the other end of said cathodes and pivotally mounted on said supports, and a resilient member having one end fixed with respect to said stem and the other end connected to said platform.

3. An electron discharge device comprising a pair of parallel filaments, a pair of supports mounted parallel to each other and to said filaments and each secured to one end of a corresponding one of said filaments, sleeve members slidably mounted on said supports, a platform carried by said sleeve members, supporting means extending from said platform, a cross-piece pivoted upon said supporting means and connected to the other end of said filaments, and a compression spring bearing against said platform to urge it toward said other end of said filaments.

4. An electrode assembly for electron discharge devices, comprising a stem, a pair of metallic uprights extending from said stem and mounted parallel to each other, means spaced from said stem maintaining said uprights in parallel relation, leading-in conductors connected to said uprights, an insulating platform slidably mounted on said uprights, a compression spring mounted on said stem and connected to said platform, a pair of supports extending from said platform, a metallic rocker member pivotally mounted on said supports, and a pair of parallel filaments each connected at one end to said uprights and at the other end to said rocker member.

5. An electron discharge device comprising a plurality of filamentary electrodes, a rocker member engaging one end of said electrodes, means including a platform supporting said rocker member, supporting members engaging the other end of said electrodes, means resiliently mounting said platform, and guiding means for said supporting means carried by said supporting members.

6. An electron discharge device comprising a pair of filamentary electrodes, a rocker member connected to one end of said electrodes, means supporting said rocker member including a platform and resilient means urging said platform toward said one end of said electrodes, fixed means connected to the other end of said electrodes, and spaced guide members mounted on said fixed means and engaging said supporting means for said rocker member.

7. An electrode assembly for electron discharge devices, comprising a stem, a plurality of filaments, a plurality of uprights extending from

said stem and connected to one end of said filaments, resilient means mounted on said stem, a platform carried by said resilient means, support means extending from said platform and connected to the other end of said filaments, and guiding means carried by said uprights and engaging said support means.

8. An electrode assembly for electron discharge devices, comprising a stem, a pair of filamentary electrodes, a pair of uprights extending from said stem and connected to one end of said electrodes, spaced guide members carried by said uprights, and support means connected to the other end of said electrodes including a rod extending through said guide members and slidable therein, a compression spring mounted on said stem and means connecting said spring to said rod.

9. An electrode assembly for electron discharge devices, comprising a stem, a pair of filaments, support members extending from said stem and connected to one end of said filaments, spaced insulating discs carried by said support members, a platform, means resiliently supporting said platform, supports carried by said platform and extending through said insulating discs and slidable therein, and a rocker member pivotally mounted on said supports and engaging the other end of said filaments.

10. An electron discharge device comprising a stem, a cathode, an electrode in cooperative relation with said cathode, supporting members extending from said stem, one of said supporting members being secured to one end of said cathode and another of said supporting members mounting said electrode, support means connected to the other end of said cathode and including a member movable longitudinally of said supporting members, and means engaging said supporting members and positioning said movable member with respect thereto.

11. An electron discharge device comprising an enclosing vessel having a stem, a plurality of uprights extending from said stem, a grid electrode mounted on one of said uprights, a cathode uniformly spaced from said grid electrode and secured at one end to another of said uprights, a

platform slidably mounted on said uprights, means carried by said platform and connected to the other end of said cathode, and resilient means supported on said stem and engaging said platform.

12. An electrode assembly for electron discharge devices, comprising a stem, a plurality of parallel uprights extending from said stem, means maintaining said uprights in parallel relation, a cathode having one end secured to one of said uprights, and extending parallel thereto, an electrode mounted on another of said uprights and having a portion adjacent and parallel to said cathode, a platform slidably mounted on said uprights, a support carried by said platform, a rocker member carried by said support and engaging the other end of said cathode, and resilient means mounted on said stem and bearing against said platform.

13. An electron discharge device comprising an enclosing vessel having a stem at one end, a plurality of uprights extending from said stem, a plate member mounted on one of said uprights, an electrode element carried by said plate member, a cathode having one end secured to another of said uprights, supporting means connected to the other end of said cathode and allowing longitudinal expansion and contraction thereof, and guiding means extending from the other end of said vessel and slidably engaging said plate member.

14. An electron discharge device comprising an enclosing vessel having a stem, support means extending from said stem, an electrode assembly mounted on said support means and including a cylindrical shell, supports extending from said stem, spaced insulating discs mounted on said supports and fitted within said shell, a plurality of filamentary electrodes connected at one end to said supports, supporting means connected to the other end of said filamentary electrodes including uprights extending through said discs and slidable therein, and resilient means mounted on said stem and urging said uprights away from said stem to tension said filamentary electrodes.

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