April 7, 1942. J. W. WEST 2,278,628

ELECTRON DISCHARGE DEVICE

Filed June 28, 1941 3 Sheets-Sheet 1

FIG. 1

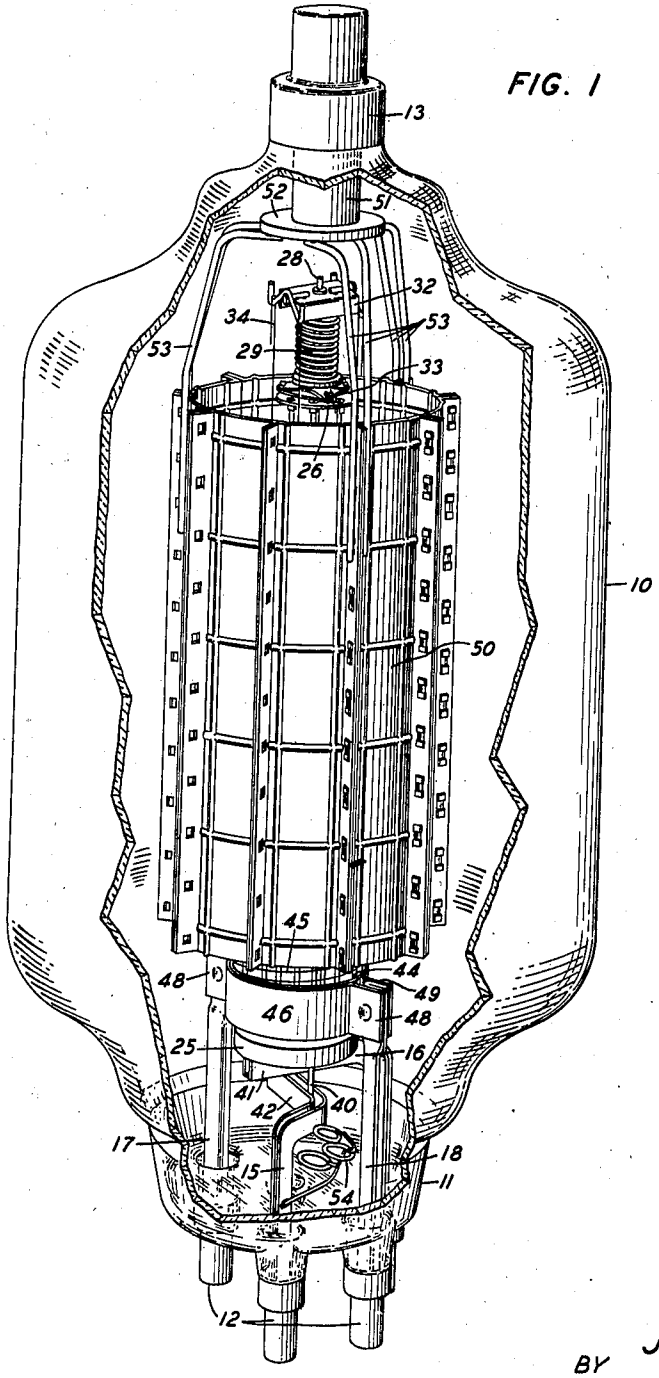

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FIG. 2

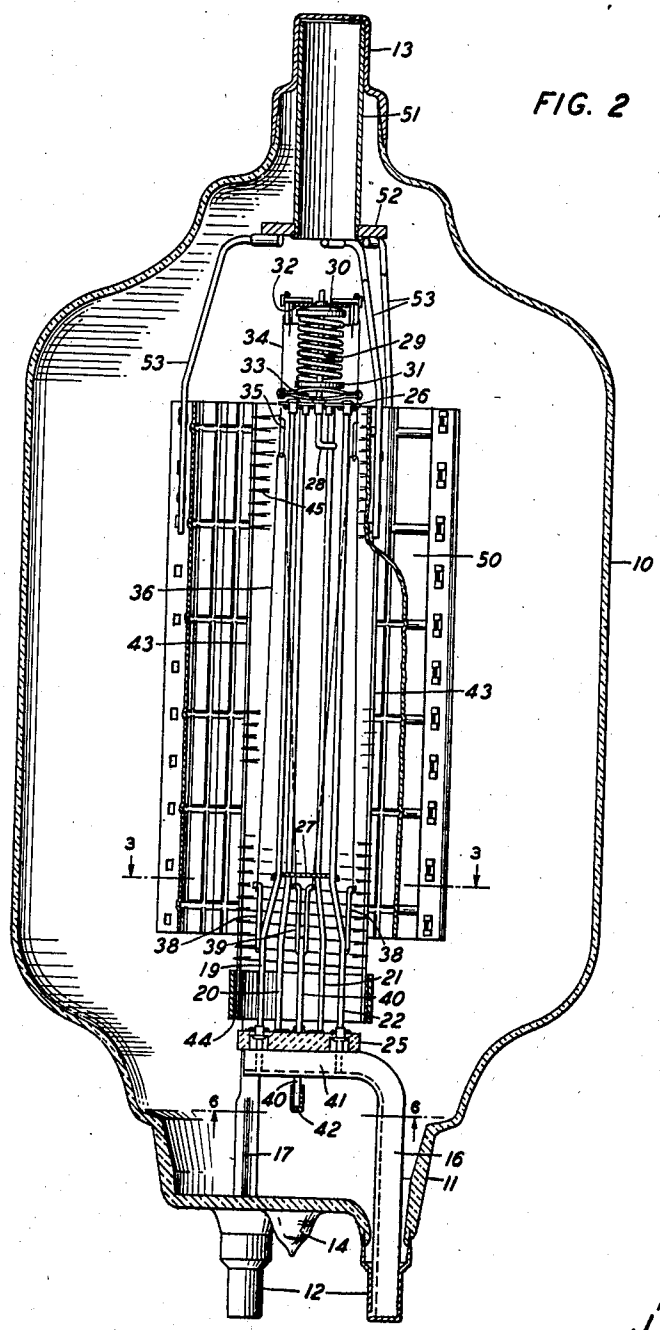

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FIG. 4

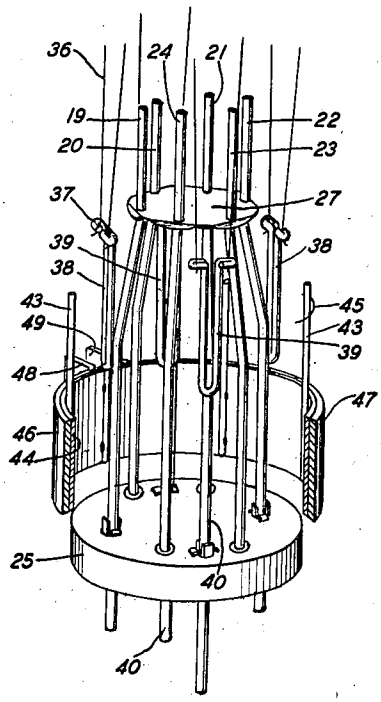


FIG. 3

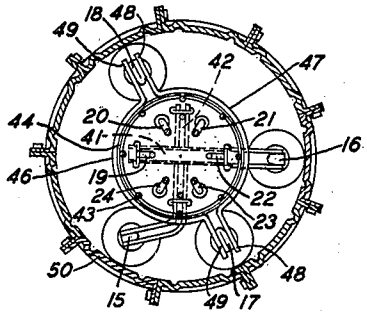


FIG. 6

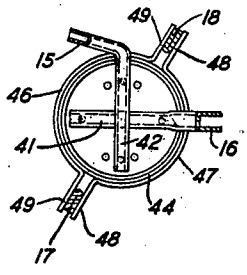
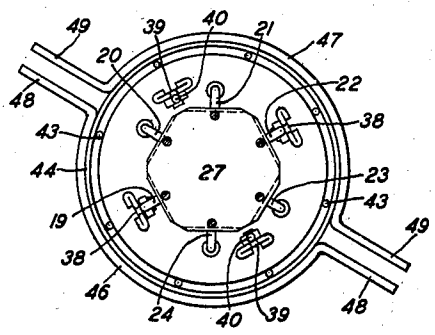


FIG. 5



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UNITED STATES PATENT OFFICE

2,278,628

ELECTRON DISCHARGE DEVICE

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Application June 28, 1941, Serial No. 400,221

18 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more especially to such devices of high power capacity employed in short-wave transmission systems.

In discharge devices having a large power output of the order of 1 kilowatt or more, the electron emitting source is usually in the form of a plurality of tungsten filament sections or strands which are tensioned to maintain the strands in uniform spaced relation to other electrodes in the device. Since the power output is dependent on the area of the electrodes, and other electrical characteristics of the device limit the diameters of the electrodes, it is evident that as the power is increased the length of the electrodes must be increased so that in order to offset turbulence and oscillatory action in the emitting strands a sturdier supporting structure must be provided to realize the highest efficiency of the device.

An object of this invention is to increase the stability of the electrode assembly in discharge devices.

Another object of the invention is to insure constant space relation between the associated electrodes in the device.

A further object of the invention is to prevent shock and vibration from distorting the electrodes from their normal relation.

These objects are attained in accordance with one aspect of the invention in an air-cooled type device comprising a glass enclosing vessel provided with an anode of large surface area, which surrounds a central standard supporting multiple filament sections or strands, and a control electrode positioned intermediate the filament and the anode. The filament assembly and the grid or control electrode are supported by pairs of terminals sealed to the opposite end of the vessel.

A feature of the invention relates to a filament assembly of rugged construction having a central skeleton column or pillar formed of a plurality of rods arranged in a cylindrical boundary rigidly secured at opposite ends to platforms, the platform at one end supporting a tension unit from which a plurality of filament sections are suspended and the platform at the other end forming the base support of the assembly.

A further feature of this assembly relates to a tie plate or truss member intermediate the platforms of the pillar for reenforcing the pillar against vibration, warpage and displacement of the individual rods of the pillar.

Another feature of the invention relates to the direct coupling of the multiple filament sections to conductors supported in the stem of the vessel. This arrangement includes channel conductors extending from terminals in the stem, the conductors having extensions in bisecting or crossing relation adjacent the supporting platform and the filament support rods extending through the platform being seated in the channel recesses of the conductors. This facilitates the mounting of the filament assembly in the axis of the vessel and insures a rigid connection of the filament rods directly to the conductors.

Still another feature of the invention relates to the support of the grid or control electrode in symmetrical relation to the filament assembly and the anode. This is accomplished by coupling a split band or other embracing member to the grid structure and supporting the band by upright channel conductors extending from terminals in the stem.

These and other features and advantages of this invention will be apparent from the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 is a perspective view of an electron discharge device illustrating one embodiment of the invention with a portion of the enclosing vessel broken away to show the internal structural elements;

Fig. 2 is a view in elevation of the device of Fig. 1, showing the enclosing electrodes broken away and various details of the assembly in cross section to aid in comprehending the invention;

Fig. 3 is a plan view in cross section of the electrode assembly taken on the line 3—3 of Fig. 2 in the direction of the arrow to illustrate the relative positions of the respective electrodes;

Fig. 4 is an enlarged perspective view of the lower portion of the filament assembly separate from its position in the enclosing vessel;

Fig. 5 is a plan view of the structure of Fig. 4 showing the relationship of the various elements of the filament assembly and the control electrode; and

Fig. 6 is a plan view of the lower end of the filament assembly taken on line 6—6 of Fig. 2 in the direction of the arrow to illustrate the position of the crossing conductors which are directly connected to the filament assembly.

Referring to the drawings, an electron discharge device illustrative of the various features of this invention comprises a double-ended enclosing vessel 10 having a molded or pre-cast dish portion 11 fused to the lower reduced end of the enclosing vessel, the stem being provided

with thimble type metallic terminal members 12, each thimble having a rim of knife-edge formation hermetically sealed into the glass wall surrounding an aperture in the dish stem 11. A larger diameter thimble terminal 13 is sealed to the reduced upper end of the vessel 10 coaxial with the axis of the vessel. The dish stem 11 is provided with a central sealing tip 14 through which the vessel is evacuated prior to sealing. A plurality of rigid conductors are mounted in the hollow terminals 12 in the stem, as shown in Figs. 1 and 2. These conductors are formed of channel-shaped members 15 and 16 for the filament assembly and 17 and 18 for the grid assembly.

The filament assembly, which forms one of the features of this invention, comprises a superstructure of rigid construction involving a cage or skeleton column or pillar formed of six rigid rods 19 to 23, inclusive, arranged in the boundary of a cylinder and anchored at one end in a "lavite" disc or platform base 25, or other ceramic material having a high insulating property, by metallic eyelets secured in the disc, the rods 19 and 22 extending beyond the opposite face of the disc. These rods are bent inwardly to a smaller diameter circumference a short distance beyond the platform and then extend vertically to a metallic disc or platform 26, the rods being secured therein by metallic eyelets. A reenforcing truss member or tie disc 27 engages the rod beyond the inward bend thereof with the edges bent downwardly in contact with the rod and welded thereto, the disc having a sexagonal configuration as shown in Fig. 5. The disc 27 offsets the tendency of the rod to vibrate and materially strengthens the pillar construction of the filament assembly, and the platform anchors at both ends of the rods insure a strong and stable construction. A filament tensioning assembly is mounted on the top of the metallic disc 26 and comprises a central rod 28 extending through the disc and having a bent portion welded to one of the pillar rods. The tension assembly includes a helical spring 29 surrounding the rod 28, which is mounted between insulating buttons 30 and 31, the upper button 30 supporting a universally movable platform 32 and the insulating button 31 being seated upon a bowed bimetallic compensating element 33 which slidably fits over the central rod 28 and is seated on the metallic disc or platform 26. This tension assembly forms no part of the present invention since the structure is disclosed and claimed in Patent 1,927,084, dated September 19, 1933, to C. Depew and Patent 2,082,120 dated June 1, 1937, to V. L. Ronci. The universally movable platform 32 carries a plurality of wire hooks 34, which are suspended below the tension assembly, each terminating in a locking loop 35 which engages the bight of a hairpin filament section 36, preferably of tungsten. There are four filament sections disposed about the pillar assembly and the lower ends thereof are clamped in the bent ends 37 of a U-shaped wire member 38 welded to the rods 19 and 22 slightly below the inward bends thereof. The other ends of the filaments are clamped in the bent terminations of similar U-shaped wire members 39 positioned intermediate the rods 20 and 21, 23 and 24, respectively, and supported on the insulating platform 25 by rods 40, which pass through eyelets in the platform and extend below the platform, as shown in Fig. 4. This arrangement distributes the various sections of the filament in a circular boundary about the pillar construction and facilitates the alignment of the filament section in a uniform boundary throughout their length.

The projection of rods 19, 22 and 40 below the platform 25 facilitates the direct connection of the filament sections in parallel to the two terminal conductors 15 and 16 projecting from the stem, the extensions of the rods 19 and 22 being seated in spaced positions in the recess of the angular channel extensions 41 and welded therein, and the longer extensions of the rods 40 being seated in the recess of the bent extension channel portion 42 of the conductor 15. The extensions 41 and 42 of the conductors are in transverse or bisecting relation to each other in different planes so that they line up with the extending rods in the platform 25 and therefore not only are electrically connected to the filament sections, but also rigidly support the whole filament assembly, the extension 41 of the conductor 16 abutting against the lower surface of the platform 25 and being seated rigidly thereon. The portions of the rods extending below the platform 25 may be welded in the channel members to insure a rigid connection and avoid high resistance coupling. The transverse or crossing extensions of the conductors 15 and 16 are in bisecting relation in the axis of the vessel and therefore equalize the bending stresses acting on the filament assembly. In view of the reenforced construction of these conductors and their short length between the filament assembly and the terminals 12, a rigid and efficient superstructure is realized. Furthermore, each filament section is electrically connected to both conductors 15 and 16 through the rods 19, 22 and 40, so that the filament sections are uniformly heated in parallel, whereby temperature variation in the sections is eliminated and undue strain is removed.

A control electrode or grid surrounds the filament assembly and is formed of a plurality of upright rods 43 secured at the lower end to the inner surface of a metallic ring 44 and having a fine wire 45 helically wound about the rods and welded thereto. The control electrode or grid is axially supported with respect to the filament assembly by a bi-part member or collar formed of a pair of arcuate bands 46 and 47 adequately secured to the ring 44 and provided with outwardly extending ears or tab portions 48 and 49, respectively at opposite ends thereof. The ears or tab portions are equally spaced from each other on opposite sides of the grid structure to form a slot or groove for the flattened ends of the straight channel conductors 17 and 18, respectively, which are welded to the extensions and rigidly support the grid structure coaxially with respect to the filament assembly.

A cylindrical anode 50 coaxially surrounds the filament assembly and grid structure and is fabricated from a plurality of arcuate sheet metal sections having longitudinal flanges mechanically secured to adjacent flanges to constitute a cylinder, the flanges aiding in dissipating the heat generated in the anode and the arcuate sections being reenforced by corrugations to prevent warping or buckling of the anode sections. The anode is rigidly supported from the hollow terminal 13 on the top of the vessel 10 by a tubular metallic member 51 rigidly seated in the terminal 13 and extending within the vessel 10, the tubular member 51 being provided with a ring flange 52. The cylindrical anode 50 is secured to the

flange 52 by a plurality of pairs of bent wires 53 which are welded to the lower face of the flange 52 at one end and secured to the outer surface on opposite sides of the spaced flanges around the anode. A getter support 54 is mounted in the stem 11 of the vessel and attached to the conductor 15 whereby the residual gases remaining after the usual evacuation process is performed may be absorbed and localized in the device. The rugged construction of the electrode elements entering into the assembly of the device enables the attainment of high operating efficiency in power output and the individual supporting assemblies of the elements insure high insulation and low internal resistance for the elements, particularly for operation in the ultra-high frequency range in transmitting energy for communication systems.

While the invention has been described with respect to a particular embodiment of the invention, it is, of course, understood that various modifications may be made in the detailed assembly of the elements and their fabrication without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel, a plurality of electrodes within said vessel including a cathode assembly, a pair of rigid conductors extending into said vessel and mounted in bisecting and insulating relation, and means connecting said cathode assembly directly to said conductors.

2. An electron discharge device comprising an enclosing vessel, a plurality of electrodes within said vessel including a cathode assembly having a plurality of sections, a platform supporting said sections, a pair of rigid conductors extending into said vessel and mounted in bisecting and insulating relation at one end of said vessel, and means extending beyond said platform connecting said sections directly to said conductors.

3. An electron discharge device comprising an enclosing vessel, a plurality of electrodes within said vessel including a cathode assembly having a plurality of sections, a platform supporting said sections, a pair of channel conductors extending into said vessel having portions in bisecting relation adjacent said platform, and connecting members for said sections extending on opposite sides of said platform and being seated in the recesses of said conductors.

4. An electron discharge device comprising an enclosing vessel, a plurality of electrodes within said vessel including a cathode assembly having a plurality of sections, a platform supporting said sections, and a pair of channel conductors extending into said vessel having portions in bisecting relation, said platform abutting against one of said portions and being joined to the other portion.

5. An electron discharge device comprising an enclosing vessel, a plurality of electrodes within said vessel including a cathode assembly having a plurality of sections, a platform supporting said sections, and a pair of channel conductors extending into said vessel having portions in bisecting relation, said platform being supported on one of said conductors in one plane and being supported by the other conductor in a transverse plane.

6. An electron discharge device comprising a vessel containing a plurality of electrodes and having a molded dish stem at one end, hollow terminals sealed in said stem, channel-shaped conductors supported by said terminals, at least two of said conductors having bent extensions crossing at the axis of said vessel in different planes, a filament assembly including an insulating platform, and supporting members extending through said platform, certain of said supporting members being joined to said channel-shaped conductors in alignment therewith.

7. An electron discharge device comprising an enclosing vessel, a plurality of electrodes within said vessel including a filament assembly formed of a plurality of incandescent sections disposed about a skeleton pillar support, said support having a plurality of upright rods connected together at opposite ends by support platforms, means on one of said platforms engaging said sections, means on the other platform securing the ends of said sections thereto, and strengthening means engaging said rods intermediate said platforms to lessen the vibration of said rods.

8. An electron discharge device comprising an enclosing vessel, a plurality of electrodes within said vessel including a filament assembly formed of a plurality of incandescent sections disposed about a skeleton pillar support, said support having a plurality of upright rods connected together at opposite ends by support platforms, means on one of said platforms engaging said sections, means on the other platform securing the ends of said sections thereto, and a tie plate extending across said rods intermediate said platforms.

9. An electron discharge device comprising an enclosing vessel, a plurality of electrodes within said vessel including a filament assembly formed of a plurality of incandescent sections disposed about a skeleton pillar support, said support having a plurality of upright rods connected together at opposite ends by support platforms, means on one of said platforms engaging said sections, means on the other platform securing the ends of said sections thereto, and an apertured metallic disc embracing said rods and extending in parallel relationship between said platforms.

10. An electron discharge device comprising an enclosing vessel, a plurality of electrodes within said vessel including a filament assembly formed of a plurality of incandescent sections disposed about a skeleton pillar support, said support having a plurality of upright rods connected together at opposite ends by support platforms, means on one of said platforms engaging said sections, means on the other platform securing the ends of said sections thereto, and an apertured metallic disc embracing said rods and extending parallel between said platforms, the edge of said disc being flattened adjacent each rod.

11. A filament assembly for an electron discharge device comprising a skeleton framework of upright rods mounted in a cylindrical configuration, a metallic plate secured to said rods at one end, an insulating platform secured to said rods at the other end, a central post extending through said plate, a tension mounting surrounding said post, a plurality of filament sections surrounding said framework and being suspended from said mounting, and U-shaped anchors secured to said rods adjacent said platform for receiving the free ends of said filament sections.

12. A filament assembly for an electron discharge device comprising a skeleton framework of upright rods mounted in a cylindrical configuration, a metallic plate secured to said rods at

one end, an insulating platform secured to said rods at the other end, a central post extending through said plate, a tension mounting surrounding said post, a plurality of filament sections surrounding said framework and being suspended from said mounting, U-shaped anchors secured to said rods adjacent said platforms for receiving the free ends of said filament sections, and a metallic truss member reenforcing said framework beyond the ends of said anchors.

13. A filament assembly for an electron discharge device comprising a skeleton framework of upright rods mounted in a cylindrical configuration, a metallic plate secured to said rods at one end, an insulating platform secured to said rods at the other end, a central post extending through said plate, a tension mounting surrounding said post, a plurality of filament sections surrounding said framework and being suspended from said mounting, U-shaped anchors secured to said rods adjacent said platform for receiving the free ends of said filament sections, and a metallic truss member reenforcing said framework beyond the ends of said anchors, said truss member having overhanging portions exterior to said rods and welded to the outer surfaces of said rods.

14. A filament assembly for an electron discharge device comprising a skeleton framework of upright rods mounted in a cylindrical configuration, a metallic plate secured to said rods at one end, an insulating platform secured to said rods at the other end, a central post extending through said plate, a tension mounting surrounding said post, a plurality of filament sections surrounding said framework and being suspended from said mounting, U-shaped anchors secured to said rods adjacent said platform for receiving the free ends of said filament sections, and auxiliary filament supports projecting from said platform parallel to said framework and positioned intermediate pairs of oppositely disposed rods, said auxiliary supports having long extensions projecting from the opposite side of said platform.

15. In an electron discharge device having a dish stem provided with tubular metallic terminals projecting therefrom, a control electrode comprising a plurality of upright support members, a helical wire wound about said upright members, a ring attached to one end of said members, a pair of arcuate bands embracing said ring and having parallelly extending arms disposed on opposite sides of said ring, and rigid conductors directly connected to said terminals and secured between said arms.

16. In an electron discharge device having a dish stem, provided with tubular metallic terminals projecting therefrom, a control electrode comprising a plurality of upright supporting members, a helical wire wound about said upright members, a ring attached to one end of said members, a pair of arcuate bands embracing said ring and having parallelly extending arms disposed on opposite sides of said ring, and channel-shaped members extending vertically between said terminals and said bands and having compressed portions seated between said arms.

17. In an electron discharge device having a dish stem, a control electrode comprising a plurality of upright supporting members, a helical wire wound about said upright members, a pair of arcuate bands surrounding and connected to said members and having parallelly extending arms disposed on opposite sides thereof, a pair of tubular terminals sealed in said dish stem, said arms being in alignment with said terminals, and channel-shaped metallic conductors interconnecting said arms and said terminals, the ends of said conductors being seated between said arms and in said terminals respectively.

18. An electron discharge device comprising an enclosing vessel having a molded dish stem, a plurality of hollow metallic terminals sealed in said stem, a channel-shaped conductor extending into said vessel from each terminal, two of said conductors having portions bent at angles which cross each other in diametrical directions transverse to the axis of said vessel, the crossing point being coincident with said axis, an elongated pillar support extending coaxially within said vessel, extensions on said support, separately engaging the crossing portions of said conductors, a plurality of filament sections surrounding and supported by said pillar support, said sections being connected to said extensions, a helical grid surrounding said filament sections, a bipart collar connected to one end of said grid, a pair of said conductors being attached to said collar on opposite sides thereof, a cylindrical anode surrounding said grid, and a terminal support at the other end of said vessel connected to said anode.

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