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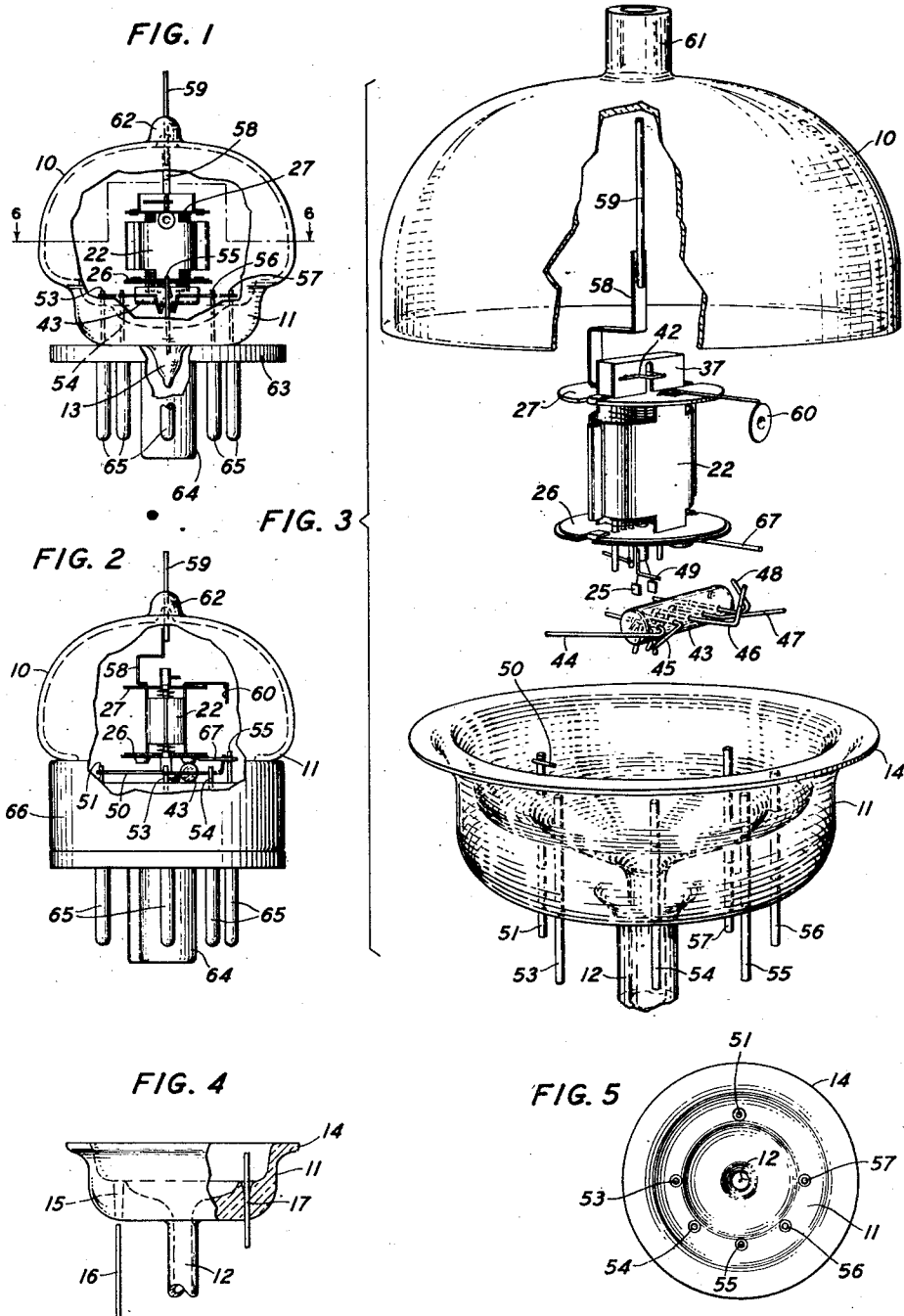
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2,227,093

ELECTRON DISCHARGE DEVICE

Filed July 11, 1939

2 Sheets-Sheet 1



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FIG. 6

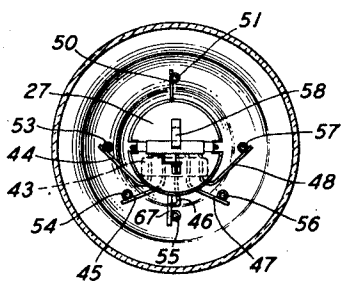


FIG. 9

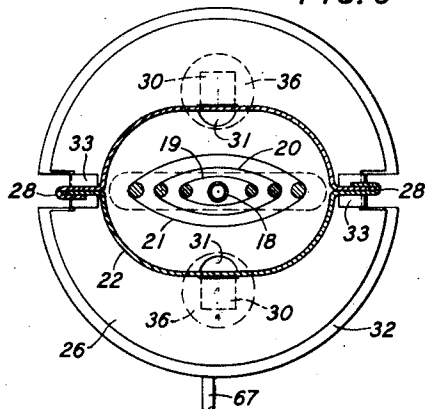


FIG. 8

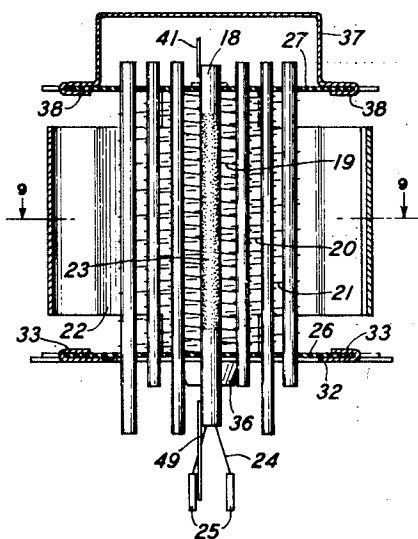
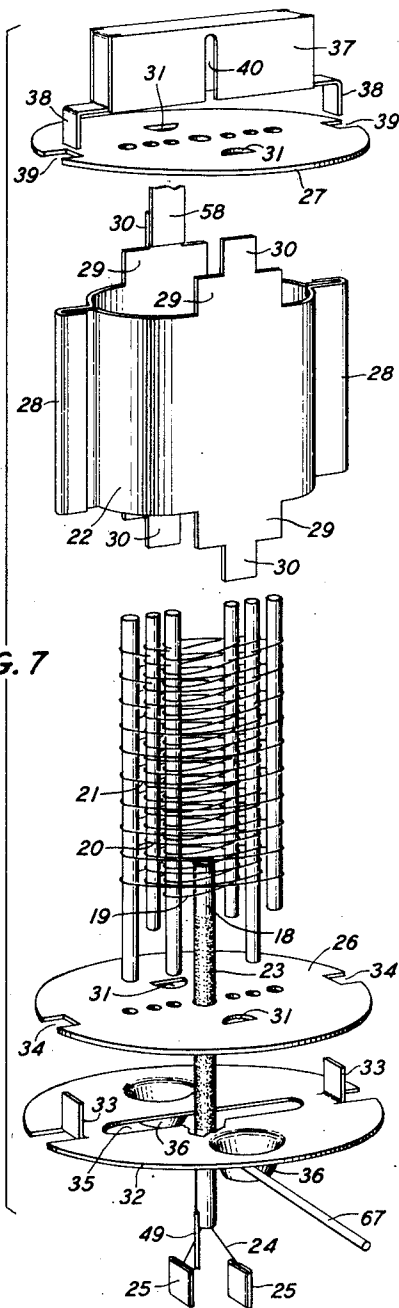


FIG. 7



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ELECTRON DISCHARGE DEVICE

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15 Claims. (Cl. 250-27.5)

This invention relates to electron discharge devices and, more particularly, to such devices for ultra-high frequency communication systems.

In order to obtain high efficiency in the operation of ultra-high frequency electron discharge devices, especially in the range between 300 to 600 megacycles, certain structural limits must be adhered to, such as short leading-in conductors, to reduce mutual conductance, wide spacing of conductors to obtain high insulation and close spacing of electrodes to attain low transit time. These limits entail certain difficulties, particularly in the production of devices on a large scale where reproducible units must be available for replacement or as matched sets of units.

An object of this invention is to overcome these difficulties so that the primary dimensional limits are not compromised.

Another object of the invention is to facilitate the assembly of multielectrode units without affecting the close electrode spacing.

A further object of the invention is to attain efficient manufacturing technique in the mass production of high frequency electron discharge devices.

In accordance with this invention, a pentode unitary electrode assembly suitable for ultra-high frequency operation and having a low transit time characteristic is mounted in a vessel having a dish portion in which the leading-in wires are sealed in suitable spaced relation to achieve the required insulation paths commensurate with the frequency range to which the electrode unit is adapted.

The wide variance in the spacing of the delicate electrodes of the unit and the leading-in conductors necessitates some means of connecting the electrodes to the conductors. The usual tie wires, if too flexible, fail to support the electrode unit and very often introduce noise due to shock or vibration. If the wires are rigid so that noise is eliminated then the wires tend to distort the electrodes and alter the characteristics of the device. These difficulties are overcome, in accordance with this invention, by introducing a coupling element in the assembly which includes an insulating block or bead having short wires held therein spaced in the same relative positions as the electrodes. The coupling element is connected to the respective electrodes in the unit and the free ends of the wires beyond the bead are bent in fan-fashion to be connected to the leading-in conductors. The coupling element furnishes adequate support for the electrode unit and, since the strain caused by bending of the wires is not communicated to

the electrodes, due to the bead barrier, no distortion occurs in the electrodes.

This assembly facilitates the fabrication of the device since the manufacturing technique is simplified, due to the arrangement of the elements embodied in the complete device and the steps of procedure may be followed in sequential order.

A feature of the assembly relates to positioning the coupling element at right angles to the axis of the electrode unit and the leading-in conductors.

Another feature relates to the shielding of the bead barrier by the disc spacer of the electrode unit so that active material is prevented from being deposited across the short path in the bead.

Another feature of the invention relates to the complete shielding of the anode or high potential electrode adjacent the low potential leading-in conductors. This is accomplished by clamping the anode to a disc insulator and shielding the clamp by a cup depression in a metallic disc shield secured to the spacer disc. This cuts off the anode field from the vicinity of the grid leading-in conductors and improves the static and dynamic characteristics of the device.

These and other features of the invention will be more clearly realized from the following detailed description taken in connection with the accompanying drawings:

Fig. 1 is a view in elevation of one arrangement of the device of this invention with a disc base and a portion of the vessel broken away to show the electrode unit;

Fig. 2 illustrates another arrangement of the device with a shell base and with the electrode unit shown at an angle with respect to the unit of Fig. 1;

Fig. 3 shows an enlarged perspective view in exploded fashion of the various elements entering into the assembly of the device of Figs. 1 and 2;

Fig. 4 is a view partly in cross-section of details of the dish stem shown in Fig. 3;

Fig. 5 is a plan view of the stem of Fig. 4;

Fig. 6 is a plan view of Fig. 1 illustrating the arrangement of the electrode unit and the coupler with respect to the conductors in the stem;

Fig. 7 is an enlarged perspective view in exploded fashion of the various details of the multielectrode unit embodied in this invention;

Fig. 8 is an enlarged view in cross-section of the electrode unit of Fig. 7 after assembly; and

Fig. 9 is a plan view of the electrode unit taken on the line 8-8 of Fig. 8.

Referring to the drawings, the electron discharge device of this invention comprises three

essential components, namely; the shell or enclosing vessel, the electrode unit and the coupling element. The enclosing vessel includes a vitreous cap portion 10 and a vitreous molded or cast dish portion or stem 11 having an outwardly extending central tubulation 12 which is sealed off close to the dish stem in the final processing of the device, as shown at 13, in Fig. 1, and a peripheral flange 14. The stem is provided with tapered bores 15, Fig. 4, for the introduction of short leading-in conductors 16 which are sealed in the thickened portion of the stem as shown at 17. Fig. 5 shows the arrangement of the conductors in the stem 11 for the device of Fig. 1 in which five conductors are spaced equidistant in a 180-degree arc, and a single conductor is positioned at a center point between the end conductors on the same boundary. This spatial relationship of the conductors insures adequate insulation paths between the various electrodes external to the vessel where the air dielectric is easily broken down by ultra-high frequency currents. The molded type stem involved in this invention offers an efficient sealing mass for the leading-in conductors and facilitates the ready fusing of the cap 10 to the flange 14 to provide a compact evacuated container for the electrode assembly.

The electrode unitary assembly embodied in this invention is the multielectrode or pentode type in which a central equipotential cathode 18 is successively surrounded by a control grid 19, a screen or shield grid 20, a suppressor grid 21, and a plate or anode 22. The cathode is a cylindrical metallic tube having an electron emissive coating 23 thereon of alkaline earth oxide or other suitable mixture of active compounds or metals or combinations thereof, and a fine wire internal heating element 24 which is suitably insulated from the cathode and provided with tabs 25 to facilitate the welding of the fine heater wire to the external conductors of the device.

The cathode and heater combination is mounted centrally between mica or other insulating spacer discs 26 and 27. The grids 19, 20 and 21 are the oval helical type supported by the usual side rods which are successively positioned in the corresponding apertures in the spacer discs 26 and 27. The anode 22 is of oval cross-section and is formed of two half portions joined together at the longitudinal flanges 28 and the anode is also provided with pairs of seating projections 29 and integral ears 30 which fit into apertures 31 in the mica spacers and are bent over on the opposite side of each of the spacers.

A metallic shield 32 is secured to the bottom of the lower spacer disc 26 by tabs 33 located in a slot 34 of the disc. This shield is provided with an elongated slot 35 to clear the projecting rods of the internal electrodes and is also provided with cup-shaped depressions 36 to effectively shield the supporting ears 30 of the anode so that the high potential field is electrically isolated or shielded from the low potential electrodes, such as the grids, and particularly the control grid. The low potential electrodes are also effectively shielded from the anode field at the top of the unit by a box shield 37 which encloses the projecting ends of the internal electrodes and is attached to the upper spacer disc 27 by tabs 38 clamped in the slots 39 of the disc. The box shield is provided with a central vertical slot 40 and a wire connection 41 from the cathode 18, Fig. 8, extends through the slot and is connected to the shield as shown in Fig. 3 at 42.

While the drawings show the devices of this in-

vention in greatly enlarged form for clarity, the actual device is a miniature compared to the drawings and the ordinary form of an electronic pentode device. The comparatively small size of the elements controls the ultra-high frequency range in which the device will function and the spacing of the elements and the leading-in conductors controls the dynamic and electrostatic characteristics of the device. As a typical example of the size of the device of this invention the over-all dimensions of the vessel and unit are: vessel diameter $1\frac{3}{8}$ inches, length $1\frac{1}{4}$ inches; unit diameter $\frac{7}{16}$ inch, length $\frac{7}{16}$ inch. The spacing between the cathode and the first surrounding grid 19 is approximately .004 inch, between grid 19 and grid 20 is .0065 inch, between grid 20 and grid 21 is .014 inch and between grid 21 and the anode 22 is .053 inch. The leading-in conductors for the cathode, heater and the grids 20 and 21 are arranged in an arc on the circumference of a $1\frac{1}{16}$ inch circle in the dish stem at angles of 45 degrees each.

The electrodes of the pentode unit, due to the small size and close spacing, are extremely delicate and can not stand stress or strain without distorting their shape which would alter the spacing over the active portion and, consequently, affect the characteristics of the device or materially injure the unit by physical contact of the adjacent electrodes. Furthermore, the wide variance between the closely spaced electrodes and the relatively wide spacing of the leading-in conductors requires an equalizing connection which not only eliminates strain but also affords support of the unit in the enclosing vessel. This is accomplished in accordance with this invention by an intermediate coupling element which connects the various electrodes to the respective leading-in conductors without straining the delicate electrodes and insures a rigid support of the unit in the device.

The coupling element of this invention is shown more clearly in Figs. 3 and 6 and comprises an insulating rod or bead 43, preferably of glass, and a group of parallel wires 44, 45, 46, 47 and 48 which are sealed in the bead so that short portions project from one side of the bead 43 and long portions project from the opposite side. This coupling element is affixed to the electrode unit prior to inserting the unit in the vessel by connecting the short portions of the wires to the respective electrodes as follows: wire 44 is welded to the long support rod of grid 21, wire 45 is affixed to the tab 25 of the heater element 24, wire 46 is connected to a stub wire 49 carried by the cathode sleeve 18, wire 47 is connected to the other tab 25 of the heater element and wire 48 is attached to the long support rod of screen grid 20. A straight wire 50 is attached at right angles to the long support rod of the control grid 19 and extends in a direction opposite to the coupling element.

In this arrangement the electrodes of the unit are rigidly supported by the coupling element and the unit in turn forms a shield for the insulator 43 so that active or conductive metal is not deposited thereon to impair the insulation resistance between the coupling wires. Furthermore, the electrodes are not subjected to any strain or stress regardless of the bending of the long portions of the coupling wires extending from the opposite sides of the glass bead 43. These wire portions may be bent to any degree desired without transmitting the bending torque to the electrodes since the bead forms a cut-off

barrier to stresses produced in the long bent wire portions.

The unit is mounted in the dish stem 11 by connecting the control grid coupling wire 50 to a leading-in conductor 51 as shown in Fig. 3. The wires 44, 45, 47 and 48 in the coupling element are bent in fan-fashion as shown in Fig. 3 and successively secured to the respective leading-in conductors 53, 54, 56 and 57. The central coupling wire 46 for the cathode is bent upwardly and welded to a rigid support wire 67 which is affixed to the shield 32, the wire 67 extending out of the leading-in conductor 55. This arrangement forms a bracing support of the unit so that the elements are not subjected to strain acting on the bead coupling. As shown in Fig. 6, these connections may be easily realized, since the leading-in conductors are arranged at a greater radius than the radius of the electrode unit. The anode 22 is provided with a conductive strap 58 to which is connected a leading-in conductor 59. A getter tab 60 is attached to a support welded to the opposite ear 30 of the anode bearing against the upper spacer disc 27.

The completion of the assembly of the device consists in lowering the cap portion 10 of the vessel so that the peripheral edge embraces the flange 14 of the dish stem 11 to permit the fusing of these portions so that the vessel assumes a shape as shown in Fig. 1. In this adjustment stage, the anode leading-in conductor 59 extends through a sleeve portion 61 at the top of the cap 10 and after the flange seal is completed the conductor 59 is sealed in the sleeve 61 as shown at 62 in Fig. 1. The completed assembly is then processed in a well-known manner to completely evacuate the device by connecting the exhaust tubulation 12 to a pumping station after which the tubulation is sealed off at 13.

The device of this invention may be provided with a disc base 63 as shown in Fig. 1 in certain installations requiring a low external capacity. This base is provided with a hollow central indexing projection 64 which forms a receptacle for the seal 13 to prevent injury thereto and the base is also provided with terminal prongs 65 for the respective leading-in conductors of the electrodes. Fig. 2 shows a modified base in which a shell 66 is cemented to the dish stem of the vessel and this shell supports a disc carrying the terminals and indexing projection.

While the invention has been described and shown as applied to a pentode device, it is, of course, understood that the invention may be utilized in other arrangements in which ultra-short wave electrode units are to be coupled to widely spaced leading-in wires in an enclosing vessel. Furthermore, various modifications may be made in the correlation of the elements entering into the device of this invention without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel having a stem, an electrode unit axially mounted within said vessel, a plurality of leading-in conductors in said stem parallel to the axis thereof and mounted in arcuate form at a radius greater than the diameter of said unit, and a coupling element connecting said electrode unit to said leading-in conductors and disposed at an angle with respect to said unit and said conductors.

2. An electron discharge device comprising an enclosing vessel having a stem, an electrode unit

axially mounted within said vessel, a plurality of leading-in conductors in said stem parallel to the axis thereof and mounted in arcuate form at a radius greater than the diameter of said unit, and a coupling element between said unit and leading-in conductors, said element having wires joined to the electrodes of said unit and held in position by an insulating member and said wires being bent in fan-fashion beyond said insulating member to intersect said leading-in conductors.

3. An electron discharge device comprising an enclosing vessel having a stem, an electrode unit axially mounted within said vessel, a plurality of leading-in conductors in said stem parallel to the axis thereof and mounted in arcuate form at a radius greater than the diameter of said unit, and a coupling element transversely positioned between said electrode unit and said leading-in conductors, said element having wires fused in a bead with the wires connected respectively to the electrodes of said unit and said conductors, whereby bending of the wires adjacent one side of the bead toward said conductors will not distort the wires on the opposite side of said bead adjacent the electrodes of said unit.

4. An electron discharge device comprising an enclosing vessel having a cup stem, an electrode unit axially mounted within said vessel and extending into said stem, a plurality of leading-in conductors in said stem parallel to the axis thereof and mounted in arcuate form at a radius greater than the diameter of said unit, and a coupling element disposed below the rim of said cup stem and connecting said electrode unit to said leading-in conductors, said element being composed of parallel wires fused in a glass bead whereby said wires may be attached to the electrodes of said unit and also to said conductors without distorting the electrodes.

5. An electron discharge device comprising an enclosing vessel having a stem, an electrode unit axially mounted within said vessel, a plurality of leading-in conductors in said stem parallel to the axis thereof and mounted in arcuate form at a radius greater than the diameter of said unit, a coupling element transverse to and connecting said electrode unit to said leading-in conductors, said element including a glass bead and individual wires attached to the respective electrodes and conductors, and means for shielding said bead from a direct path of active material diffused from one of the electrodes.

6. An electron discharge device comprising an electrode assembly having a plurality of electrodes, an insulated spacer at each end of said electrodes for coupling them together, a stem having spaced conductors sealed therein parallel to the axis thereof, a cap portion enclosing said assembly and sealed to said stem, and an insulating coupling element extending at right angles with respect to said electrodes and said conductors having individual wires secured therein and attached to said electrodes and said conductors.

7. An ultra-high frequency electron discharge device comprising an enclosing vessel having short leading-in conductors, an electrode unit having electrodes spaced apart between approximate limits of .004 to .053 inch, and a coupling element including connecting wires held in an insulating member, said wires between said member and said electrodes being substantially straight and beyond said member, the wires being spread out for connection to said conductors.

8. An ultra-high frequency electron discharge

device comprising an enclosing vessel having short leading-in conductors sealed therein, an electrode unit having electrodes spaced apart between approximate limits of .004 to .053 inch, and a coupling element supporting said unit in said vessel, said element including wires connecting said electrodes to said conductors.

9. An ultra-high frequency electron discharge device comprising an enclosing vessel having short leading-in conductors sealed therein, an electrode unit having electrodes spaced apart between approximate limits of .004 to .053 inch, and a coupling element mounted at right angles to said unit and said conductors and interposed therebetween and connecting the electrodes of said unit to said conductors.

10. An electron discharge device comprising an enclosing vessel having leading-in conductors, a unitary electrode assembly within said vessel including a cathode and anode, means supporting said assembly from said conductors, insulating spacers at opposite ends of said cathode and anode, means on said anode projecting through said spacers, and a metallic shield adjacent one of said spacers having depressed portions enclosing the projecting means of said anode.

11. An electron discharge device comprising an enclosing vessel having leading-in conductors, a unitary electrode assembly within said vessel including a cathode and anode, means supporting said assembly from said conductors, insulating spacers at opposite ends of said cathode and anode, said anode having integral ears projecting through said spacers to clamp said anode thereto, and a metallic shield attached to one side of one of said spacers and having cup extensions mounted in alignment with the anode ears and forming a barrier between said anode and said leading-in conductors.

12. An electron discharge device comprising an enclosing vessel having leading-in conductors sealed therein, a unitary electrode assembly within said vessel including a cathode, an anode, and a plurality of grid elements between said cathode and anode, insulating discs spacing the electrodes in cooperating relation, said anode having ear projections engaging said discs to hold the electrodes in the unit, a coupling member connecting said cathode and said grid elements to said leading-in conductors, and a metallic disc adjacent the insulating disc between said electrodes and said conductors and

having recessed portions enclosing the ear projections exposed to said conductors.

13. An ultra-high frequency multielectrode device comprising a molded dish stem having short leading-in conductors mounted in a circular boundary and parallel to the axis of said stem, an electrode unit of smaller diameter than the boundary radius of said leading-in conductors mounted in said stem, an enclosing cap surrounding said unit and sealed to the periphery of said stem, and a coupling element interposed transversely between said unit and said conductors having wires connected between said electrode unit and said conductors.

14. An ultra-high frequency multielectrode device comprising a molded dish stem having short leading-in conductors mounted in a circular boundary and parallel to the axis of said stem, an electrode unit of smaller diameter than the boundary radius of said leading-in conductors mounted in said stem, an enclosing cap surrounding said unit and sealed to the periphery of said stem, and a coupling element consisting of a plurality of wires held in an elongated bead and extending horizontally below said unit, said wires being attached at one end to the electrodes of said unit and at the other end being secured to said conductors.

15. An ultra-high frequency electron discharge device of miniature size comprising an enclosing vessel of approximately one inch dimension having a dish stem and a cap portion sealed thereto, leading-in conductors sealed in said stem on a radius of approximately one-half inch, an electrode unit axially mounted within said vessel having approximate dimensions of one-quarter inch length and one-half inch diameter, said unit including insulator spacer discs and a cathode, three grids and an anode supported therebetween, the lateral spacings between said cathode and said grids being between .004 to .014 inch, and a support for said unit including individual wires extending through a joining insulator, the wires on one side of said insulator being substantially parallel and connected to said cathode and said grids and the same wires on the other side of the insulator being bent toward and attached to said conductors in a horizontal plane, said insulator preventing the bending stress of said wires being communicated to the electrodes.

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