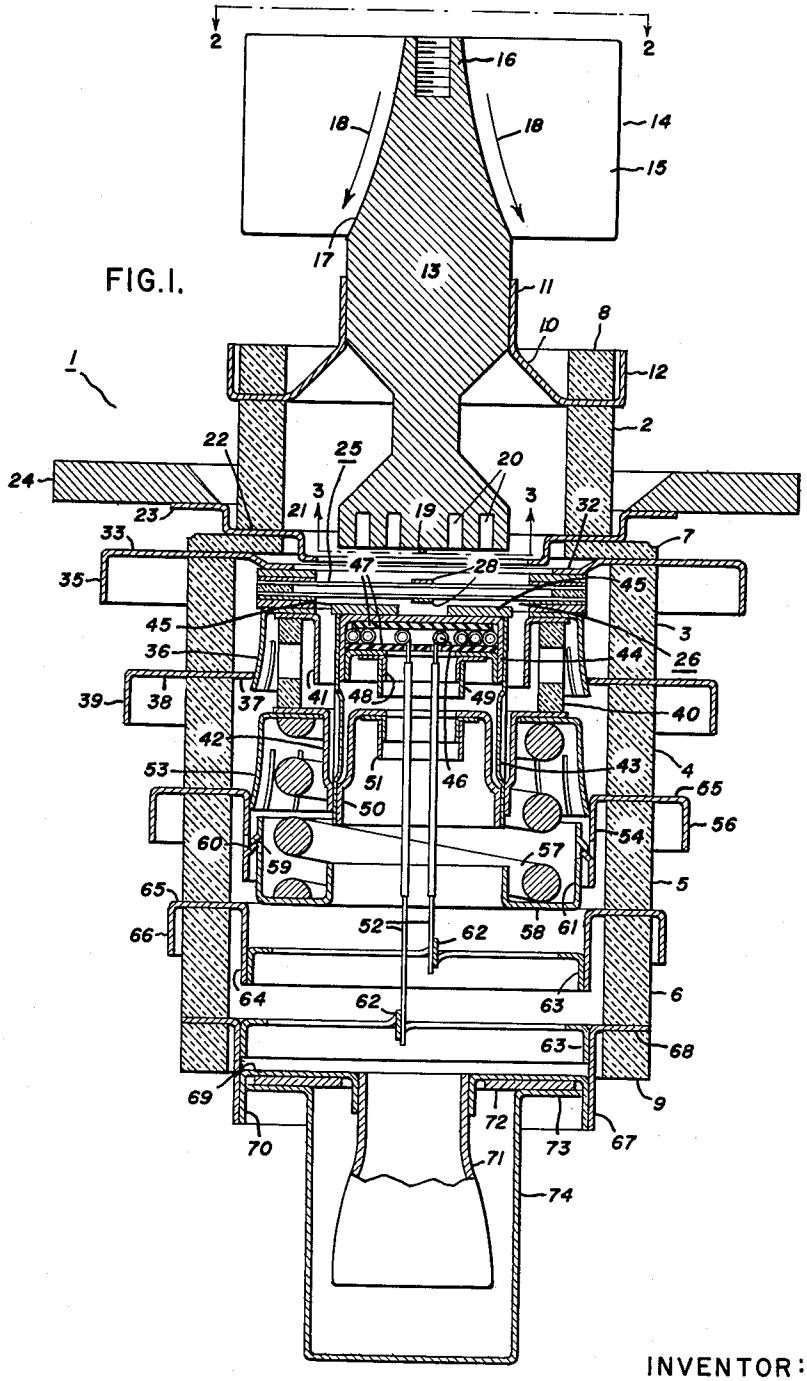
March 19, 1963 R. E. MANFREDI 3,082,339

ELECTRIC DISCHARGE DEVICE

Filed Aug. 11, 1959 2 Sheets-Sheet 1

FIG. 1.



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ELECTRIC DISCHARGE DEVICE

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FIG.2.

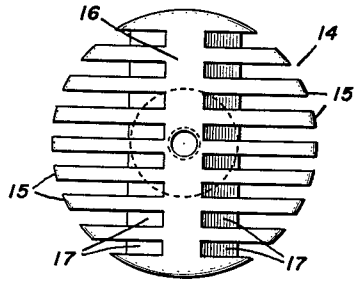


FIG.3.

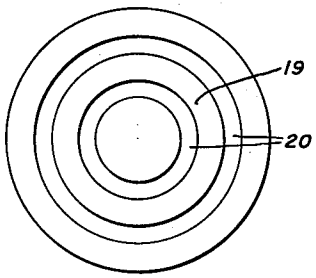


FIG.4.

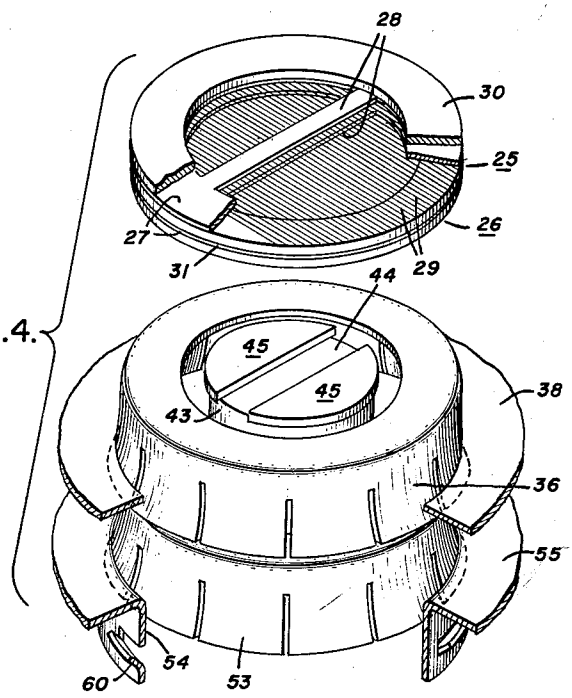
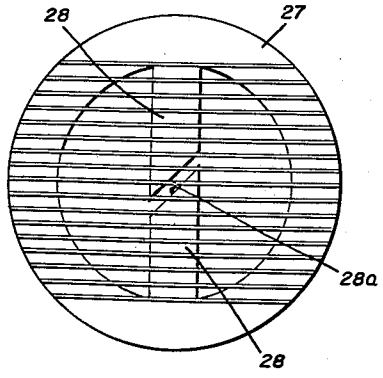


FIG.5.



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3,082,339

ELECTRIC DISCHARGE DEVICE

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Filed Aug. 11, 1959, Ser. No. 832,994
17 Claims. (Cl. 313—43)

The present invention relates to electric discharge devices and pertains more particularly to an improved electric discharge device adapted for withstanding substantial shock and vibration.

The primary object of the present invention is to provide an electric discharge device including an envelope and electrode contact construction adapted for withstanding substantial shock and vibration and for facilitating manufacture.

Another object of the present invention is to provide an improved planar electrode beam power tetrode.

Another object of the present invention is to provide an improved planar-electrode device including an improved envelope and electrode mounting arrangement.

Another object of the present invention is to provide an improved planar anode including improved means for minimizing secondary emission therefrom.

Another object of the present invention is to provide an improved planar-electrode device including an improved grid-cathode assembly.

Another object of the present invention is to provide an improved planar-electrode tetrode including an improved multiple-grid sub-assembly adapted for affording the required internal capacitance when the tetrode is employed for grounded grid amplification.

Another object of the present invention is to provide an improved electric discharge device including improved anode and seal cooling means.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularly in the claims annexed to and forming part of this specification.

In carrying out the objects of the invention there is provided an electric discharge device comprising an envelope structure including a stacked series of axially aligned ceramic insulators of uniform diameter. Butt-sealed between the opposed ends of adjacent insulators are metallic cup-like contact members with downturned rims spaced laterally from the walls of the insulator and with the contact members diminishing in diameter toward one end of the envelope. Inserted in the device from one end thereof is a grid-cathode assembly with resilient contact elements making line contact with the inner rims of appropriate ones of the contact members bonded in the envelope wall. One of the contact members removably supports a retainer cup which carries a compressed coil spring biasing the grid-cathode assembly in position. The grid-cathode assembly includes means for rigidly mounting the various electrodes comprising same and for affording satisfactory predetermined close spacing. The grid sub-assembly comprises a pair of planar grids brazed to opposite sides of a ceramic washer of predetermined thickness. The individual grid elements include means for avoiding sagging of the grid wires thereof. Reduction of the upper diameter of the envelope is afforded by a flat annular insulator sealed between the grid contact in a focusing shield member. An outer rim of the focusing shield member carries a mounting flange for mounting the device in a circuit. The anode includes means for trapping secondary electrons and thus minimizing secondary emission therefrom. A radiator carried by the anode is adapted for improving the cooling of the anode seal. A low-mass, envelope-end construction includes a capped tubulation completing the envelope structure and adapted for serving as an electrical contact to one side of the cathode heater.

For a better understanding of the invention reference may be had to the accompanying drawing in which:

FIGURE 1 is an enlarged sectional view of an electric discharge device incorporating an embodiment of the invention;

FIGURE 2 is an enlarged plan view taken along the lines 2—2 in FIGURE 1 and looking in the direction of the arrows;

FIGURE 3 is an enlarged view taken along the line 3—3 in FIGURE 1 and looking in the direction of the arrows;

FIGURE 4 is an enlarged partially exploded view of the grid-cathode assemby; and

FIGURE 5 is a plan view of a grid element incorporated in my device.

Referring to the drawing, there is shown in FIGURE 1 an electric discharge device embodying a form of the present invention and including an envelope structure generally designated 1. The envelope structure illustrated comprises a first cylindrical ceramic insulator or section 2 which supports an anode sub-assembly to be described in detail hereinafter. The envelope further comprises a vertically stacked coaxially aligned series of ceramic insulators or sections including four ceramic cylinders of greater diameter than the cylinder 2 and which are of uniform diameter and length. For convenience of reference, these last-mentioned four uniform cylinders are designated 3, 4, 5, and 6. Additionally, the envelope includes a flat washer-like ceramic section 7 which serves as a cantilever element in effecting the diametric transition of the envelope from the cylindrical section 2 to the larger ceramic cylinders. This element is completely metallized on both opposed surfaces and the additional functions thereof will be described in greater detail hereinafter. Annular ceramic sections 8 and 9 at the top and bottom ends of the envelope, respectively, serve to back up ceramic-to-metal seals or metallic bonds at the ends of the envelope. Bonded to the upper end of the insulator 2 is a cup-like contact member 10. The bond can be effected by any suitable ceramic-to-metal sealing method and is between the transverse end surface of the member 2 and the bottom or horizontally extending surface of the member 10. The member 10 includes upstanding inner and outer rims 11 and 12, respectively, which are spaced radially from the walls of the insulator 2. Disposed in the member 10 and sealed to the bottom thereof directly over the bond to the ceramic cylinder 2, thus to back up and strengthen the latter, is the above-mentioned ceramic 8. In this arrangement the member 10 is butt-sealed between the ceramics 2 and 8 by a metallic bond and the outer rim 12 is spaced outwardly from the insulator 8, thus to provide a resilient electrical contact surface.

The inner rim 11 of the member 10 receives a metallic anode block 13 which is sealed at a cylindrical mid-section thereof by a suitable metal-to-metal bond to the inner rim 11. Formed on a longitudinally extending outer end of the anode is a heat radiator generally designated 14 which, as shown in FIGURE 2, includes a plurality of spaced parallel longitudinal fins 15 extending from either side of a central support portion 16. The radiator 14 is particularly adapted for being cooled by air moving axially thereagainst. Additionally, as shown in FIGURES 1 and 2, the roots or bottom surfaces 17 between adjacent fins are arcuate or curved outwardly downwardly. This configuration of the surfaces 17 serves to direct axially flowing air outwardly in the manner indicated by the arrows 18 which has a desired effect of

causing turbulent movement of air immediately adjacent the seals between the members **2, 8** and **10**. This turbulence of air tends to sweep out of the cup-like member **10** air that otherwise would tend to be relatively stagnant and of less cooling effect. Thus, the radiator construction illustrated is adapted for improving cooling of the seals between the contact member **10** and associated insulative members.

The inwardly projecting end of the anode **13** includes a planar active end portion **19** adapted for collecting electrons emanating from an axially spaced emitter to be described in detail hereinafter. As seen in FIGURES 1 and 3, the active surface of the anode is formed to include a plurality of circular recesses **20** which are greater in depth than in width. The recesses **20** serve to entrap secondary electrons which would tend to move from the anode back toward the emitter. The circular recesses are more effective than straight recesses for entrapping secondary electrons emitted from the surfaces of the recesses because secondary electrons traveling from the recess walls at an angle are more inclined to be intercepted by the curved walls of the recesses than by straight walls. In other words, if the recesses were straight many electrons emitted from the surfaces thereof and traveling in the same general direction as the straight walls would not be intercepted by the walls of the recesses while the chances of their interception are greater if the walls are curved.

Electrons traveling from the mentioned emitter toward the anode are influenced by a suppressor electrode **21** which comprises an apertured metallic cup-shaped member **22**. The inner rim of the electrode **21** defines the potential at the edge of the electron stream migrating toward the anode. The member **22** includes an intermediate stepped surface to which is sealed the lower transverse surface of the insulator **2**. To the opposite side of the stepped surface of the member **22** is sealed the above-mentioned ceramic washer **22**. Thus, the member **22** is butt-sealed between corresponding portions of the ceramic insulators **2** and **7**.

The member **22** also includes a horizontally extending rim **23** which is outwardly spaced from the outer wall of the insulator **2**. Bonded to the rim **23** is a substantially thicker and more sturdy metal mounting ring or flange **24** adapted for securing the device in an operating circuit.

In operation the suppressor grid **21** is maintained at ground potential and the inner rim thereof establishes a potential well or minimum which prevents secondary electrons from the anode from reaching the other grid electrodes which are disposed between the electrode **21** and the emitter and which will now be described in detail.

The grid electrodes are two in number and together comprise a grid sub-assembly which, in turn, is included in a grid-cathode assembly. The grid sub-assembly includes a screen grid **25** and a control grid **26**. As seen in FIGURES 1 and 4, each of the grids **25** and **26** comprises a substantially thin washer **27** including a straight diametrically extending cross bar **28** across which are brazed a plurality of closely spaced parallel coplanar grid wires **29**. Brazed to the circular portion of the washer **27** on the side thereof opposite the grid wires is a relatively thicker washer **30**. In this structure the washers can be advantageously formed of tungsten or any other suitable refractory metal. Additionally, the wires are brazed to the cross bar **28** as well as the circular portion of the washer **27** and the cross bar serves to support the grid wires at their mid-points to prevent excessive sagging and to increase the resonant mechanical frequency of vibration. The thicker washer **30** serves to prevent buckling of the thinner washer **27** due to the previously placed tension of the many grid wires **29**. This structure also avoids the difficulty of attempting to form a thick washer with a cross bar.

As better seen in FIGURE 5 each of the cross bars **28** of the grid washers **27** is split or broken by a slanted or diagonally extending slot **28***a*. These slots prevent buckling of the grid washers and, because of the diagonal extension thereof, do not subtract from the effectiveness of the cross bars in preventing sagging of the grid wires.

The control grid is identical to the screen grid except that the control grid includes twice the number of grid wires provided in the screen grid. Additionally, and as illustrated in the drawing, the screen and control grids are arranged for having the cross bars thereof disposed on the upper and lower surfaces thereof, respectively, and are separated and predeterminedly spaced by a thin insulative washer **31** which can advantageously be formed of alumina or any suitable dielectric material and is suitably bonded to the grid wire sides of each grid washer. Thus, a unitary rigidly constructed sub-assembly is provided wherein the ceramic washer **31** solely determines the spacing betwen the grid wire arrays of the two grids. The inner diameter of the ceramic washer **31** is substantially greater than that of the metal washers of the grids, whereby the inner surface of the ceramic washer is disposed reentrantly and is substantially shielded by the grid washers from cathode evaporants which would tend to deposit across the ceramic washer and electrically short circuit the grid. Additionally, in the grid sub-assembly the wires of one grid are precisely aligned with corresponding wires of the other grid to obtain a satisfactory ratio of anode to screen grid current.

As constructed the grid sub-assembly provides for an internal or built in by-pass capacitor. In grounded grid amplification when using a tetrode it is necessary to maintain both grids at the same R.F. ground potential. At lower frequencies this can be accomplished with the use of an external by-pass capacitor. However, at higher frequencies of the type at which the present device is adapted for operation an external capacitor would be too far removed electrically and thus ineffective. In the presently disclosed grid sub-assembly the required internal capacity is provided in the arrangement including the two grids and the ceramic spacer, which spacer as described above, also serves to support and predeterminedly closely space the two grid elements.

In the structure described above the thin washer-like ceramic **7** in the envelope construction serves as a by-pass capacitor between the screen grid and the suppressor grid and as a cantilever envelope section allowing reduction in diameter of the envelope, thus to provide for the use of the smaller-size anode ceramic **2**. This structure including the smaller diameter anode insulator is provided to insure the achievement of resonance in the fundamental mode at the desired operating frequency of the device, which, in one operative embodiment, was of the order of 1000 megacycles.

The grid sub-assembly is held in place in the device by means to be described in detail hereinafter and with the screen grid washer **30** engaging the inner rim **32** of a generally cup-like metal screen grid contact member **33**. In this construction the rim **32** serves both as a contact member for the screen grid and as an electrode assembly positioning stop, determining the positions in the envelope of the grids and cathode. The member **33** is butt-sealed by metallic bonds at the bottom surface thereof between the envelope wall insulators **3** and **7**. Additionally, the contact member **33** includes a dependent rim **35** which is spaced substantially outwardly of the insulator **33**, thus to provide a coaxial electrical contact surface.

Electrical connection to the control grid is made by a resilient cup-like contact member **36**. The member **36** includes an annular bottom surface engaging the reinforcing washer **30** of the control grid and a multiple-slit rim which serves to provide a plurality of spring fingers for engaging the inner rim **37** of a cup-like metal grid contact member **38**. The inner rim **37** of the member **38** is straight and the spring finger portions of the member

36 engage it at an angle which results in a fine line contact between the latter member and one edge of the rim 37. Thus, is provided a substantially desirable radio frequency contact between these elements.

The contact member 38 is butt-sealed between the insulators 3 and 4 by a metallic bond and is similar to the screen grid contact in that it includes the alignment tabs 34 and a dependent rim 39 which is laterally spaced from the wall of the ceramic and is of progressively smaller diameter than the outer rim of the screen grid contact member 33. The internal contact member 36 is held in electrical connection with the control grid by engagement in the bottom thereof of the aforementioned cathode sub-assembly which is biased upwardly in the device. The cathode sub-assembly includes a ceramic spacer cylinder 40 which can also be advantageously formed of alumina. To the upper rim of the cylinder 40 is bonded a metal eyelet extending dependently in the cylinder 40 in spaced relation to the inner wall thereof for shielding the ceramic from undesirable deposition thereon of emissive material from the emitter. To the lower rim of the cylinder 40 is bonded another dependent metal eyelet 42. Disposed in the eyelet 42 and extending upwardly in the sub-assembly in spaced relation to the eyelet 41 is a metal foil cathode support sleeve 43. Welded in the upper end of the sleeve is an inverted metal cup 44. Bonded to the bottom of the cup 44 are a pair of thermionic emitter segments 45 each disposed on a side of the cross bars of the grid sub-assembly and which together comprise a split emitter. This construction enables close spacing of the control grid and emitter without danger of undesirable contact therebetween. Additionally, it minimizes undesirable deposition of emissive materal on the grid cross bars.

Provided in the cup 44 for heating the emitter is a flat coiled filament 46 interposed between a pair of insulators 47 and held in position by an apertured cup 48 bonded in the cup 44. Suitably supported from the bottom of the cup 48 is a cylindrical getter member 49. Bonded in the lower end of the sleeve 43 is another apertured cup 50 which supports another cylindrical getter member 51. The cups 44 and 50 are apertured to enable the extension therethrough of a pair of filament leads 52.

Positioned beneath the eyelet 42 and electrically contacting same is a cup-like resilient contact member 53 which, like the member 30, is multiply-slit at the rim to provide a plurality of resilient contact fingers. The fingers of the member 53 electrically contact a dependent inner rim 54 of a cup-like metal cathode contact 55. The mentioned fingers extend at an angle to the rim 54 which results in a fine-line circumferential contact between the member 53 and rim 54 for improved radio frequency contact. Additionally, the contact member 55 is butt-sealed between the insulators 4 and 5 by metallic bonds and, like the previously described electrode contact members, includes aligning tabs 34 and a dependent outer rim 56 spaced outwardly from the insulators. The rim 56 is, however, progressively smaller than those above it.

All of the various elements comprising the grid-cathode assembly and the spring contacts 36 and 53 are held in position in the device by a relatively large coil spring 57, the upper end of which is seated in the bottom of the internal contact 53 directly beneath the ceramic 40. The lower end of the spring 57 is seated in a retaining cup 58, the center of which is apertured for extension therethrough of the filament lead 52. Provided for holding the retaining cup 58 in position are two pairs of detents 59 and 60 each bent out of the outer rim 61 of the retaining cup 58 and the inner rim 54 of the cathode contact 55, respectively.

The lower end of the mentioned filament leads 52 are suitably bonded to staggered chordally extending cross bars 62 of vertically spaced annular metal contact members 63. The upper one of the member 63 is bonded to the inner dependent rim 64 of a cup-like metal filament connector 65 which is butt-sealed between the insulators 5 and 6 by a metallic bond. Additionally, the member 65 includes a dependent outer rim 66 spaced outwardly from the insulator 6 and of smaller diameter than the rims of the contact thereabove. The lower member 63 is bonded to the inner surface of a dependent flange 67 of a sealing member 68 having a horizontal flange butt-sealed between the ceramic members 6 and 9 by a metallic bond. The filament lead connecting structure including the members 63 with chordal cross bars relatively staggered and bonded to the filament leads does not comprise part of the present invention but is disclosed and claimed in co-pending U.S. Application Serial No. 832,993 of Walter J. Rutkowski filed August 11, 1959, now Patent Number 2,961,569, patented November 22, 1960, and assigned to the same assignee as the present invention.

The lower end of the device is closed by a header construction including a metal cup-like element 69 positioned in the filament connector 67 and having an outer rim 70 bonded at the edge thereof to the lower edge of the member 67. The member 69 includes an inner rim having bonded therein a substantially large pinched-off metal tubulation 71. A metal reinforcing washer 72 is positioned in the member 70 and is interposed between the bottom of the member 69 and an outwardly extending flange 73 on a sheetmetal tubulation protecting cap 74 which is bonded at the flange 73 to the member 67. This construction provides an end closure which can be easily and effectively welded in place to complete the envelope. Additionally, it provides a low mass header and tubulation structure adapted for withstanding substantial vibrations without damage to the tube envelope or seals.

In manufacture, the device envelope is first fabricated including all of the electrode contacts and filament connectors and the anode asesmbly, or, in other words, all of the disclosed structure except the grid-cathode assembly including the resilient contact members 36 and 53 and the filament connecting members and the bottom end header construction.

The grid assembly is separately fabricated to provide the double grid structure illustrated in FIGURE 4. Then the cathode sub-assembly is fabricated first by brazing the eyelets 41 and 42, which can advantageously be nickel, to the respective ends of the insulator 40. Any suitable means can be provided for holding aligned the cross-bars of the grids sub-assembly and the split in the emitter and for locking the grid and cathode subassemblies together to complete the grid-cathode assembly.

Then the cathode heater structure carried by the sleeve 43 is slipped through the lower eyelet 42 and pushed upward until the upper surface of the emitter 45 lightly engages the grid wires of the control grid. Then the cathode support sleeve 43 is spot welded to the lower eyelet 42. At this point there is no spacing between the control grid and cathode. To provide the required spacing, the grid and cathode sub-assemblies are then unlocked at the grid-washer upper eyelet junction and the contact member 36, which can advantageously be molybdenum, is placed between the subassemblies and these sub-assemblies are again locked together. Thus, the bottom of the member 36 serves also as a spacer for determining the operating space between the control grid and the emitter.

The just-described assembly of the grid and cathode structures occurs exteriorly of the envelope and the resultant grid-cathode assembly is then inserted into the previously fabricated envelope with the contact members thereof, coil spring 57 and retaining cup 58 in the relative positions illustrated in FIGURE 1. The retaining cup 58 is pressed inwardly for compressing the spring and enabling turning of the retaining cup 58 to bring the detents 50 thereof into locking engagement with the detents 60 if the member 55, following which the grid-cathode

assembly is firmly, resiliently and removably locked in position in the device.

Subsequently the heater connectors **63** are welded in place in the members **65** and **67** and the heater leads **52** are each welded to one of the cross bars of the connectors **63**.

Then the header, including the tubulation assembly, is welded in place in the member **67** and the device is thereafter ready for exhaust following which the tubulation **71** is pinched off and a protective cap **74** is welded in place to effect the low-mass and cap sealation. The cap **74** also serves as a heater terminal. The disposition of the exhaust tubulation at the lower end of the device also avoids any adverse effects of the exhaust operation on the emitter. In some prior structures the exhaust path occurred above the emitter with the undesirable result that all gases were swept by the cathode with a poisoning effect on the cathode. This undesired result is not encounterable in the present device.

It will be seen that in accordance with the present invention there is provided an electric discharge device which is substantially rugged and adapted for withstanding substantial shock and vibration. The construction including the step contact surfaces and insulator sections of uniform diameter provides for desired butt-seals between each of the contact members and the envelope wall insulators. Uniform diameter of the insulators on either side of each contact member results in each ceramic-to-metal seal or metallic bond being effectively backed up by another seal thus providing seals of greater strength. The ability of the device to withstand greater shock and vibration is enhanced also by the provision of the mounting flange **24** carried by the suppressor grid contact **23** and the low-mass lower end of the device. Additionally, in accordance with the disclosed invention, assembly of the overall device is facilitated in view of the fact that individual sub-assemblies can be separately fabricated and easily assembled into an assembly which in turn can be simply inserted and locked in position in a pre-fabricated envelope. Further, the present invention affords means for minimizing back emission of secondary electrons toward the grid assembly. Still further, in accordance with the present invention, more effective cooling of the anode seal is provided by the construction of the anode radiator whereby the latter is adapted for predeterminedly controlling the movement of cooling air in the vicinity of the anode seal. Additionally, the fact that the fin construction on the radiator can in its present form be easily machined adds considerably to the desirability of this construction.

While there is shown and described a specific embodiment of the present invention it is not desired that the invention be limited to the particular forms shown and described, and it is intended by the appended claims to cover all modifications within the spirit and scope of the invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An electric discharge device comprising an envelope including a plurality of vertically stacked coaxial ceramic cylinders of uniform diameter, a cup-like metal contact member interposed and butt-sealed between the transverse ends of adjacent pairs of said cylinders, said contact members including rims projecting inwardly and outwardly of the walls of said cylinders, electrode means mounted in said envelope and including a cup-like resilient contact member having the rim thereof engaging the inner rim of one of said first-mentioned contact members and effecting only a line contact therewith.

2. An electric discharge device comprising planar anode cathode and grid electrodes mounted in spaced parallel relation, an envelope containing said electrodes and including a pair of vertically stacked coaxial ceramic cylinders of different diameters and a relatively thin ceramic washer interposed between said cylinders, said anode being supported by the cylinder of smaller diameter, an annular metallic contact butt-seal between the transverse end of the larger of said cylinders and a corresponding outer marginal area of said washer, said metal contact including an inner rim electrically contacted by said grid, another annular metal contact butt-seal between the transverse end of the smaller of said cylinders and a corresponding inner marginal area of said washer, and said other contact including an inner rim adapted for operating as a suppressor grid between said anode and grid.

3. An electric discharge device according to claim 2 wherein said annular contact members are cup-like with outer rim portions spaced outwardly of the walls of said cylinders and include a metallic flange of relatively thicker metal than said contact member secured to the outer rim of said second mentioned contact member.

4. An electric discharge device comprising a plurality of cooperating electrode elements, an envelope containing said electrode elements, and including a pair of vertically stacked coaxial ceramic cylinders, an annular metallic member electrically connected to one of said elements and including a flange butt-sealed by a metallic bond between said cylinders, a metal cup-like header positioned in said metal member and having the rim thereof bonded to the edge of said metal member, a metal tubulation sealed in said header, a metal cap positioned over said tubulation in and bonded to said cup-like header for protecting said tubulation and serving as electrical contact for one of said electrode elements, said header, tubulation and cap constituting a low-mass construction relative to the remainder of said device.

5. An electric discharge device comprising an electrode assembly, an envelope containing said assembly and including an assembly positioning stop engageable by said assembly, said envelope further including a pair of vertically stacked coaxial ceramic cylinders and an annular contact member interposed and butt-sealed between opposed transverse ends of said cylinders, said contact member including a dependent inner flange, a cup-like contact member in said envelope electrically contacting said electrode assembly opposite said stop and including a circumferentially extending flange resiliently electrically contacting said inner flange of said contact member, a compressed coil spring seated in and biasing said cup-like contact member into engagement with said assembly for maintaining the latter against said stop, and a cup-like retaining element holding said spring compressed and disengageably connected to said flange on said annular contact member.

6. An electric discharge device according to claim 5 wherein said electrode assembly comprises a cathode sub-assembly electrically connected to said cup-like contact and a grid sub-assembly interposed between said cathode sub-assembly and said positioning stop, and another cup-like contact member is positioned between said sub-assemblies and resiliently electrically contacts another metallic annular contact member butt-sealed between another pair of vertically stacked ceramic cylinders included in said envelope.

7. An electric discharge device comprising an envelope including a series of vertically stacked coaxial annular insulators, a plurality of annular metal contact members each butt-sealed between a pair of said insulators and including an inwardly projecting rim, the uppermost of said rims comprising an electrode assembly positioning stop, a grid sub-assembly comprising a pair of insulatively spaced planar grid elements one of which engages and electrically contacts said stop, a cup-like contact member electrically engaging the other of said grid elements and including a rim resiliently electrically contacting another of said annular metal contacts, a cathode sub-assembly positioned in and engaging said cup-like contact member whereby the latter determines the op-

erating spacing between said cathode sub-assembly and said grid sub-assembly, another cup-like contact member electrically engaging said cathode sub-assembly and including a rim resiliently electrically contacting still another of said annular metal contact members.

8. An electric discharge device according to claim 7 wherein a compressed coil spring is seated in said second-mentioned cup-like contact member and is retained in position by an element supported in said envelope from an element in the wall of said envelope.

9. An electric discharge device comprising an envelope including a series of vertically stacked coaxial annular insulators, an anode mounted in one end of said envelope, a plurality of annular metal contact members each butt-sealed between a pair of said insulators and including inwardly projecting rims, the uppermost of said rims defining a suppressor grid aperture, the next lower of said rims comprising an electrode assembly stop, a grid sub-assembly comprising a pair of insulatively spaced planar grids one of which engages and electrically contacts its stop, a cup-like contact member electrically engaging the other of said grid elements and including a rim resiliently electrically contacting another of said annular metal contacts, a cathode sub-assembly positioned in and engaging said cup-like contact member whereby the latter determines the operating spacing between said cathode sub-assembly and said grid sub-assembly, and another cup-like contact member electrically engaging said cathode sub-assembly and including a rim resiliently electrically contacting still another of said annular metal contact members.

10. In an electric discharge device an envelope, an electrode mounted at one end of said envelope and including a heat radiator projecting externally from said envelope, a seal between said electrode and said envelope at said one end thereof, and said radiator including a plurality of longitudinally extending fins having the surface portions of said radiator between said fins curved for directing axially applied cooling air in a predetermined manner relative to said seal.

11. In an electric discharge device an envelope including a ceramic insulator and a cup-like metal sealing member sealed by a metal bond, an anode mounted in said envelope from said seal member and including a longitudinally externally projecting heat radiator block, said block including a plurality of spaced parallel fins extending longitudinally on either side of said block, and the portion of said block between said fins increasing in cross section toward the inner end of said anode for defining outwardly curved root portions between said fins for directing axially applied cooling air outwardly past the rim of said cup-like member to minimize air stagnation in said sealing member and thereby improve cooling thereof.

12. A grid electrode comprising a metal washer including an integrally formed cross bar, a plurality of spaced grid wires extending across said washer and bonded to the rim and cross bar thereof said cross bar being split by a slot extending thereacross, and a relatively thicker washer bonded to said first-mentioned washer on the side thereof opposite said wires.

13. A grid electrode comprising a metal washer including a cross bar, a plurality of spaced grid wires extending across said washer and bonded to the rim and cross bar thereof, and said cross bar being split by a slot extending diagonally thereacross.

14. A grid electrode assembly comprising a pair of grid elements each including a metal washer including a cross bar, a plurality of spaced grid wires extending across said washer and bonded to the rim and cross bar thereof, said grid elements being arranged with said cross bars disposed exteriorly of said grid wires, a ceramic washer interposed between said grid elements and bonded on opposite sides thereof to the sides of said grid elements to which said wires are bonded, and the inner diameter of said ceramic washer being substantially greater than the inner diameter of said grid washer, whereby the inner surface of said ceramic washer is reentrantly disposed and thereby shielded from deposition thereon of undesirable material.

15. A grid-cathode assembly comprising a cathode sub-assembly including a planar cathode having a diametrically extending non-emissive area, a planar grid sub-assembly comprising a metal washer including a cross bar, a plurality of spaced grid wires extending across said washer and bonded to the rim and cross bar thereof, said cross bar being on the cathode side of said grid and aligned with said non-emissive area thereof, and means holding said cathode and grid sub-assemblies in closely spaced parallel relation and against relative rotational movement therebetween.

16. An electric discharge device comprising a plurality of cooperating electrode elements, an envelope containing said electrode elements, and including a pair of vertically stacked coaxial ceramic cylinders, an annular metallic member electrically connected to one of said elements and including a flange sealed between said cylinders, a metal cup-like header positioned in said metal member and having the rim thereof bonded to the edge of said metal member, a metal tubulation sealed in said header, a metal cap positioned over said tubulation in and bonded to said cup-like header for protecting said tubulation and serving as electrical contact for one of said electrode elements.

17. A grid electrode assembly comprising a pair of grid elements each including a metal washer including a cross bar, a plurality of spaced grid wires extending across said washer and bonded to the rim and cross bar thereof, said grid elements being arranged with said cross bars disposed exteriorly of said grid wires, a ceramic washer interposed between said grid elements and bonded on opposite sides thereof to the sides of said grid elements to which said wires are bonded.

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