

Nov. 28, 1950

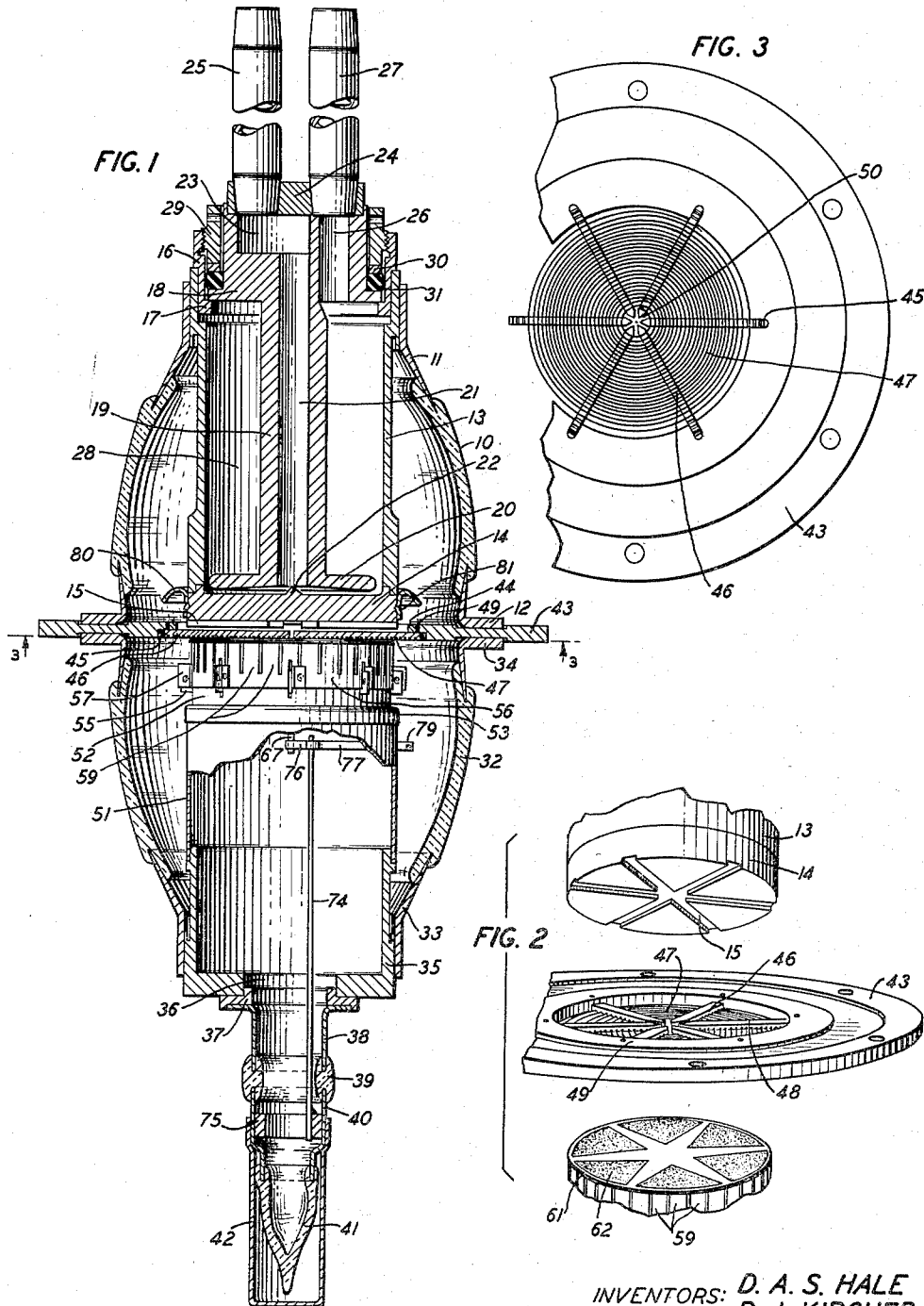
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2,531,623

HIGH-FREQUENCY ELECTRONIC DISCHARGE DEVICE

Filed Oct. 16, 1948

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 4

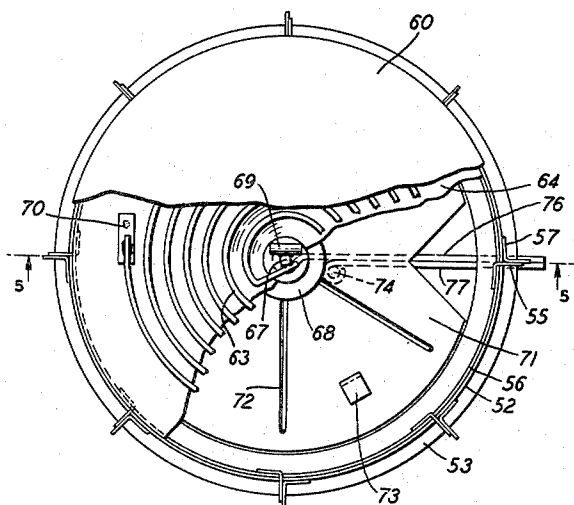


FIG. 5

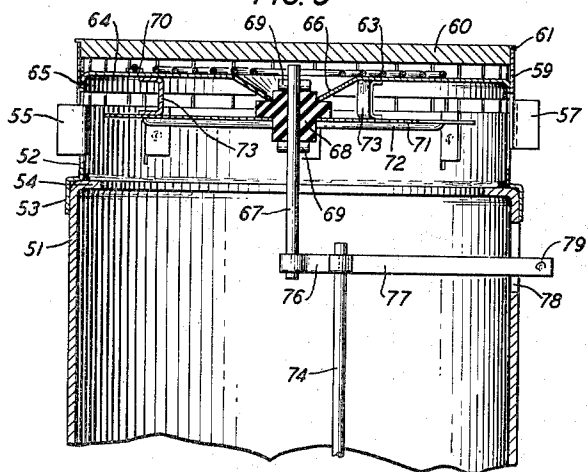
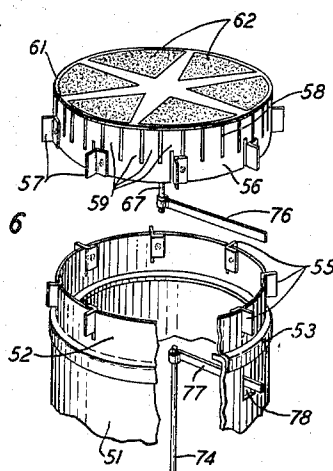


FIG. 6



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UNITED STATES PATENT OFFICE

2,531,623

HIGH-FREQUENCY ELECTRONIC
DISCHARGE DEVICE

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Application October 16, 1948, Serial No. 54,924

20 Claims. (Cl. 250—27.5)

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This invention relates to electron discharge devices and more particularly to such devices especially suitable for use as high power generators at ultra-high frequencies.

In ultra-high frequency transmitting systems, for example in "grounded grid" circuits, it is essential that stable interelement spacing be attained in the electronic devices to maintain the required operating characteristics of the system. Furthermore, such spacing, particularly between the grid and cathode, should be constant throughout a wide operating range of frequencies, for example in the 500-megacycle region, in wide-band applications with relatively high power outputs of the order of 1500 to 2500 watts. Operation at such high power ratings may result in warping or buckling of the cathode and/or the grid surfaces which materially affects the inter-electrode space relation and therefore the constants of the device. Other attributes of the electronic transmitting device pertain to its performance as the function of frequency, maximum band-width in practical circuit configurations, low internal capacitance between electrodes, high transconductance characteristics and amount of compression in use as a Class B amplifier.

A primary object of this invention is to decrease the electron transit time effects at high frequency, thereby to realize an increase in the anode efficiency and power output rating of the electronic transmission device in ultra-high frequency applications.

Another object of the invention is to maintain the operating characteristics of such devices at high stability over a broad band of frequencies and power ratings.

A further object of the invention is to eliminate variation in interelectrode spacing under high load operation.

Another object of the invention is to provide standard peak output power required for video transmitters with a combination of grounded grid stages of electronic devices at frequencies of up to 600 megacycles or higher.

A further object is to improve the construction of the cathode so that the heating effects of back bombardment of this surface by electrons at ultra-high frequencies is minimized and the cathode operating temperature is maintained substantially constant.

Another object of the invention is to increase efficiency and power gain for transmitter applications where CW power outputs of 1.5 kilo-

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watts are required at frequencies of 600 megacycles or higher.

A further object of the invention is to provide a grid structure which will operate at relatively low temperature and to improve the radio frequency functioning of the grid structure by minimizing the effective inductance in the grid.

These objects are obtained in accordance with features of this invention by a planar-type triode involving rugged constructions for the flat grid, the cathode and the anode. The cathode and anode are on opposite sides of the grid and closely spaced relative thereto so that high transconductance into a low output impedance is assured in operation, and constant interelement laterality may be realized at high power output ratings.

A feature of the invention relates to the construction of the grid so that both radio frequency current conduction and heat transfer are secured in the device whereby stable physical constancy of the grid structure is obtained in relation to the other cooperating electrodes in the device. This is accomplished by a spider of high heat conducting metal in an opening of the grid ring or frame and supporting a pancake spiral grid winding also of high heat conducting metal thereon relatively close to the cathode surface.

Another feature of the invention relates to a grid constructed to eliminate variation in planarity due to thermal changes in operation of the device. The spider support of the grid laterals is slotted at the center so that the cantilever arms may expand and contract radially. The curve of the laterals therefore provides a biasing directive so that as the laterals expand they do so by decreasing the radius of curvature in the plane of their bends. This obviates warping in a direction perpendicular to the grid plane and toward the cathode and anode so that the grid is constant in planar relation to the anode and cathode surfaces. This arrangement facilitates the fabrication of the grid structure in assembly under high temperature treatment.

A further feature of the construction involves the main components of the grid structure so that heat dissipation and radio frequency conduction are maintained at a high order during operation at high power levels. The grid frame, spider and helix are formed of highly conductive metal, such as copper, as one example so that unity of expansion and contraction between the components is achieved in the combined assembly. Furthermore, the copper elements increase the heat transfer or conduction so that the grid temperature is relatively low thus minimizing

primary emission of electrons during operation.

Another feature of the invention relates to the cooperative and conductive active surface of the main electrodes being in symmetrical relation to reduce the interelement spacing between these electrodes and eliminate projection of emissive material on the cathode to the heavy supports of the grid. In this arrangement, the cathode constitutes a heavy gauge metallic disc on one side of the grid adjacent to the grid spiral winding, the cathode being provided with thermionically active materials to furnish a copious emission of electrons during the operation of the device. The active emissive coating is applied to the cathode surface in segmental coextensive relation to the grid spiral winding so that the portions of the cathode in line with the grid spider arms are uncoated. This greatly reduces projection of active material from the cathode to the grid arms so that electron emission is confined to the transmission portions of the grid structure. In conformity with the relation of the grid and cathode surfaces, the anode is also provided with radial slots corresponding to the grid arms of the spider support so that the slots are in register with the arms and permit the anode surface to be mounted closer to the grid winding than would otherwise be possible. The slots in the anode are wider than the arms, of the grid. The coaxial and aligned electrodes provide a closely integrated assembly in which relatively close space relation is maintained to reduce the transit time of electrons between the respective electrodes.

Another feature of the invention relates to the cooling and heat dissipation construction of the anode assembly to keep the anode at a low temperature consistent with highly efficient operation. The hollow anode on one end of the device is adapted to receive a cooling assembly which may readily be disconnected from the device when replacement is necessary without disturbing the coolant coupling which may be a permanent part of the tube installation. A central stem or tubular spout having a mushroom shaped extension is arranged within the anode with the extension close to the anode surface so that the cooling fluid strikes the anode and is constrained to spread out radially in a thin film, absorbing heat from the surface of the anode. A gallery and exhaust tubing is provided to drain off the cooling liquid after passage through the anode. The cooling assembly is rigidly locked to the top of the device through a clamping ring and sealing gasket to form a liquid-tight joint.

Another feature of the invention is concerned with a cathode construction to insure constancy of the planar relationship of the cathode surface with respect to the grid surface. The cathode is a solid, relatively thick disc supported peripherally by a castellated annular metallic ring or sleeve which permits radial expansion and contraction, but substantially eliminates axial expansion. The cathode assembly includes a spiral heater element, heater support disc, heat reflector disc, and a central terminal post extending away from the cathode surface as a subassembly of the cathode structure.

A further feature involved in the cathode construction of this invention relates to the coupling of the subassembly described above in relation to the rigid mounting body of the cathode portion of the device to facilitate the junction of the subassembly to the body and connection of the cathode and heater to the terminals of the device. This arrangement comprises a tubular extension

within the device on a portion of the external vessel in association with a coaxial terminal connection formed on one end of the device. The coaxial terminal is provided with a rigid conductor which extends toward the tubular extension of the cathode structure, the conductor having a transverse arm which projects through the side of the extension. A similar arm is secured to the central heater terminal post so that as the subassembly is fitted to the tubular extension, the two arms are in lateral relation and may be welded together to couple the heater element in the device.

Another feature of the cathode structure relates to the junction of the subassembly to the tubular extension of the device. Both the sleeve and tubular extension are provided with angular ears or fins aligned in slots in the members and these members are placed together in telescopic relation so that the ears are radially disposed in abutting relation and may be welded together around the periphery of the cathode assembly to form a rigid structure.

These and other features and advantages of the invention will be more clearly set forth in the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a view in section of the complete assembly of the device of this invention showing the close relationship of the electrodes at the medial plane of the device and the detailed structure of the cathode and anode portions of the device;

Fig. 2 illustrates in an exploded perspective view the cooperative segmental arrangements of the cathode and anode surfaces with respect to the spider assembly of the grid disc as incorporated in the device of Fig. 1;

Fig. 3 is a plan view of the grid disc of this invention and shows the separation of the spider arms at the center of the spiral winding of the grid;

Fig. 4 is a plan view of the cathode structure of the device of Fig. 1 with portions of the superimposed elements broken away to show the detailed assembly;

Fig. 5 is an elevational view in section of the cathode assembly taken on the line 5—5 of Fig. 4; and

Fig. 6 illustrates in an exploded perspective view the two sections of the cathode assembly and shows the assembly of the structure.

Referring to the drawings, the invention is shown in a specific embodiment of a grounded grid type amplifier tube of high power output and stable characteristics at high voltages and capable of meeting efficiency objectives in wide-band high frequency applications up to 700 megacycles with a definite power output of 1.5 kilowatts or more at 500 megacycles, without space variation of the grid structure with respect to the other electrodes in the device.

As shown in Fig. 1, the device employs two similar shaped sections in opposed relation joined to a medial copper ring section to form an enclosing vessel for the cooperating cathode, grid and anode electrodes in the device. The anode or output section is formed of a glass bell portion 10 having copper ring members 11 and 12 sealed to opposite ends and a cylindrical anode housing 13, preferably of copper, brazed at the upper end to the ring 11 and projecting toward the large diameter end of the bell portion 10. A thick copper disc 14 is soldered to the lower end of the housing and is provided with a plurality of intersecting slots 15, as shown in Fig. 2, in equal spaced relation

across the planar surface of the disc. Although the anode housing is shown as formed of two elements it may be fabricated as an integral assembly.

The open end of the anode housing supports an internally threaded nipple 16, preferably of stainless steel, which is soldered thereto, the nipple being provided with an internal flange or seat 17 to form a receptacle for a cylindrical block or insert 18 which fits within the nipple and rests on the seat 17. The insert has a central integral spout or tubular extension 19 which terminates in a mushroom-shaped nozzle 20 placed close to the inner surface of the anode disc 14, the bore 21 of the spout being axially aligned with a pointed projection 22 at the center of the disc 14. The bore 21 communicates with a chamber 23 which is closed by an apertured plate 24 with an inlet pipe connection 25 leading into the chamber. An offset bore 26 in the insert is coupled to an outlet pipe connection 27 so that a cooling liquid or medium, such as water, may be circulated within the anode housing to dissipate heat energy generated during operation of the device. The cooling liquid is projected in a thin film against the anode disc by the nozzle 20 to carry away the heat absorbed by the anode disc and the water flow rises in the gallery 28 to the outlet 27. The insert, which preferably is formed of bronze or other suitable metal, is securely locked in the nipple 16 by a clamping ring 29 which presses a metallic washer 30 against a gasket 31, preferably of neoprene rubber, to form a watertight joint, the gasket 31 being deformed by the pressure of the washer 30 so that it presses laterally against the inside surface of the nipple 16 and against the cylindrical surface of the block 18. The clamping assembly facilitates removal and connection of the device in its circuit position without disturbing the water supply connections which may be part of the circuit structure so that replacement is easily accomplished.

The cathode or input section having a similar bell-shaped glass portion 32 terminated by copper ring seals 33 and 34, and a cup-shaped housing or member 35, preferably of copper, having a central aperture 36, is brazed to the inner wall of the ring 33 to form a closure at the smaller diameter end of the cathode section. A steel washer 37 is soldered to the outer end of the housing around the aperture 36 and supports a flanged sleeve 38, preferably of Kovar alloy, to form a sealing joint to a glass collar 39 which is joined to another sleeve or nipple 40, of similar alloy metal. The nipple has a reduced end sealed to a glass tubulation 41 which is sealed after complete evacuation of the device. A metallic cap terminal 42 protects the sealed glass tip and is soldered to the nipple 40.

Another portion of the enclosing vessel of the device is the intermediate flat grid or control electrode which forms a partition between the input and output electrodes. A relatively thick copper ring 43 is provided with a wide annular recess on each side adjacent the periphery to form seats for the flat flange portion of the sealing rings 12 and 34 for brazing the two bell sections to opposite sides of the grid ring 43 to form a completely enclosed casing or container. The exposed rim of the ring forms a highly conductive annular terminal for the grid electrode of the device. The internal rim of the ring is provided with an inner flange 44 and spaced radial slots 45 on the opposite surface to receive a heavy gauge copper spider 46, shown more clearly in

Figs. 2 and 3, to constitute a frame support for a flat spiral coil of wire 47. The latter forms the grid helix or winding for controlling the flow of electrons between the cathode and anode of the device.

The spider support is machined from a solid plate of copper so that the arms 48, the number of which may be suited to the particular design, six or eight being typical numbers, are rectangular in cross-section, as shown in Fig. 2, and form a strong and rigid mounting for the more fragile wire helix 47 which is also formed of copper. By fabricating the components of the grid of highly conductive metal, such as copper, the radio frequency current conduction is relatively high and heat conduction is readily accomplished throughout the whole grid structure so that the grid is maintained at a low temperature, eliminating primary electron emission and insuring stable structural condition. Since there is unity of thermal properties throughout the expanse of the grid structure, warping is reduced to a minimum.

The spider 46 is formed with six arms, as shown in the present embodiment, but other configurations may be employed in various modifications of the structure depending on the power rating and the diameter of the device. The outer ends of the arms fit into corresponding slots 45 in the grid ring and rest on the internal flange 44 which is provided with drill holes 49, as shown in Fig. 2, so that high melting point solder, such as 40 per cent silver and 60 per cent copper, having a fusing point of 1400 degrees F., will securely braze the spider in position in the grid ring with the solder flowing through the drill holes to insure a tight joint. The arms are provided also with spaced slots in a helical path on the side of the spider facing the cathode structure to rigidly affix the wire winding 47 thereto, as by welding or staking or preferably by solder brazing. After the winding is fitted and secured in the slots of the spider and the spider staked in the slots 45, the grid is subjected to heat treatment which simultaneously brazes the joints of the wire to the arms of the spider and the spider to the ring. This heat cycle also sets the helix and avoids subsequent distortion by heating conditions arising during operation of the device. Prior to assembly of the wire on the spider, both are gold-plated to a weight of 50 milligrams per square inch which corresponds to a thickness of .0005 inch. This operation facilitates the spot welding of the wire helix in the slots of the spider in the event that round cross-section wire is used, due to the local high resistance of the gold plating on the copper elements. If flat or strip wire is employed and mounted edgewise in the slots, the wire is usually secured to the spider by staking. A silver copper solder alloy is employed to finally secure the assembled spider and frame together. The assembly is laid face down on a suitable base and a small piece of solder is placed in each slot 45 in the frame 43 at the ends of the arms of the spider. The grid assembly is then heated to 850 degrees C. in hydrogen which melts the solder to braze the grid frame in the mounting ring. This heating also causes fusion of the gold plating at the joints of the wire laterals and arms and the excess gold is absorbed by the copper during the brazing operation. The copper wire helix provides a low temperature grid which results in reduced primary emission and improves the operating characteristics of the device.

Prior to the high temperature heat treatment of the grid, the axis of the spider support is sep-

arated by cutting or milling intersecting slots 53, as shown in Figs. 2 and 3, at the central hub of the spider to free the arms from each other. Since the outer ends are securely fastened to the ring, this operation does not affect the combined helix and spider support in the grid ring. The feature of this construction is that the arms can expand and contract radially due to the spacing of the arms at the axis of the grid and no transverse movement occurs in the grid structure. This is especially advantageous in the high temperature heat treatment of the grid since no buckling or distortion occurs in the grid winding at such temperatures which are ordinarily higher than any temperature encountered during the operation of the device. While the components of the grid structure are preferably formed of copper they may be fabricated from other metals, such as tungsten or molybdenum to attain the same unity of expansion desired in the structure. In a similar manner the fabricated grid structure would be gold-plated to reduce primary emission.

The cathode structure of this invention also contributes to the efficiency of the device in that substantially no axial displacement occurs between the cathode surface with respect to the closely adjacent grid winding in the operation of the device. The cathode assembly is shown more clearly in Figs. 4 to 6 inclusive. When these figures are considered in connection with Figs. 1 and 2, the various structural features of the cathode assembly will be apparent and also this relation of the cathode with respect to the other cooperating electrodes in the device.

The cathode cup 35, which carries the terminals of the heater type cathode, is formed of copper to facilitate brazing to the sealing sleeve or ring 33 but in view of the highly conductive character of the cup, it is preferable to interpose a low heat conduction sleeve member 51 between the cathode and the terminal cup. The sleeve 51 is formed of copper-plated Kovar alloy and therefore extends the cathode housing further within the casing of the device. A slotted ring of nickel 52 has a flanged rim 53 brazed to the internal flange 54 of the sleeve 51 and a plurality of angular ears or fins 55 are welded to the inner wall of the ring 52 and extend through the slots as radial projections. Another nickel ring or castellated member 56 of slightly larger diameter is provided with corresponding slots in the lower edge and angular fins 57 are welded to the outer surface of this sleeve adjacent the slots. The ring 58 is provided also with a number of vertical slots 53 extending toward the opposite edge to form a plurality of resilient fingers 59 which are spot-welded to a heavy nickel disc 60. These fingers form yielding ribs which are forced outwardly by expansion of the disc during heating so that the planar position of the disc is practically unchanged in an axial direction regardless of expansion and contraction of the disc. The disc is fitted into the peripheral series of fingers and positioned by a seating rim 61. The surface of the disc is coated with active electron emissive material, such as barium and strontium oxides in a suitably dense layer, to provide adequate electron emission from the cathode.

Since the grid structure includes the large area spider arms 48 which extend across the space between the cathode and anode, it is desirable to avoid deposition of electron emissive material on the arms inasmuch as active material on

such large surfaces may result in electron emission by the grid. Primary emission from the grid has a detrimental effect on the operation of the device. A feature of this invention is concerned with applying the coating to the cathode surface in segmental areas, preferably by applying a mask to the surface, in crossing relation corresponding to the number of arms on the spider support, so that the active coating will be limited to segmental areas 62, as shown in Figs. 2 and 6, after the mask is removed. These areas will correspond to the wire segments of the grid and the grid wire arms will be aligned with the blank or uncoated radial strips of the cathode surface. Therefore, active material projected from the cathode surface will not be deposited on the grid arms by impact, nor will electron bombardment of the grid radial arms be serious since electrons travel in straight lines from the surface.

By reason of the cooperative radial expansion of the cathode disc and grid winding, in accordance with this invention, it is possible to bring these electrodes closer together and thereby to reduce the electron transit time and increase the transconductance therebetween. In one embodiment, the spacing between the cathode disc plane surface and the grid winding is 0.025 inch and in order to maintain this spacing constant, it is essential that axial movement should be eliminated between the cathode and grid. This is accomplished by radial expansion of both the grid and cathode so that compensation for thermal conditions are attained and perpendicular displacement is substantially avoided. Therefore, buckling or distortion of the parallel surfaces of the grid and cathode are eliminated.

In order to raise the heavy disc cathode surface to emission temperature, a heater element is mounted in close relation behind the disc. As shown in Figs. 4 and 5, a flat spiral tungsten heater wire 63 having an insulating coating thereon is mounted on a disc platform 64 by spot welding the outer end to the platform. This platform, which may be of molybdenum, is provided with a central spun dished portion 66 of truncated conical form extending away from the cathode disc. A central post or wire 67 supported on a ceramic bushing 68 by welded stud wires 69 thereto is connected to the inner end of the heater wire while the outer end is welded at 70 to the platform. The insulated bushing is held in position by a nickel reflector disc 71 provided with radial reinforcing ribs 72 and attached to the platform by angle brackets 73.

In the structure described with the grid winding close to the cathode surface the arms of the spider which support the grid helix project toward the surface or plane of the anode disc. As previously described, the anode disc 14 is provided with radial slots 15 which are in register with the grid arms so that the anode may be placed close to the grid winding to attain the required operating characteristics in the device under service conditions. The slots 15, are wider and deeper than the width of the arms 48 by about 50 per cent so that adequate separation for the potential between grid and anode is obtained. In the same embodiment as above the anode spacing from the grid winding is .070 inch and the slots 15 provide the means of securing this close space relation without danger of shorting the electrodes due to the fact that the arms expand and contract

radially and axial motion is substantially eliminated.

The mounting of the cathode and anode surfaces in accurate lateral relation with respect to the grid surfaces is predetermined by accurate gauging of these surfaces with the flange portions 34 and 12, respectively, of the bell-shaped sections of the vessel. When these sections are assembled with the grid therebetween and the whole unit brazed by soldering the desired spacing of the electrode is assured with close tolerances, of the order of plus or minus .003 inch, being easily attained.

The heavy cathode disc provides a rigid surface which will not buckle or warp and while the thick disc requires more time to reach operating temperature, its surface is uniformly maintained at optimum emission temperature due to the fact that heat loss conduction is low because of the high thermal resistance of the Kovar section of the mounting assembly. The alloy housing having a low heat conduction, impedes the loss of heat from the cathode disc and in addition backward radiation losses from the heater element are minimized by the platform reflector mounting within the cathode housing.

Since the bi-part assembly of the cathode structure permits the mounting of the heater on a separate subassembly of the cathode, the fabrication of the structure is expedited and a strong rigid mounting is assured. It is only necessary to align the slots and fins in both sleeves of the cathode structure to allow telescopic coupling of the sleeves with the sleeve 56 sliding over sleeve 52 and the angular fins 55 extending into the slots of sleeve 56 so that the extending faces of the fins are in abutting relation and may be welded together externally, as shown in Fig. 4.

When the closure cathode disc is mounted on the housing and welded in position, it is necessary to provide means to couple the heater element to the external terminal provided on the cathode end of the device. This is accomplished in accordance with another feature of the invention by transverse arms which may be joined together exterior to the cathode housing.

Referring again to Fig. 1, the coaxial terminal arrangement provided by sleeves 38 and 40 on the cathode section of the device facilitates the coupling of the device to an input circuit by a conductive connection to the sleeve 38 for the cathode disc through the housing and a connection to the heater element by contact with the nipple 40. This latter connection is provided within the cathode housing by a rigid conductor 74 which is secured to a metallic collar 75 joined to the internal wall of the nipple 40. The central rod 67 carries a transverse conductive strap 76 and a shorter strap 77 projects radially through a slot or opening 78 in the side wall of the alloy housing 51. When the cathode disc assembly is mounted on the housing prior to welding the fins together on the bi-part sleeve, the transverse arm 76 is projected through the slot 78 to be in parallel and abutting relation to the strap 77 and after welding the fins around the periphery of the cathode, the straps may be spot-welded at 79 to form a continuous conductive path from the heater element to the external terminal. The cooperative relation of the primary electrodes in planar surfaces, in accordance with this invention, insures an efficient structure capable of withstanding high power loads at ultra-high fre-

quencies in which buckling is eliminated and constant operating characteristics attained.

As a further safeguard in the structure of the assembly of the electrode components of the device, a protective shield is mounted on the periphery of the anode adjacent the grid to prevent bombarding electrons being projected from the cathode toward the glass seal of the anode section. A flared copper ring or annulus 80 is placed in an inverted position around the anode disc 14 and is secured thereto by forcing small indentations, as shown at 81, into the periphery of the anode disc at a plurality of points. The shield or skirt 80 is gold-plated before assembly and during the high temperature processing of the device on the pumping station the plating on the skirt diffuses into the copper anode disc to form a diffusion solder joint between the shield ring and the copper anode disc. The flare portion of the shield as shown in Fig. 1 will intercept any stray electrons projected from the cathode so that they do not bombard the glass portion 10 adjacent the seal to the copper ring 12 thereby eliminating damage to the glass vessel due to localized hot spots which might result in fracture.

While the invention has been disclosed with respect to a particular combination of the respective parts of the assembly, it is, of course, understood, that various modifications may be made in the detailed elements without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device of the planar electrode type, comprising a pair of hollow vessel sections in opposed relation, cathode and anode elements mounted within said sections with their plane surfaces in aligned axial symmetry, a grid ring extending across and sealed to said sections coaxial and parallel with said cathode and anode elements, a flat spiral grid winding within said ring interposed between said cathode and anode plane surfaces, and a multi-armed support extending within said ring and having the turns of said winding secured thereto, said arms being freely expansible longitudinally in accordance with temperature changes.
2. An electron discharge device of the planar electrode type, comprising a pair of hollow vessel sections in opposed relation, cathode and anode elements mounted within said sections with their plane surfaces in aligned axial symmetry, a grid ring, coaxial with said cathode and anode elements, extending across and sealed to said sections, a flat spiral grid winding within said ring interposed between said cathode and anode plane surfaces, and a multi-armed support extending within said ring having the turns of said winding secured thereto, said support being slotted to allow expansion of the arms thereof in a radial direction.
3. A high frequency high power electronic discharge device, comprising opposed dome-shaped sections forming parts of the enclosing vessel, a cathode having a heavy flat disc portion supported from one section, an anode having a flat disc portion supported from the other section in opposed relation to said cathode disc portion, both disc portions having radial gaps therein in aligned relation, and a flat spiral grid portion intermediate said cathode and anode and supported between said sections, said grid having radial support arms aligned with the gaps in said disc portions,

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4. A high frequency high power electronic discharge device, comprising a cathode having a heavy flat disc portion, an anode having a flat disc portion in opposed relation to said cathode disc portion, said cathode disc portion having segmental areas coated with an electron emissive layer, said anode disc portion having a plurality of slots, a planar grid ring between said disc portions, a spiral grid winding, and arms on said ring supporting said winding, said arms being aligned with said slots in said anode.

5. A high frequency high power electronic discharge device, comprising opposed dome-shaped sections forming parts of an enclosing vessel, a cathode having a heavy disc portion supported from one section, an anode having a disc portion supported from the other section in opposed relation to said cathode disc portion, said cathode disc portion having segmental areas coated with an electron emissive layer, said anode disc portion having a plurality of slots, a grid ring between said sections, a spiral grid winding, and arms on said ring converging towards the center and supporting said winding, said cathode coated segmental areas being aligned with said spiral winding between said arms.

6. A high frequency high power electronic discharge device, comprising an enclosing vessel having opposed dome-shaped sections, a cathode having a disc portion supported from one section, an anode having a disc portion supported from the other section in opposed relation to said cathode disc portion, said cathode disc portion having segmental areas coated with an electron emissive layer, said anode disc portion having a plurality of slots, a planar grid ring between said sections, a spiral grid winding, and arms on said ring supporting said winding, said arms being in alignment with said slots in said anode disc portion and the uncoated areas of said cathode disc portion between said segmental emissive areas also being in alignment with said arms.

7. An electron discharge device according to claim 1, in which said grid ring, spiral winding and arms are of the same metal to have the same thermal properties under heating conditions.

8. An electron discharge device according to claim 4, in which said arms are adjacent said anode disc portion and said spiral winding is adjacent said cathode disc portion.

9. The combination in an electron discharge device, including hollow cathode and anode electrodes having surfaces in planar relation to an intermediate grid disc, each forming a conductive portion of the enclosing vessel of the device, and a cooling member detachably secured to said anode including a mushroom-shaped nozzle extending close to the internal surface of said anode.

10. The combination in an electron discharge device, including hollow cathode and anode electrodes having surfaces in planar relation to an intermediate grid disc, each forming a conductive portion of the enclosing vessel of the device, said anode having an opening at one end of said vessel, a metallic insert fitted into said opening having a central tubular spout, a mushroom-shaped nozzle at the lower end thereof parallel to the internal surface of said anode, inlet and outlet ports extending from said insert, a sealing gasket surrounding said insert, and a locking ring engaging said hollow anode and said gasket and forming a water-tight joint therebetween.

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11. An electron discharge device of the planar electrode type including parallel grid and anode surfaces, and a cathode structure adjacent thereto, comprising a two-part housing including slotted metallic sleeve members in telescopic relation, a thick cathode disc supported on one member, and peripheral aligned extensions on both members rigidly connecting said members together.

12. An electron discharge device comprising an enclosing vessel having a cathode portion at one end, said cathode portion including a tubular metallic housing having a central aperture, an insulated sleeve terminal extending from said housing in line with said aperture, a conductor secured to said terminal and extending within said housing, a cathode disc supported on said housing, an internal heater element adjacent said disc having a central terminal post, and a pair of arms connected to said conductor and post and extending through the side of said housing coupling said conductor and post together.

13. An electron discharge device comprising two half-shell portions arranged in opposing relation, a hollow cup-shaped cathode extending within one portion, a hollow cup-shaped anode extending within the other portion, said cathode and anode having coaxial planar surfaces spaced in the opposing shell portions, a flat ring interposed between and sealed to said portions to form a housing, a metallic spider of rectangular cross-section affixed to said ring, a flat spiral grid winding secured to said spider and spaced between the planar surfaces of said cathode and anode, a heater element adjacent said cathode surface, cooling means projecting into said anode from one end of said housing, and a sealed terminal sleeve on the opposite end of said housing connected to said heater element.

14. A cathode assembly for an electron discharge device, comprising a cylindrical housing, a thick disc portion having an electron emissive coating thereon, a metallic sleeve on said housing, a castellated flexible metallic sleeve having the portion between the slots secured to the periphery of said disc portion, said sleeves being in telescopic relation, and spaced fins on said sleeves rigidly securing said sleeves together as a closure for said housing.

15. A cathode structure for electron discharge devices, comprising a cylindrical housing, a thick disc portion having an electron emissive coating thereon, a metallic sleeve on said housing, a castellated flexible metallic sleeve having the portion between the slots secured to the periphery of said disc portion, said sleeves having aligned slots therein, and angular extensions adjacent said slots projecting radially from said sleeves joining said sleeves in overlapping relation.

16. An electron discharge device of the planar electrode type, comprising an anode and a cathode in opposing relation and an intermediate flat grid in close spacing position between them, said cathode including a cylindrical housing, a thick disc portion having an electron emissive coating thereon, a metallic sleeve on said housing, a castellated flexible metallic sleeve secured to the periphery of said disc portion, said sleeves having aligned slots therein, and pairs of cooperating extensions on said sleeves in abutting relation around the periphery thereof securing said sleeves together.

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17. A high power, high frequency electronic discharge device, comprising a pair of opposing bell-shaped glass shell portions having sealing rings on opposite ends, an inverted cup-shaped anode extending within one portion and attached to a ring at the smaller end, a cup-shaped housing having a central aperture in the closed end carried by a ring at the smaller end of the other portion, the open end of said housing projecting coaxially within said other portion, a metallic sleeve secured to said closed end in line with said aperture, an insulating collar sealed to the outer end of said sleeve, a metallic nipple joined to said collar, a terminal cap enclosing said nipple, a conductor extending from said nipple within said housing, a cathode disc assembly including a flexible ring member mounted on the open end of said housing, a supporting disc attached within said ring member parallel to said cathode disc, a flat spiral heater element mounted between said discs, a central insulated post extending through said supporting disc, the ends of said element being connected to said supporting disc and post respectively, means coupling said post and conductor together, a grid ring mounted between said shell portions and sealed to the opposing rings and forming an integral structure, and a spider supported flat grid helix winding spaced between the opposing surfaces of said anode and cathode discs and supported by said grid ring.

18. A high frequency, high power electron discharge device comprising opposed dome-shaped sections forming parts of the enclosing vessel, a cathode having a heavy flat disc portion supported from one section, an anode having a flat disc portion supported from the other section in opposed relation to said cathode disc portion, both disc portions having radial gaps therein in aligned relation, and a flat grid intermediate said cathode and anode and supported by the said sections, said grid having radial support arms aligned with the gaps in said disc portions.

19. A high frequency, high power electron dis-

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charge device comprising a cathode having a flat disc portion, an anode having a flat disc portion in opposed relation to said cathode disc portion, said cathode disc portion having areas coated with an electron emissive layer, said anode disc portion having a plurality of grooves therein, a planar grid ring between said disc portions, and a grid supported by said grid ring, said grid comprising support arms, said arms being aligned with said grooves in said anode disc portion.

20. A high frequency, high power electron discharge device comprising opposed dome-shaped sections forming parts of an enclosing vessel, a cathode having a heavy disc portion supported from one section, an anode having a disc portion supported from the other section in opposed relation to said cathode disc portion, a planar ring between said sections, and a grid supported by said ring, said grid comprising wire and support members, said cathode disc portion having certain areas coated with an electron emissive coating and other areas uncoated, said anode disc portion having a plurality of grooves therein, and said cathode uncoated areas, said grooves and said grid support members being all in axial alignment.

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