

Jan. 8, 1946.

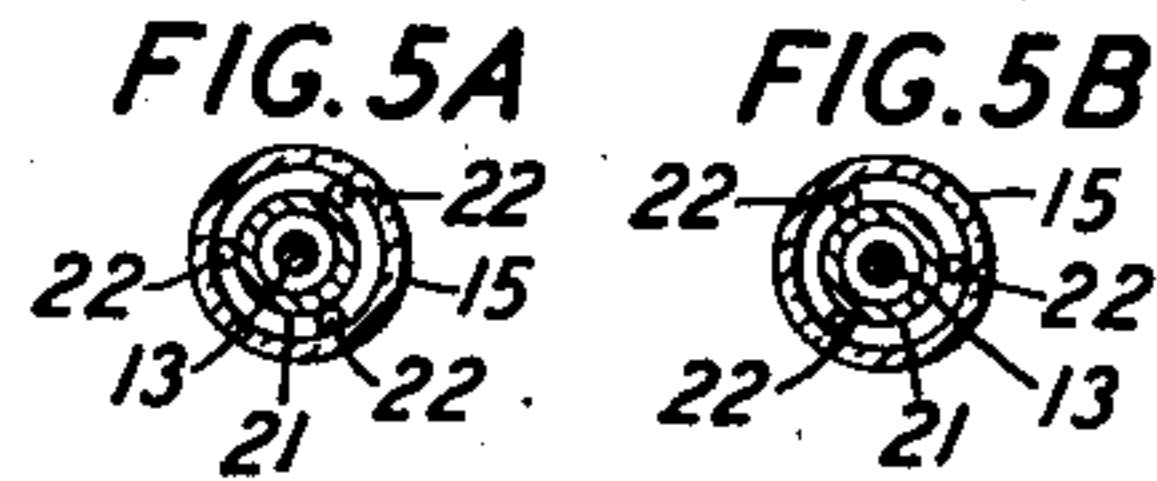
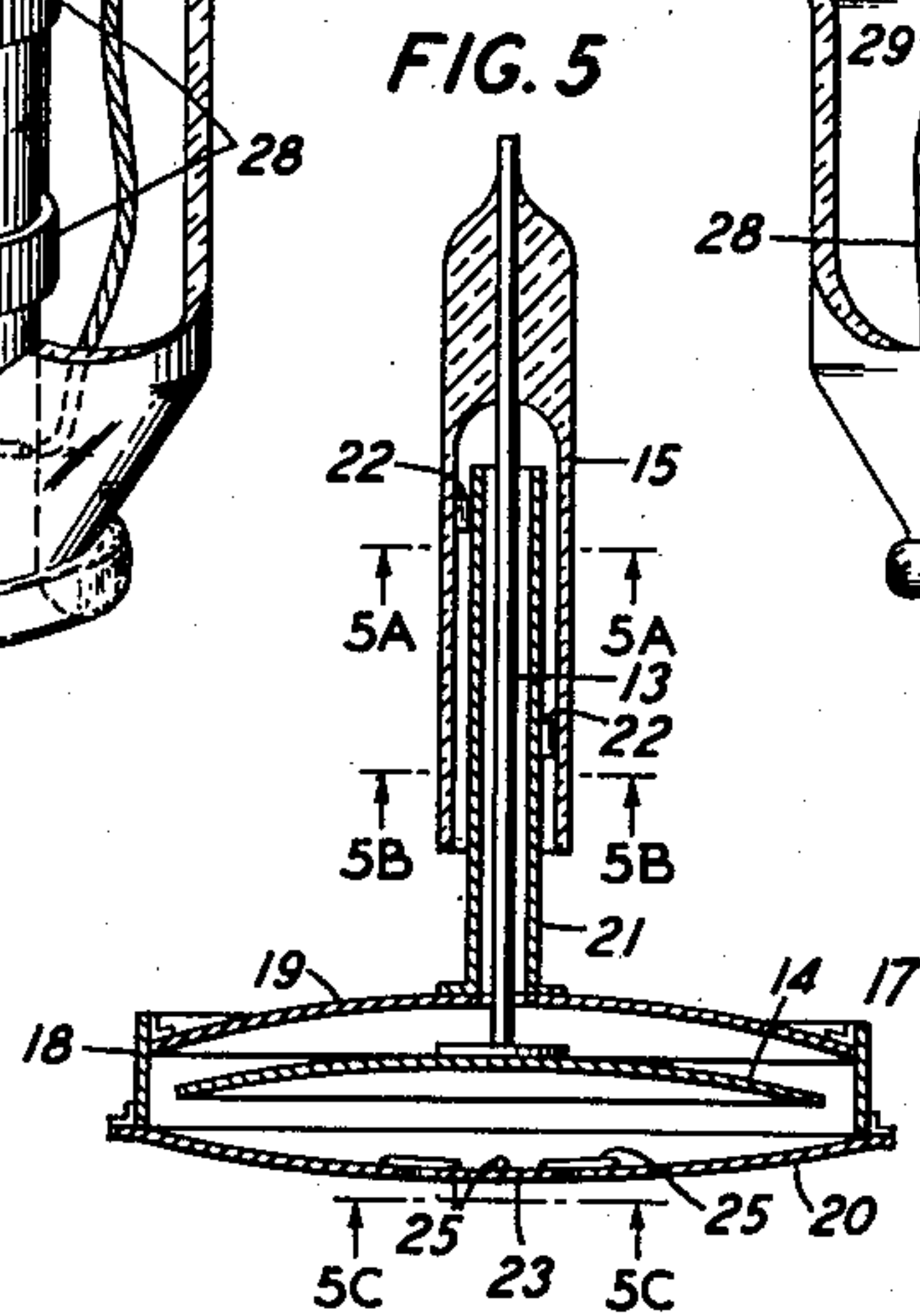
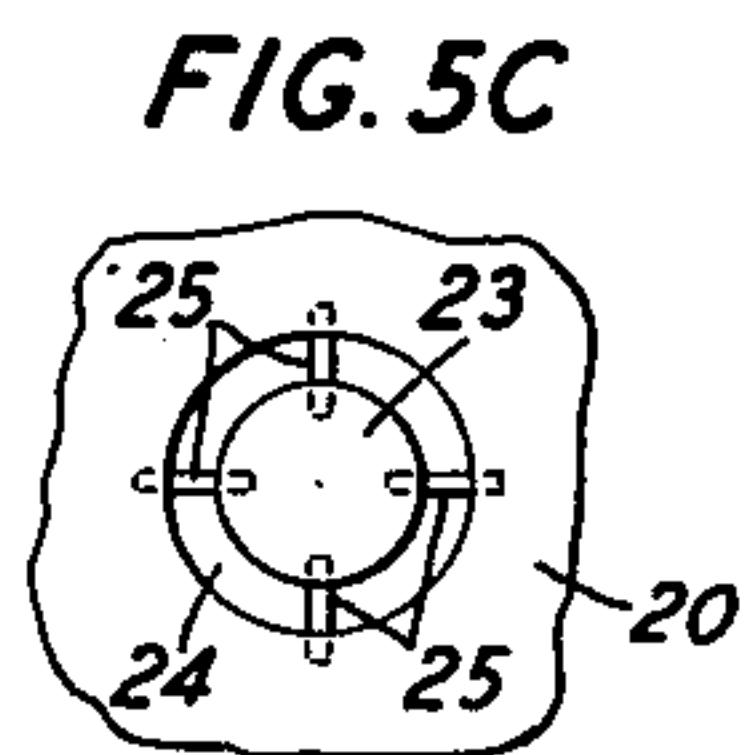
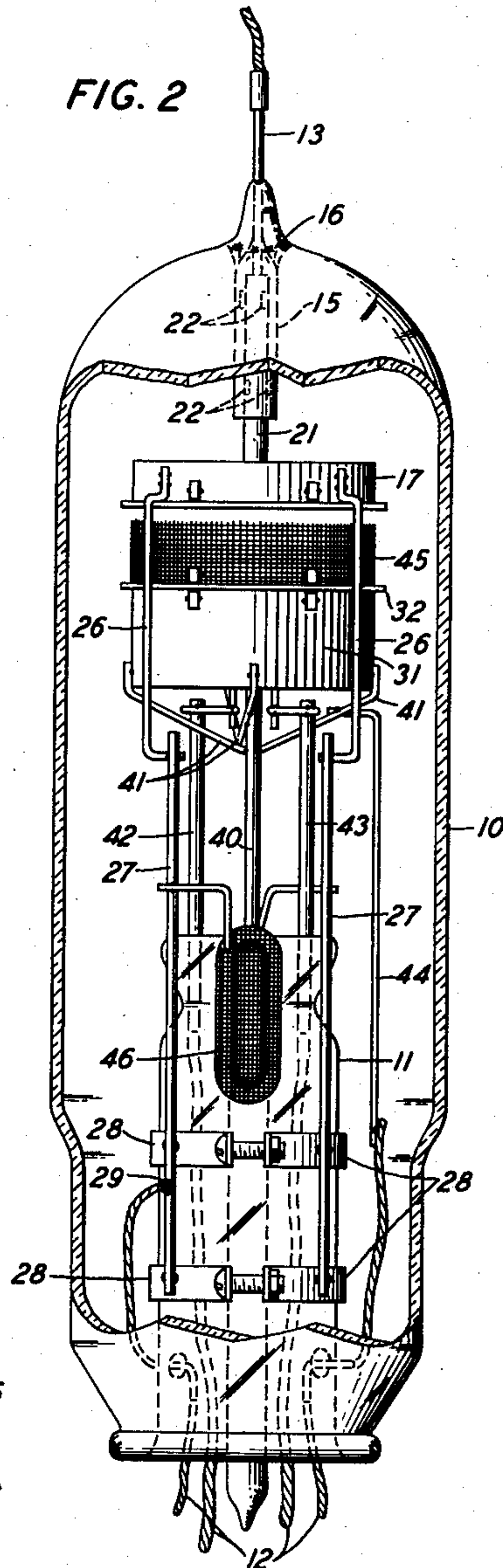
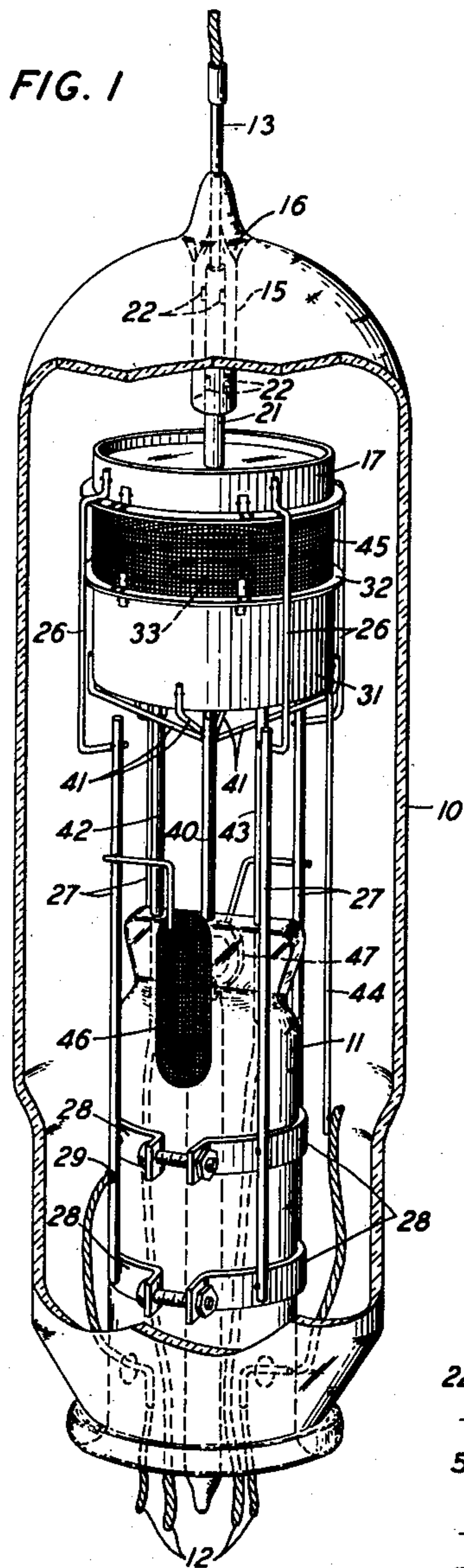
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2,392,367

ELECTRON DISCHARGE DEVICE

Filed Nov. 17, 1942

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 6

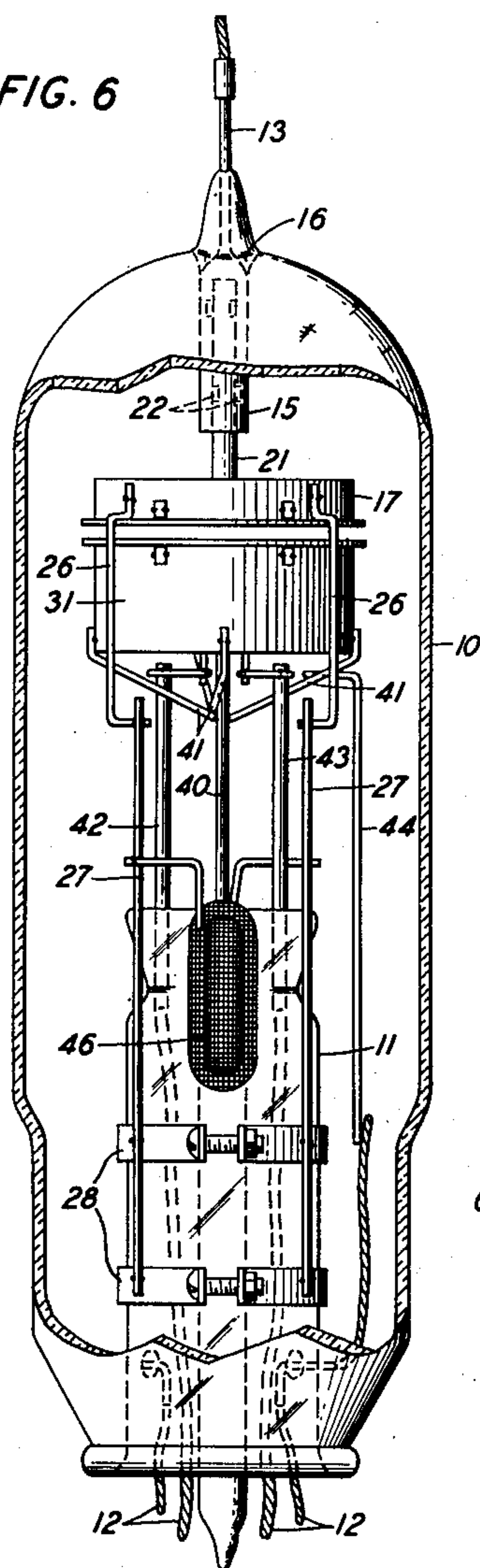


FIG. 3

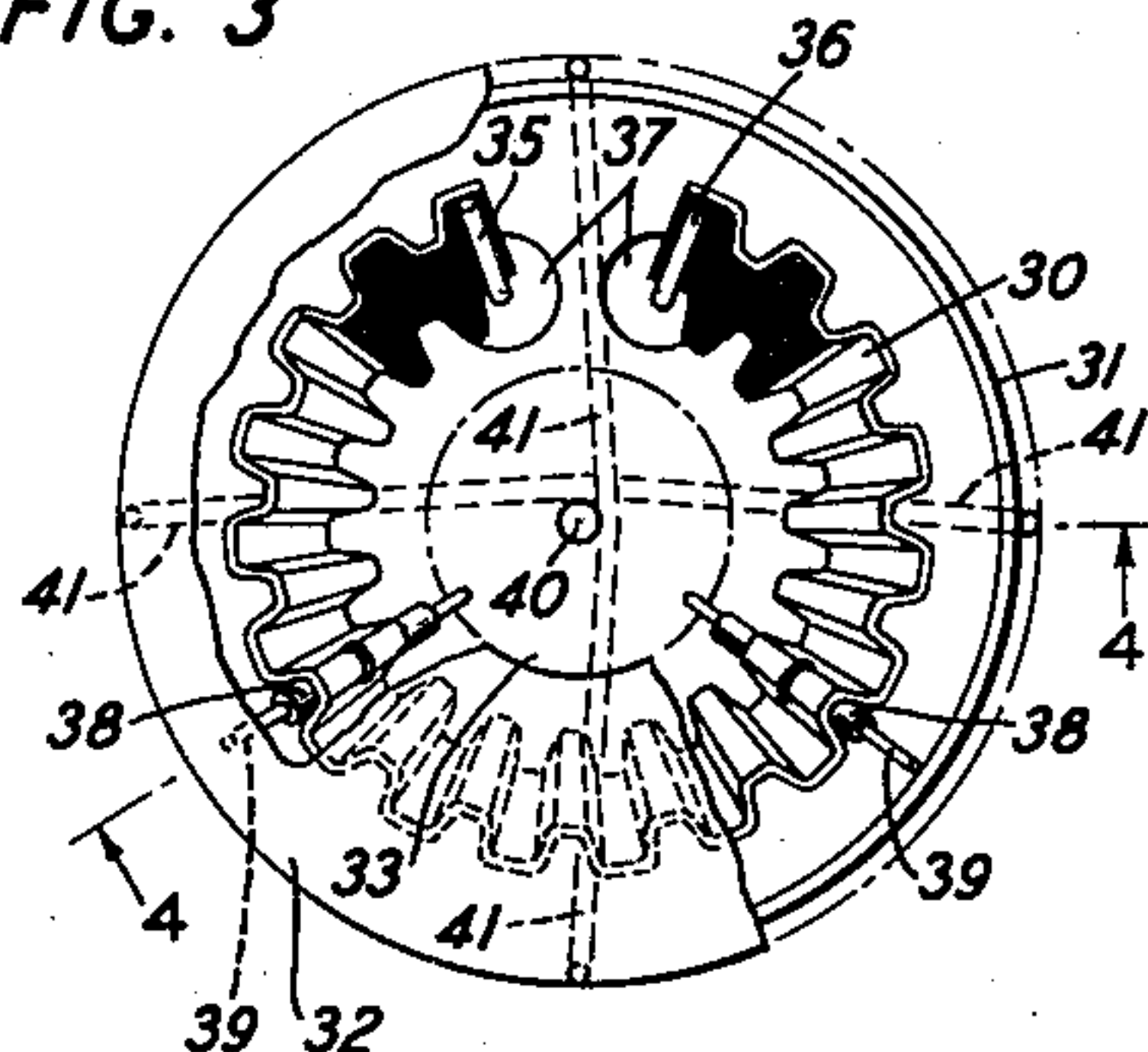


FIG. 4

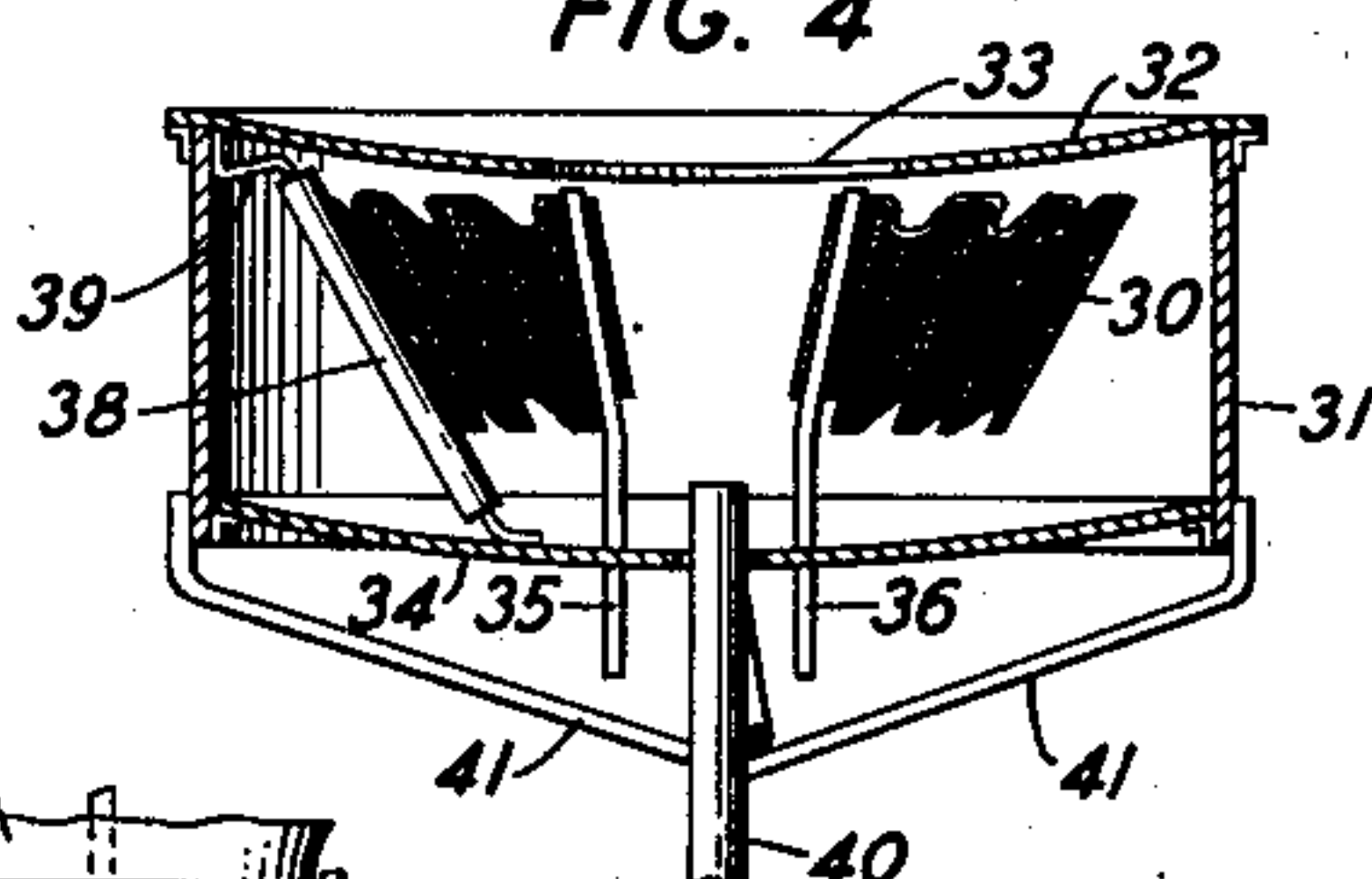


FIG. 7

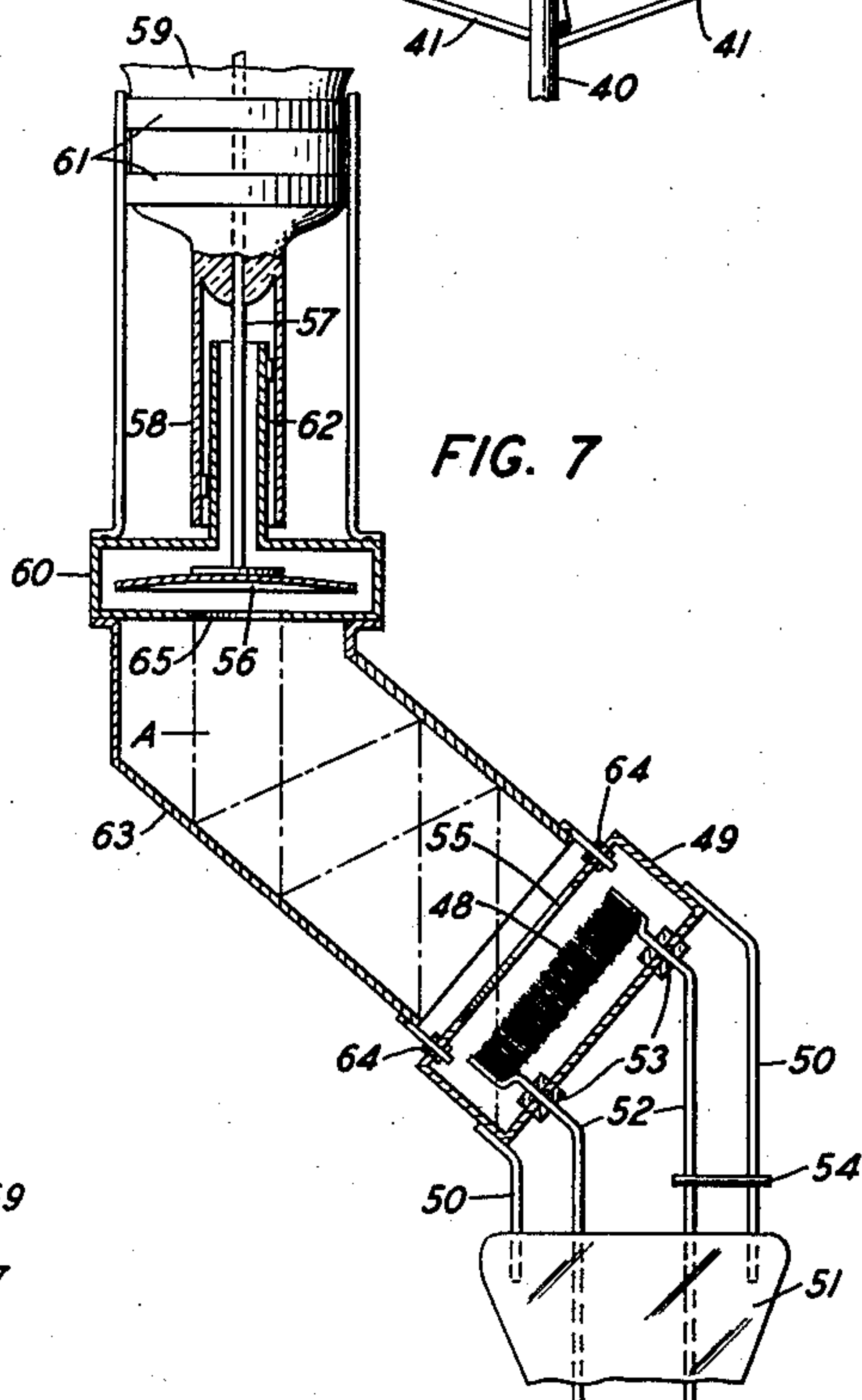
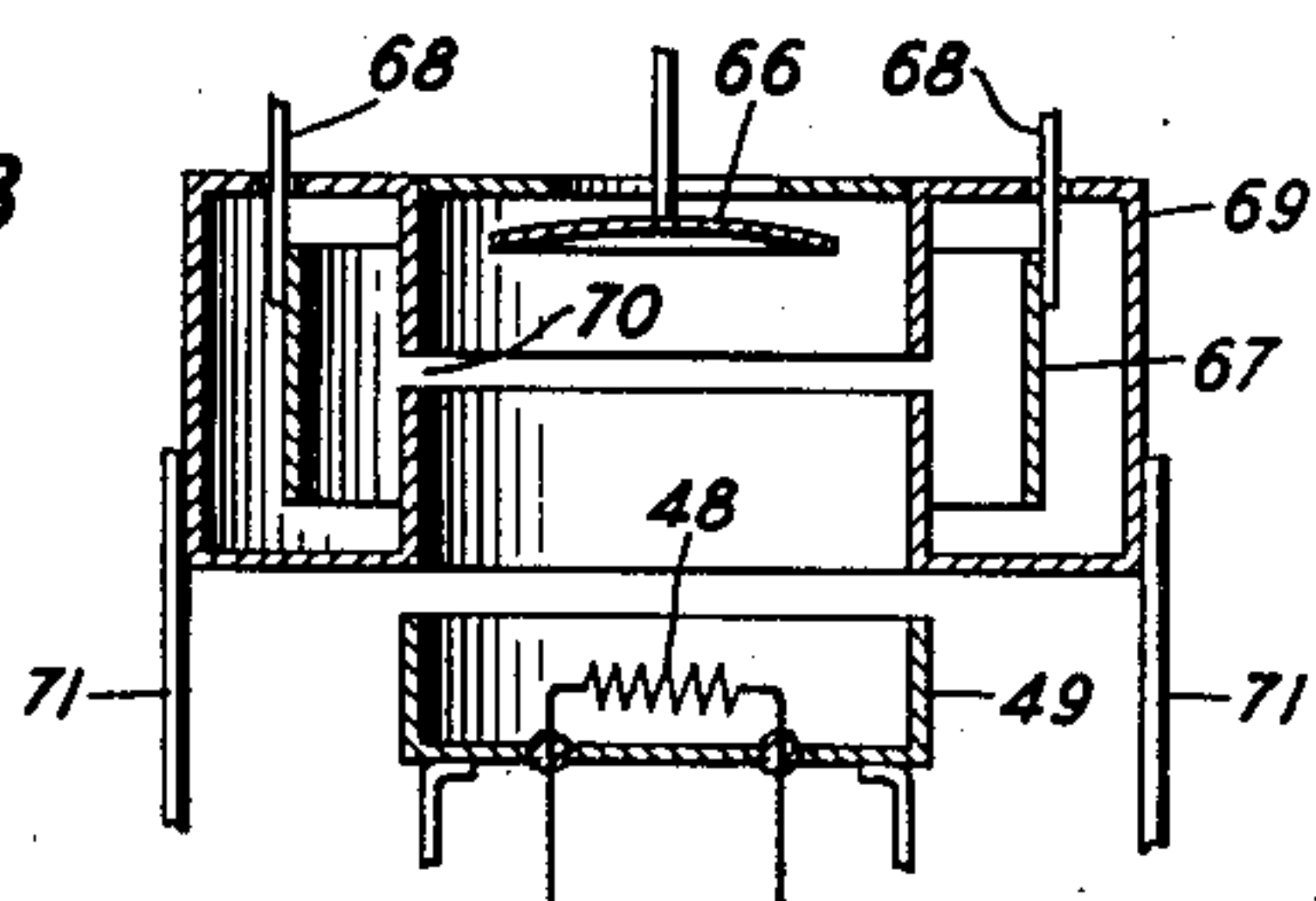


FIG. 8



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2,392,367

ELECTRON DISCHARGE DEVICE

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17 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices employing an ionizable medium for the conduction of electrical energy in the device.

The gaseous conduction device of the emissive cathode type which is thermally energized has proved highly beneficial in a wide range of commercial applications and particularly since alternating current supply may be directly utilized in the operation of the device. However, a paramount drawback to the realization of the high efficiencies capable of being attained with such devices is the inherent reactionary effect the starting and stopping of the space current imposes on the operating life and efficiency of the heated cathode and particularly the electron emissive coating applied thereto. This coating is susceptible to attack by the high velocity positive ions which bombard the cathode coating and disintegrate or sputter the active material from the cathode surface so that the emission efficiency of the cathode is materially reduced or the cathode is rendered inactive or materials may be sputtered or dissociated from the anode surface and be deposited on the active cathode coating thereby contaminating or effectively destroying the emissive properties of the coating. These difficulties are especially evident in high power energy converters or rectifiers and adaptations of the same in which grid electrodes are employed for switching or relay operations where the loss in efficiency is quite costly.

An object of this invention is to overcome loss of efficiency in such devices by preventing the deleterious effects of the high velocity positive ions on the active cathode surface.

Another object of the invention is to shield the sensitive emissive coating of the cathode from destructive effects without reducing the emission output of the cathode.

A further object of the invention is to increase the operating life of the device by eliminating a direct path between the cathode and the anode.

A still further object of the invention is to reduce the velocity and therefore to hinder the destructive power of material sputtered from the anode and directed towards the cathode surface.

These objects are attained in accordance with the general aspects of this invention by diverting the flow of high velocity positive ions in the device or displacing the cathode surface with respect to the anode so that there is no direct line of attack between these electrodes and the cathode coating is not vulnerably exposed to the de-

structive ionic bombardment and contaminating materials diffused from the anode.

In more limited aspects of the invention the discharge devices embody a vessel containing a gaseous or vaporizable atmosphere capable of conveying large currents by ionized carriers between an output electrode or anode and an electron emitting electrode or cathode in which the cathode is displaced or shielded from the discharge from the anode so that vaporized substances from the anode are not deposited on the cathode surface to deactivate the cathode coating or emissive layer.

These constructions may be manifested in a device in which the cathode surface is in the form of a section of a cone of large diameter and the anode is a small plane surface perpendicular to the axis of the cone with a shielding member interposed between the cathode and anode so that the linear path from the anode along the axis does not intersect the cathode surface or the cathode may be mounted centrally and the anode is offset or displaced from the axial path of the cathode, for instance, by forming the anode into a cylinder and shielding the surfaces thereof directly exposed to the cathode but permitting a discharge path therefrom at right angles to the cathode surface.

A feature of these construction is the control of the high velocity ions from the anode so that the ionic charges emanating from the anode do not accumulate sufficient velocity in the direction toward the cathode during the initial phase of the current build-up to bombard the cathode coating and thereby cause disintegration or sputtering of the particles of active emissive material deposited thereon.

Another feature of the invention relates to the protection or shielding of the cathode either in the vicinity of the cathode or the anode so that destructive particles thrown off the anode will not reduce the efficiency of the sensitive emissive coating on the cathode.

A further feature of the invention relates to the positioning of the cathode with respect to the anode so that the cathode is obliquely mounted and offset with respect to the anode so that destructive materials from the anode are not deposited on the sensitive coating of the cathode. This arrangement is represented in a device in which the anode is mounted in a horizontal plane on one side of the axis of the enclosing vessel and the cathode assembly is mounted at an angle on the other side of the axis, the conducting path therebetween being surrounded by a shielding

member which directs the flow of electrons to the anode but intercepts any vaporized material from the anode to prevent the cathode coating being injuriously affected by the vaporized material.

These and other features and advantages of the invention are more clearly set forth in the following detailed description which, together with the accompanying drawings, represent various embodiments of the devices of this invention:

Fig. 1 is a perspective view of an electron discharge device made in accordance with this invention and is shown with a portion of the vessel broken away to illustrate the assembly of the electrodes therein to eliminate contamination of the cathode in the device;

Fig. 2 illustrates the device of Fig. 1 in elevation to show the details of assembly and the relation of the electrodes;

Fig. 3 is an enlarged plan view showing the configuration and assembly of the emissive cathode in the cathode structure with a portion of the cover plate broken away;

Fig. 4 is a view of the cathode structure in cross section taken on the line 4—4 of Fig. 3;

Fig. 5 illustrates in cross section, on an enlarged scale, the anode and shielding assembly at the top of the vessel;

Figs. 5a and 5b show views of cross sections of the respective details of mounting of the anode assembly taken on the lines indicated in Fig. 5 to illustrate the coaxial alignment of the shield extension in the stem and Fig. 5c is a partial plan view across the central portion of the shield assembly of Fig. 5 to show the mounting of the inserts in the shield aperture;

Fig. 6 is a view in elevation of a modification of Fig. 2 wherein the cathode structure is closer to the anode and shield electrode assembly;

Fig. 7 is a further modification of the invention with the assembly shown in cross section to illustrate the offset relation of the main electrodes in the construction; and

Fig. 8 illustrates another modification of the invention in cross section, partly diagrammatic, showing the isolation of the anode in an assembly so that the cathode is protected from the vaporized material from the anode.

Referring to the drawings, and particularly to Fig. 1, the electron discharge device of this invention embodies a vitreous enclosing vessel 10 having an inwardly projecting stem 11 at one end for supporting various electrodes in the vessel and for conveying energy to the electrodes by a plurality of conductors 12 sealed in the stem. The other end of the vessel is provided with a central conductor 13 sealed therein and connected to an output electrode or anode 14, shown more clearly in Fig. 5, which cooperates with the electrodes supported from the stem 11.

The anode 14, as shown in Fig. 5, is a slightly dished metallic surface centrally supported by the conductor 13 which extends through an insulating tubular member or sleeve 15 which is fused to the vessel 10 at the sealing-in point of the conductor. The anode surface may be coated with carbon or other heat radiating material, to more readily dissipate thermal energy generated in the surface during the operation of the device. The anode is completely enclosed in a metallic shield casing or control electrode member 17, which includes a boundary ring member 18 having the ends closed by disc members 19 and 20 which are convex and concave, respectively, in relation to the anode surface to prevent distortion or buckling by heating conditions extant within the

closely confined area of the anode shield 17. Fig. 5 shows the curvature of the anode and the discs 19 and 20 slightly exaggerated to more clearly depict the construction and assembly of the anode structure.

The disc member 19 is provided with a central aperture to clear the anode support or conductor 13 extending therethrough and a tubular metallic extension 21 projects from the outer surface of the disc 19 and is disposed within the insulating sleeve 15. The extension 21 is coaxially mounted with respect to the inner conductor 13 and the outer sleeve 15 by groups of equally spaced aligning pieces 22, in the form of short stub wires, which are welded to the outer surface of the tubular extension 21 adjacent the ends of the cavity within the sleeve and these wires engage the inner surface of the sleeve 15, the lower group of aligning pieces, as shown in Fig. 5b, being distributed in opposite relation to the group shown in Fig. 5a, to accurately center the extension 21 in the sleeve 15. The disc member 20 has a large central aperture directly opposite the anode 14 which is partially reduced by a concentric disc insert 23, to provide an annular orifice 24. This orifice forms the communicating conductive path for the main discharge current in the device between the cathode structure and the anode 14 since all other paths are completely shielded from any possible conduction from the cathode to the anode. The insert 23 is secured to the disc 20 by equally spaced stub wires 25 extending radially from the disc insert to the disc 20 on the inner surfaces thereof.

The shield enclosure 17, which may be utilized as a grid electrode by applying suitable breakdown potentials thereto, is preferably supported in a horizontal plane so that the anode 14 is uniformly spaced therein with respect to the closure discs 19 and 20, by a frame mounting including a plurality of angularly shaped rods 26 attached to four upright standards 27 which are secured to a pair of spaced collars 28 clamped to the exterior of the stem 11 to rigidly mount the shielding enclosure in suitable space relation to the anode 14 and the cathode structure. A voltage may be applied to the shielding closure 17 by connecting one of the conductors 12 to one of the standards, as shown at 29.

In high power converter devices of the gaseous conduction type where high operating potentials are applied to the electrodes and particularly in the case of alternating current supply sources, the high energy transformed causes reactionary effects in the operation of the device due to the reversals of current during half cycles of the applied voltage. This results in the anode becoming the negative electrode during the non-conducting cycle of operation so that positive ion carriers present in the discharge path are energized toward the anode and being of large mass are capable of accumulating sufficient energy to deleteriously attack or bombard the anode surface. This inverse cycle, particularly during high voltage operation, is considerably destructive if the cathode utilized to enhance electronic emission is provided with an oxide coating, such as alkaline earth oxides, i. e., barium and strontium oxides. The bombardment of the anode releases vaporized particles of the metal of the anode which are sputtered from the anode surface and if the anode is coated with carbon, particles of this material are also disintegrated from the surface. If these materials are deposited on the active cathode coating they contaminate the

emissive particles of the coating or render the coating less efficient from an emission standpoint.

It is, therefore, the primary object of this invention to protect the cathode and especially the electronically active coating thereon from the destructive effects of the inverse cycle of the anode current when alternating current is employed in the operation of the device. This is realized by mounting the oxide coated cathode, which may be the filamentary type directly heated to emission temperature or an indirectly heated type brought to emission temperature by heat conduction, in such a relation with respect to the anode that the cathode surface is not exposed to disintegrated materials from the anode surface.

In one preferred form of this invention, the emitter or active cathode surface, as shown in Figs. 3 and 4, is an accordion pleated or folded ribbon 30, of woven or wire mesh material, formed into the configuration of a section of a cone and mounted in relation to a shielding enclosure 31 so that the cathode surface is effectively displaced from the direct line with the discharge path from the anode 14. The enclosure 31 is provided with a cover portion or plate 32 having a central opening 33 for forming a conductive path to the anode in which a copious supply of electrons is projected from the cathode surface 30 under the influence of the potential attracting the electrons to the anode surface to convert the energy applied to a direct current. It will be seen from Fig. 3 that the top closure plate 32 effectively shields the sensitive cathode coating from deleterious substances dissociated from the anode surface since the cathode surface is displaced from the direct axial line of the anode path. The enclosure 31 is also provided with a bottom closure plate 34 to intercept particles of material which are projected beyond the shield 32. It will be noted that the cover plates 32 and 34 are slightly convex, although shown exaggerated in Fig. 4, to prevent distortion of the shield casing enclosing the cathode. The conical shaped cathode 30 is mounted in the casing 31 with its larger diameter adjacent the cover plate 32 and the ends thereof are attached to support wires 35 and 36 which project through a pair of apertures 37 in the casing. Intermediate portions of the mesh ribbon 30 are tied over angularly positioned insulating sleeves 38 which are held in such positions by wire braces 39, secured to the side and bottom walls of the casing 31.

The cathode structure which includes the casing and conical filament is supported in opposed relation to the anode structure by a central support or standard 40 extending from the stem 11, the standard slidably projecting into a central aperture in the bottom plate 34 of the cathode structure to form a guiding means therefor whereby expansion and contraction of the cathode structure is compensated yet the structure is accurately aligned in central relation to the anode structure. The casing 31 is supported by the standard 40 through a plurality of branching arms 41 secured at the center to the standard 40 and welded to the periphery of the casing 31. The filament support wires 35 and 36 are attached to extensions 42 and 43, respectively, of a pair of the conductors 12 projecting above the stem 11. The shield casing 31 surrounding the cathode may be connected to a wire 44 which is joined to the remaining conductor in the stem to apply a separate negative potential thereto or the casing may be externally connected to the cathode or ground to maintain the shield at a low

value of potential. The shield casing 31 may also be provided with an annular shield 45, of wire mesh material, which extends towards the anode structure and substantially surrounds the discharge path between the cathode and anode thereby limiting the dispersion of the ionic discharge in the path between the main electrodes.

The completely enclosed anode 14 substantially eliminates stray discharge paths in the operation of the device which materially alter the static and dynamic characteristics of the switching function of the device. The limited path between the anode 14 and the adjacent walls of the enclosing shield member 17 prevents the occurrence of a cold discharge between the anode and shield at high voltages.

The annular opening 24 in the shield member 17 which is necessarily provided to permit the main discharge current to flow to the anode, obviously presents an area of the anode which is subject to attack by large mass positive ions to disintegrate the anode surface and form vaporized substances which are liable to attack the sensitive emissive coating on the cathode surface.

In accordance with this invention the destructive precipitation from the anode surface is prevented from affecting the active coating of the cathode surface by disposing the cathode surface in such relation to the direct path from the anode that the disintegrated material cannot reach the active coating on the cathode surface. The invention also contemplates the disposition of the cathode surface in such relation to the anode that although the coating is exposed to the inverse discharge from the anode, the destructive effect of the discharge is dissipated before it reaches the coated surface and disintegration of the active material on the cathode surface is prevented since the velocity of the inverse discharge particles is so reduced in magnitude that bombardment of the coating is greatly reduced.

Referring to Figs. 3 and 4, it will be realized that the deleterious material from the anode escaping from the annular orifice 24 of the shield member or grid 17 is projected toward the cathode structure and either strikes the top cover shield 32 and is deposited thereon or enters the discharge opening 33 in the cathode casing and strikes the bottom cover shield 34 where it is also deposited. The cathode surface 30 which carries the active coating material is completely offset from the direct line of the anode discharge so that the diffused particles from the anode do not strike or bombard the sensitive coating to impair the electronically emissive properties thereof.

The modification shown in Fig. 6 is substantially similar to Fig. 2 except that the discharge path between the main electrodes is decreased to improve the impedance characteristics of the device for certain circuit applications. Furthermore, the short distance between the anode and cathode materially reduces the destructive effect of the inverse discharge cycle from the anode since the particles in the discharge have less chance of dispersion in the path toward the cathode and therefore follow paraxial paths into the cathode casing where their destructive properties do not affect the coating.

The vessel 10 of the devices shown in Figs. 2 and 6 is initially evacuated to remove injurious gases and occluded impurities in the electrode assemblies and after sealing the vessel, a mesh capsule 46 is inductively heated by high fre-

quency heating current to fracture a glass pill containing mercury mounted within the capsule. The diffused mercury collects in the lower end of the vessel and serves as a source of ionizable vapor for increasing current conduction in the vessel by gaseous ionization. It is also preferable to add a small quantity of an inert gas, such as argon, at a low pressure of .1 millimeter of mercury to stabilize the control characteristics of the grid electrode 17 with variations in vapor pressure due to temperature changes. A getter mounting 47 on the opposite side of the stem 11 is provided to diffuse a barium-magnesium pellet which absorbs residual gases in the device too difficult to remove by the usual pumping procedure.

Another modification of the invention relates to a construction in which the sensitive cathode coating is adequately protected from destructive attack by deleterious particles from the anode so that the efficiency of the cathode as an electron emission source is unimpaired. This is produced by offsetting the cathode structure with respect to the anode and providing a channel enclosure between the electrodes which intercepts the dissociated particles from the anode surface and dissipates the destructive effect of the particles before they reach the sensitive electron emitting coating on the cathode surface.

As shown in Fig. 7, the cathode and anode structures are located on opposite sides of an imaginary axis which might be the axial plane of an enclosing vessel, the vessel being omitted to avoid complications in the illustration and to limit the disclosure to the essential concepts of the invention. It is, of course, understood that the vessel may be of any desired shape to accommodate the combination of units to achieve the results of this invention and the vessel will contain a gas or vapor or a combination thereof to facilitate conduction by ionic discharge in the device. An oxide coated cathode surface 48, in the form of a zig-zag folded ribbon filament is mounted at an oblique angle in a heat conserving metallic casing or enclosure 49 attached to a pair of supports 50 secured in a stem 51 which may be formed at one end of a vessel (not shown). The filament is attached at the ends to a pair of conductors 52 which extend through insulating bushings 53 mounted in the bottom of the enclosure 49, the conductors projecting exterior to the stem so that energizing current may be supplied to the cathode ribbon to thermally activate the emissive coating on the cathode surface. The casing 49 may be connected to one side of the filament by a strap 54 to maintain the casing at negative or cathode potential. As shown, the cathode structure is offset to the right side of the axis of the vessel and is positioned at an oblique angle thereto. In this position the electrons from the filament 48 are projected through the opening 55 in the top of the casing to enter the discharge path towards the anode structure yet the cathode structure is displaced from the direct axial line of the anode.

The anode structure is mounted in offset relation to the left of the axis of the vessel, as viewed in the drawing of Fig. 7, and consists of a concave metallic disc anode 56 supported by a conductor 57 extending through a glass tubular extension or sleeve 58 projecting downwardly from the stem 59 joined to the top portion of the vessel. The anode 56 is enclosed by a shield casing or grid electrode 60 which is supported from the stem 59 by a frame secured to collars 61 clamped

to the stem 59. The shield 60 is provided with a tubular extension 62 coaxially mounted with respect to the conductor 57 and the sleeve 58, in a manner similar to the structure of Fig. 1.

An elbow-shaped tubular shield member or casing 63 joins the anode structure with the cathode structure, a short cylindrical portion extending downwardly and coaxially form the grid electrode 60 and being physically secured thereto, and a long portion extending angularly from the cylindrical portion is insulatingly supported by the cathode casing 49 by rods extending through insulating bushings 64. This tubular casing provides an enclosed channel passageway for the main discharge path between the electrodes and the inner surface of the long angular portion forms an impact receiving surface for particles of material diffused from the anode surface on reversals of current. Since this surface intersects the direct axial line from the anode through the opening 65 in the grid electrode 60, as shown by the dotted outline A, it intercepts ionic discharge material and prevents attack of the cathode surface during the non-conducting cycle of the device. In view of the channel casing 63 being electrically connected to the grid electrode 60, it is at the same potential as that electrode which is slightly negative during the conducting cycle of the device, so that the force of the high velocity positive ions is dissipated upon contact with the channel casing surface. Any rebounding particles having sufficient energy to progress further in the casing are directed towards the opposite surface where further energy is absorbed so that the particles that may finally reach the cathode surface are relatively slow moving particles which do not have sufficient energy to bombard the cathode coating on the filament surface 48. Furthermore, these particles are directed toward the lower end of the casing 49 and only a small portion strike the cathode but being of low energy force, the cathode coating is not bombarded or disintegrated by the spent particles.

Another modification of the invention is shown in Fig. 8, in which the electrode assembly is coaxial but the anode is shielded in such a manner that there is no path leading from the anode directly to the cathode structure. In this arrangement the cathode surface 48 is shown diagrammatically as being mounted in a shield casing such as 49, which is supported in a vessel (not shown) in a horizontal position coaxial with the axis of the vessel. An auxiliary anode or electrode 66 is supported in opposed relation to the cathode structure, to initiate the flow of current in the main discharge path of the device. The main anode 67 is in the form of a cylindrical body coaxially arranged with respect to the cathode and auxiliary anode. This anode 67 is of large diameter so that the surface thereof is outside the confines of the cathode structure. The anode 67 may be supported from the top of the vessel by suitable support rods 68.

The cylindrical anode 67 is surrounded by an annular hollow shield casing 69 which completely isolates the anode from all direct paths in communication with the cathode structure. The inner wall of the casing 69 is provided with a continuous circular orifice 70 which forms a passageway for the main discharge path from the cathode surface 48 to the anode surface 67. The inner wall, therefore, intercepts substantially all the particles bombarded from the anode 67 except the limited amount of material which escapes through the orifice 70. However, the radial

direction of this discharge causes the particles from the anode to impinge on the opposite outer wall of the inner boundary of the shield casing 69 where they may be deposited and, therefore, are prevented from reaching the cathode 48. The casing or grid electrode 69 may be supported from the same end of the vessel as the cathode structure by upright support rods 71 to rigidly maintain the position of the casing 69 with respect to the anode 67.

While various embodiments of the invention have been described and illustrated, it is of course, understood that many modifications and alterations may be made in the relationship of the electrodes to achieve the primary concepts of this invention, therefore, the constructional limits of the invention are only to be confined within the scope of the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel containing a gaseous filling, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode structure, said cathode structure including a cathode surface having an active emissive coating which is easily contaminated by materials discharged from said anode during the inverse current cycle, and a hollow metallic member surrounding said cathode and having an opening for directing an electronic discharge from said cathode to said anode, said cathode surface being so disposed in said hollow member with respect to said opening that materials from said anode projected toward the surface of said hollow member and through said opening are deposited on surfaces of said hollow member in preference to impinging on said cathode surface.

2. An electron discharge device comprising an enclosing vessel containing a gaseous filling, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode structure, said cathode structure including a cathode surface having an active emissive coating which is easily deactivated by deleterious material dissociated from said anode, and a hollow metallic member surrounding said cathode and having an opening for directing an electronic discharge from said cathode to said anode, said cathode surface having the configuration of a section of a cone and substantially shielded from said anode in directions parallel to the axis of said cathode structure and anode whereby destructive particles projected from said anode are incapable of being deposited on said active coating.

3. An electron discharge device comprising an enclosing vessel containing a gaseous filling, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode structure, said cathode structure including a cathode surface having an active emissive coating which is easily deactivated by deleterious material dissociated from said anode, and a hollow metallic member surrounding said cathode and having an opening for directing an electronic discharge from said cathode to said anode, said cathode surface being formed of fluted ribbon material shaped in the configuration of a conical boundary having the larger diameter thereof adjacent said opening but shielded by said hollow member from said anode.

4. An electron discharge device comprising an enclosing vessel containing a gaseous filling, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode

structure, said cathode structure including a cathode surface having an active emissive coating which is easily contaminated by particles precipitated from said anode surface, a shielding member surrounding the gap between said cathode structure and said anode and connected to said cathode structure, and an electrostatic enclosure surrounding said anode and having an opening for directing an electronic discharge from said cathode to said anode, said cathode surface being so disposed with respect to said shielding member and the opening in said enclosure that material dissociated from said anode surface and projected towards a surface of said shielding member through said opening is deposited on said enclosure out of line with said cathode surface.

5. An electron discharge device comprising an enclosing vessel containing a gaseous filling, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode structure, said cathode structure including a cathode surface having an active emissive coating, an electrostatic enclosure surrounding said anode, and a shielding member substantially surrounding the gap between said cathode structure and said enclosure and being connected to said cathode structure.

6. An electron discharge device comprising an enclosing vessel containing an ionizable medium, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode structure, said vessel having a tubular extension projecting toward said anode, a conductor secured to said anode and disposed within said extension, and a hollow metallic casing surrounding said anode, said casing having a tubular metallic portion projecting into said extension and spaced intermediate said extension and said conductor.

7. An electron discharge device comprising an enclosing vessel containing an ionizable medium, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode structure, said vessel having a tubular extension projecting toward said anode, a conductor secured to said anode and disposed within said extension, a metallic enclosure about said anode having an opening directed toward said cathode structure, a metallic sleeve member extending into said tubular extension between said conductor and said extension and connected to said enclosure, and means situated at opposite ends of said extension and carried by said sleeve to space said sleeve coaxially with respect to said conductor and said extension.

8. An electron discharge device comprising an enclosing vessel containing a gaseous filling, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode structure, said cathode structure including a cathode surface having an active emissive coating which is easily deactivated by particles precipitated from said anode by ionic bombardment, an electrostatic enclosure surrounding said anode, said enclosure having an apertured surface substantially parallel to said cathode structure, a hollow metallic member surrounding said cathode and having an opening for directing an electronic discharge from said cathode to said anode, said cathode surface being so disposed in said hollow member with respect to said opening that the precipitated particles from said anode projected towards a surface of said hollow member through said opening are incapable of being deposited on said cathode surface, and a coplanar insert centrally supported in the aperture of said enclosure.

9. An electron discharge device comprising an enclosing vessel containing a gaseous filling, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode structure, said cathode structure including a cathode surface having an active emissive coating, a hollow metallic member surrounding said cathode and having an opening for directing an electronic discharge from said cathode to said anode, said cathode surface being formed of fluted ribbon material shaped in the configuration of a conical boundary having the larger diameter adjacent said opening but shielded by said hollow member from said anode, and a central support slidably extending through said hollow member.

10. An electron discharge device comprising an enclosing vessel containing a gaseous filling, a cathode structure mounted therein, an anode disposed in cooperating relation to said cathode structure, said cathode structure including a cathode surface having an active emissive coating which is easily contaminated by particles deposited thereon which are precipitated from said anode, a hollow metallic member surrounding said cathode and having an opening for directing an electronic discharge from said cathode to said anode, said cathode surface being so disposed in said hollow member that it is substantially shielded from particles bombarded from said anode, a central support extending through said hollow member, and a plurality of diagonal arms extending from said central support to the periphery of said hollow member.

11. An electron discharge device comprising an enclosing vessel having a stem and containing a gaseous filling, a cathode structure mounted on said stem, an anode disposed in cooperating relation to said cathode structure, said cathode structure including a cathode surface having an active emissive coating which is easily deactivated by material derived from said anode surface under inverse bombardment conditions, a hollow metallic member surrounding said cathode and having an opening for directing an electronic discharge from said cathode to said anode but preventing deleterious material from said anode being deposited on said active coating, an electrostatic enclosure surrounding said anode, and supporting means attached to said enclosure and extending from said stem.

12. An electron discharge device comprising an enclosing vessel containing an ionizable material, a cathode structure and an anode mounted in said vessel, said cathode structure including a thermionic emission surface, an electron emitting coating on said surface sensitive to destructive substances emanating from said anode on inverse passage of current, and a shielding enclosure surrounding said anode having an orifice on its surface constructed and arranged so that diffused particles from said anode are directed perpendicular to the longitudinal axial direction toward said cathode structure.

13. An electron discharge device comprising an enclosing vessel containing an ionizable material, a cathode mounted in said vessel coincident with the axis thereof, a cylindrical anode mounted in spaced relation to said cathode and coaxial therewith but separated therefrom by a large gap along said axis, an electron emitting coating on said

cathode sensitive to destructive substances emanating from said anode on inverse passage of current, and an annular hollow metallic casing enclosing said anode and shielding said cathode from all directions leading from said anode, said casing having a slit opening on its inner boundary forming the sole ingress to said anode, said slit opening directing diffused particles from said anode radially whereby contaminating attack of said cathode coating is eliminated.

14. An electron discharge device comprising an enclosing vessel containing a vaporizable material, a cathode mounted in said vessel coincident with the axis thereof, a cylindrical anode mounted in space relation to said cathode and coaxial therewith but separated therefrom by a large gap along said axis, an electron emitting coating on said cathode sensitive to destructive particles emanating from said anode on inverse passage of current, an annular hollow metallic casing enclosing said anode and shielding said cathode surface from all directions leading from said anode, said casing having a slit opening directing particles from said anode radially whereby contaminating deposition on said cathode coating is eliminated, and an auxiliary electrode disposed opposite said cathode.

15. An electron discharge device comprising an enclosing vessel containing a vaporizable material, a cathode structure mounted in offset position on one side of the axis of said vessel, an anode mounted in offset position on the other side of said axis, said cathode structure including a cathode surface having an active emissive coating which is sensitive to deleterious materials dissociated from said anode, and a channel enclosure surrounding the space between said cathode structure and said anode and so constructed that the dissociated materials are deposited on the surfaces of said enclosure and substantially no material reaches said cathode surface.

16. An electron discharge device comprising an enclosing vessel containing an ionizable material, a cathode structure mounted in said vessel, said cathode structure including a surface coated with electron emissive material, an anode supported in cooperating relation to said cathode, and a cylindrical metallic shield casing diagonally mounted in said vessel to form a communicating passageway between said cathode structure and said anode, said casing having surfaces in receiving relation to the discharge flow from said anode whereby deleterious materials dissociated from said anode are deposited thereon and said materials do not contaminate said cathode surface.

17. An electron discharge device comprising an enclosing vessel containing a gaseous filling, an anode therein, a cathode having an oxide-coated emitting surface angularly positioned with respect to said anode, said emitting surface being out of alignment with the longitudinal axis of said anode, and a metallic channel casing extending diagonally between said cathode and anode within said vessel, the walls of said casing intercepting particles precipitated from said anode so that their energy is dissipated and thereby prevented from attacking said emitting surface.

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