April 1, 1947. D. A. S. HALE ET AL 2,418,117

ELECTRON DISCHARGE DEVICE

Filed May 29, 1944 3 Sheets-Sheet 1

FIG. 1

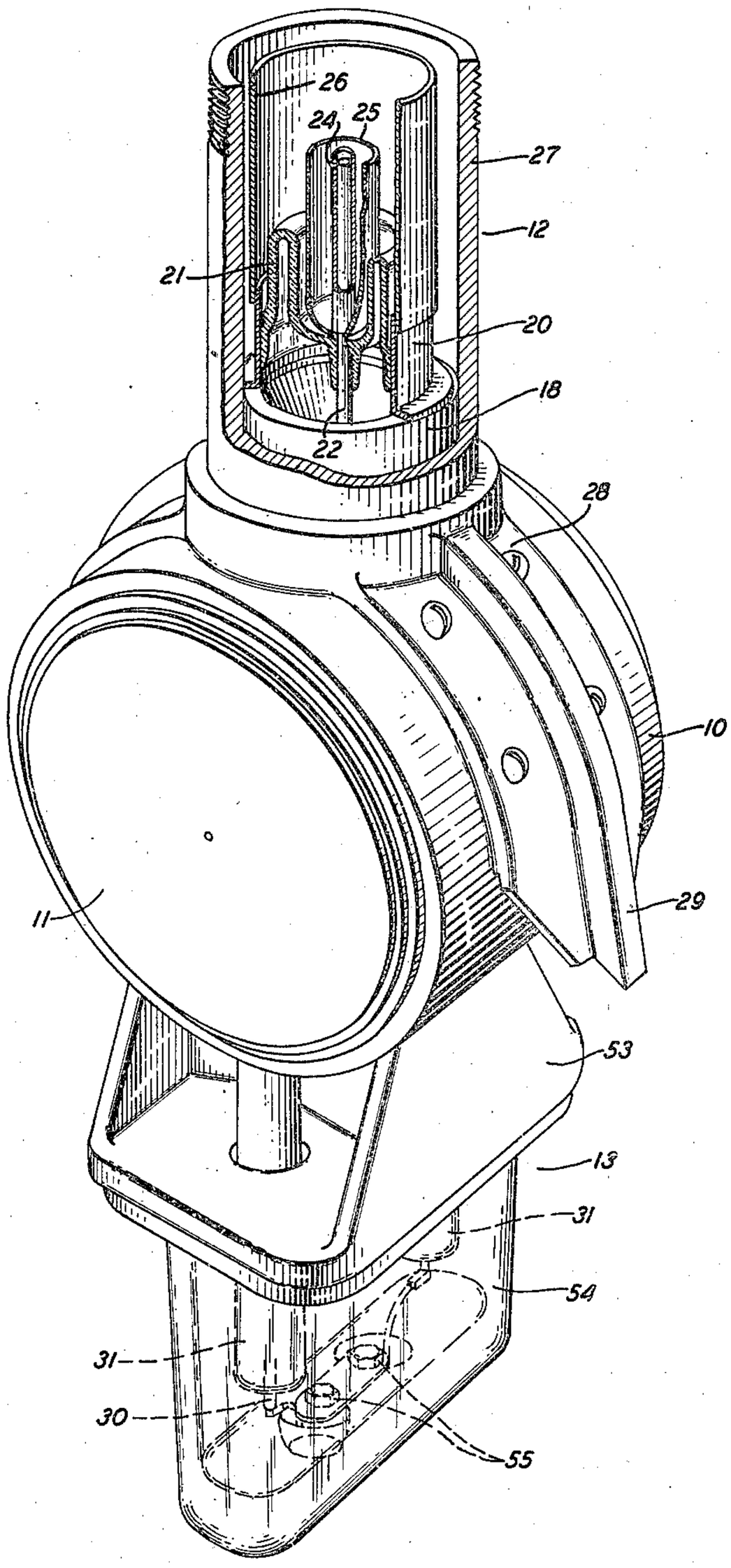

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FIG. 2

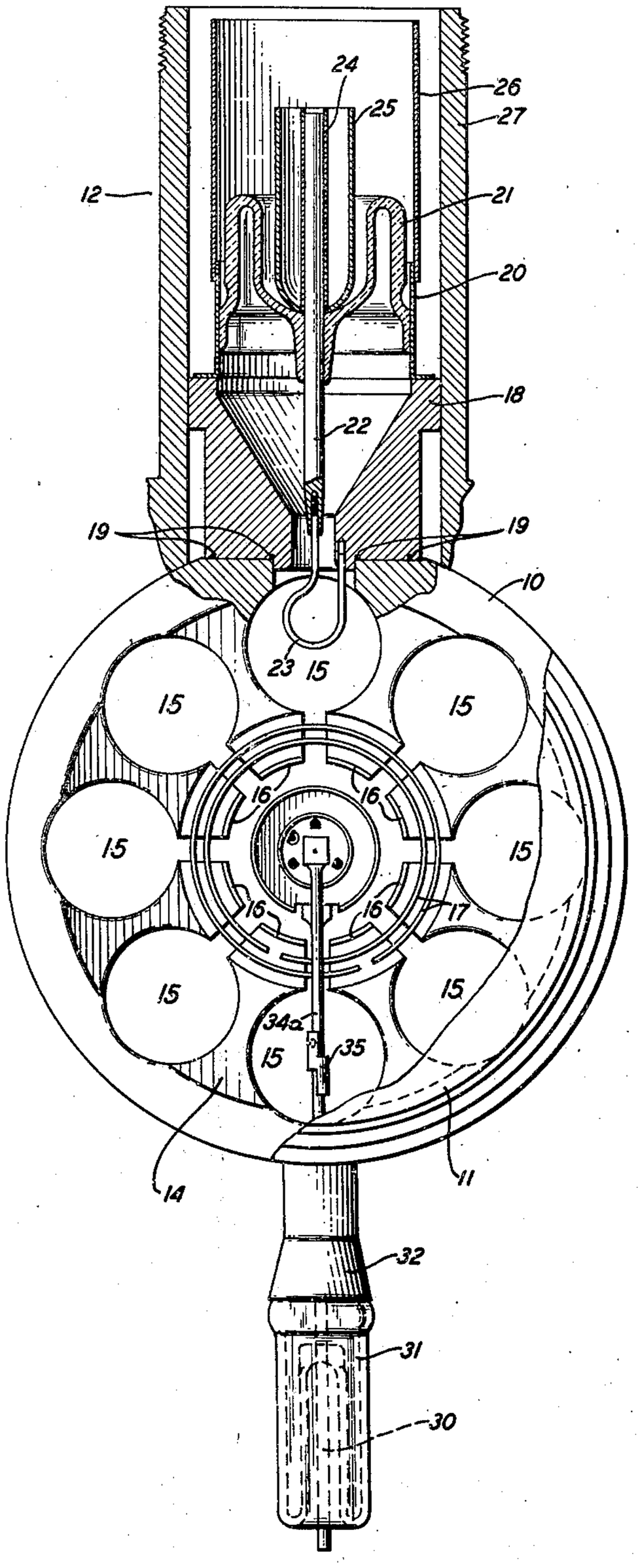

FIG. 3

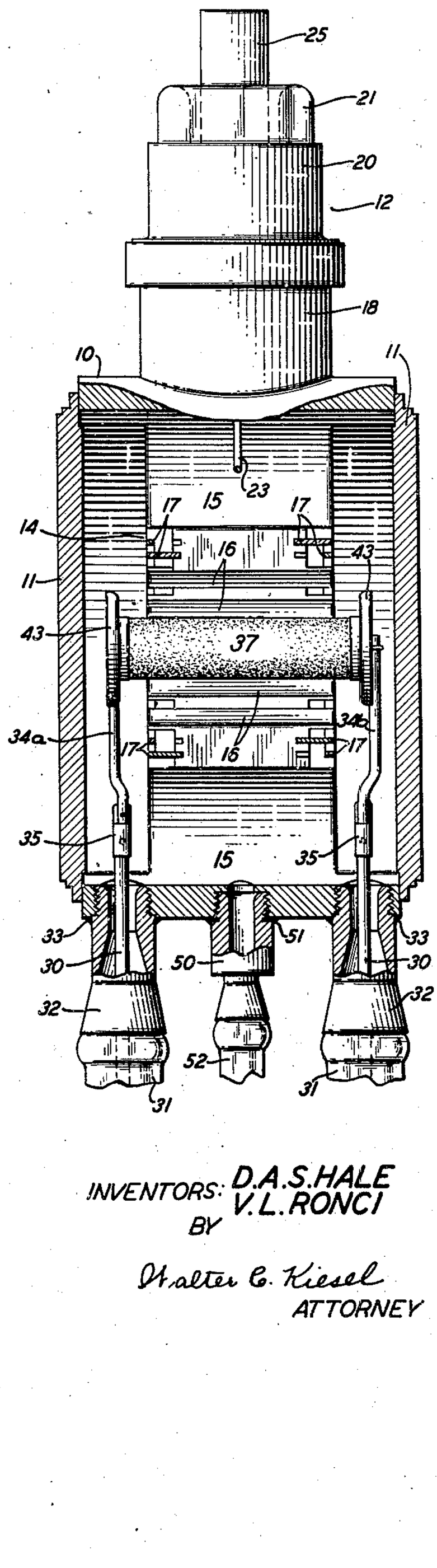

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FIG. 4

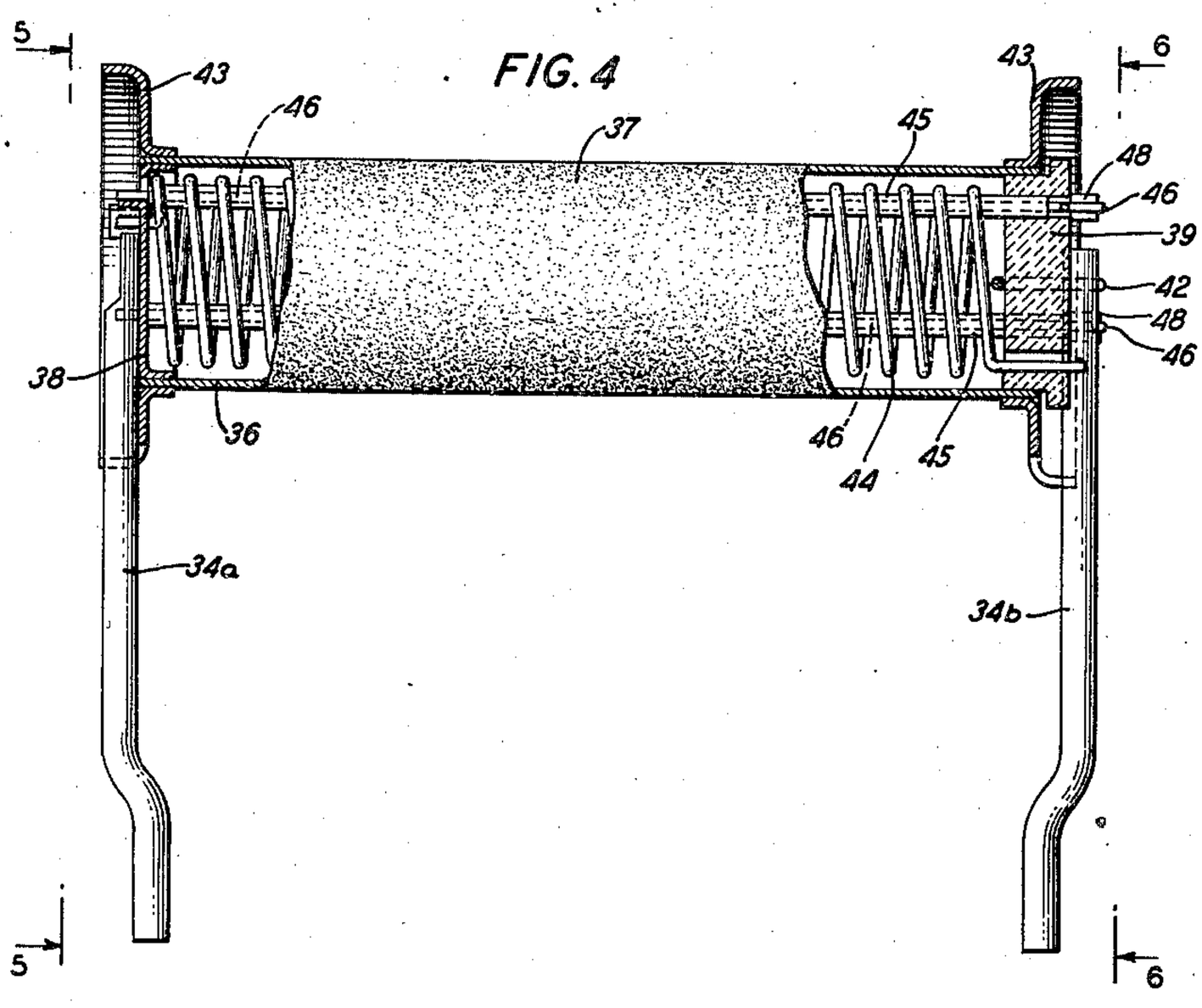


FIG. 5

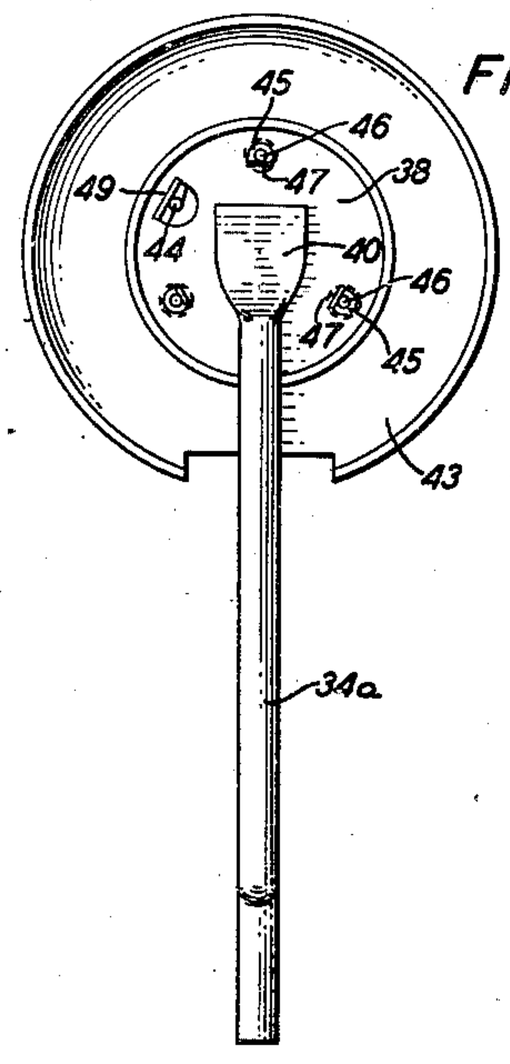
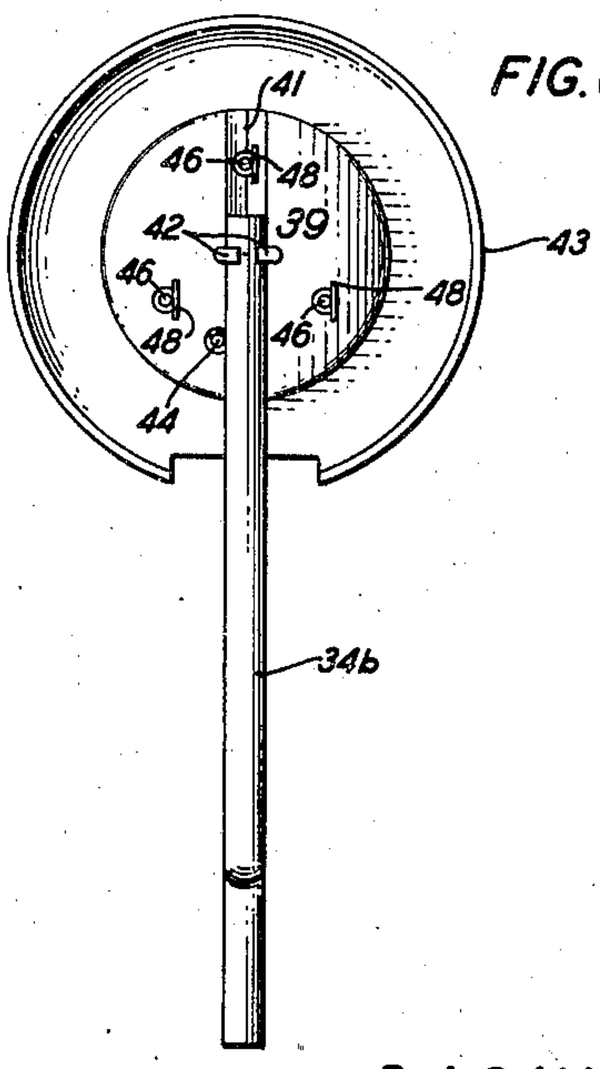


FIG. 6



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UNITED STATES PATENT OFFICE

2,418,117

ELECTRON DISCHARGE DEVICE

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Application May 29, 1944, Serial No. 537,858

5 Claims. (Cl. 250—27.5)

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This invention relates to electron discharge devices and more particularly to indirectly heated cathode structures for such devices.

One object of this invention is to improve the construction of indirectly heated cathodes and, more specifically, to increase the insulation resistance between the heater and emissive elements in equipotential type cathodes without deleteriously affecting the thermal efficiency thereof, and to facilitate the fabrication of such cathodes and the mounting thereof in electron discharge devices.

Another object of this invention is to realize electrical symmetry of the cathode with respect to an associated electrode in electron discharge devices, such as of the magnetron type, operable at ultra high frequencies.

In one illustrative embodiment of this invention, a cathode especially suitable for utilization in a multianode magnetron operable in the centimeter range comprises a cylindrical cathode sleeve or shell having an electron emissive coating on its outer surface, and a helical heater filament within the cathode sleeve.

In accordance with one feature of this invention, the heater filament is supported in proximity to but spaced from the inner surface of the cathode sleeve, upon a plurality of insulating posts extending between a metallic closure at one end of the sleeve and an insulating disc at the other end of the sleeve. A leading-in conductor is connected in common to the cathode sleeve and one terminal of the filament at one end of the sleeve and the other terminal of the filament, located at the other end of the sleeve, is connected to a second leading-in conductor. The heater filament, thus, is mounted in good heat transferring relation to the cathode sleeve and by virtue of the support of the heater filament by the posts and the insulating disc high resistance insulation is provided between the body of the heater filament and the cathode sleeve.

In accordance with another feature of this invention, the metallic closure and the insulating disc are mounted in fixed space relation, as by the leading-in conductors aforementioned, and the cathode sleeve has one end fixed to the metallic closure and its other end slidable upon the insulating disc so that the sleeve can expand and contract freely longitudinally in accordance with temperature variations. When utilized in a device, such as a centimeter range magnetron, wherein symmetry of the electrodes is highly important, the cathode sleeve is mounted so that normally, that is when it is unheated, it is unsymmetrical by a predetermined extent with respect to the transverse median plane of the electrode system. When the cathode is heated to the intended operating temperature, it expands longitudinally so that it becomes symmetrical with respect to the plane noted whereby electric and electronic symmetry of the cathode with respect to the cooperating electrode, for example the anode, during operation of the device is realized.

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The invention and the above noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is an elevational view in perspective of an electron discharge device and a protective element for parts thereof, illustrative of one embodiment of this invention, portions of the output structure being broken away to show details of construction;

Fig. 2 is a front view mainly in section of the device illustrated in Fig. 1;

Fig. 3 is a side view, partly in section and partly broken away, of the device;

Fig. 4 is a detail view to an enlarged scale of the cathode assembly included in the device illustrated in Figs. 1 to 3, a portion of the cathode sleeve being broken away and parts being shown in section to illustrate details of construction; and

Figs. 5 and 6 are end views, as seen from planes 5—5 and 6—6 respectively of Fig. 4, of the cathode structure.

Referring now to the drawing, the electron discharge device illustrated is a magnetron oscillator of the multianode type especially suitable for operation in the centimeter range and comprises a generally cylindrical metallic body or block 10, advantageously of copper, and closure discs 11 sealed heremetically to the ends of the body or block 10 as by soldering. Extending from the body or block 10 and diametrically aligned are an output structure designated generally as 12 and an input conductor structure designated generally as 13.

As shown clearly in Figs. 2 and 3, the body or block 10 includes an internal cylindrical portion 14 of somewhat shorter length then the body or block, which portion is provided with a plurality of substantially identical, cylindrical resonating cavities 15 having their longitudinal axes parallel and equally spaced. The cylindrical portion 14, as will be apparent from Fig. 2, defines a multianode element, the several anodes or anode segments having arcuate inner faces 16 which are arranged in a circular cylindrical boundary. At

opposite ends of the anode portion 14 and associated with the anode segments are arcuate conductors 17 which, as described fully in the applications Serial No. 529,619, filed April 5, 1944, of James B. Fisk and Serial No. 517,660, filed January 10, 1944, of Victor L. Ronci, serve to assure oscillation of the device in a desired mode.

The output end structure 12 comprises a metallic platform 18, for example of copper, affixed to the body or block 10 as by brazing material indicated at 19. Hermetically joined to the platform 18 is a cylindrical metal sleeve 20 to which a vitreous stem 21 is sealed. The stem 21 has sealed thereto a conductor 22 which is connected at one end to a coupling or pickup loop 23. The loop is positioned in one of the cavities 15, advantageously midway between the ends thereof as shown in Fig. 3, and has one end fixed to the platform 18. The conductor 22 mounts a connector element having coaxial inner and outer metallic members 24 and 25 respectively and the sleeve 20 has affixed thereto a cylindrical metallic member 26. In operation of the magnetron, the connector element 24, 25 and the cylindrical member 26 are fitted to the inner and outer conductors respectively of a coaxial transmission line.

The platform 18 and sleeve 26 may be encompassed by a protective metallic cylinder 27 which extends from a bracket 28 affixed to the body 10 and fitted over the platform. Advantageously, the bracket 28 is provided with a rigid finger 29 which is adapted to engage a spring, not shown, on a mounting for the device and lock the device against accidental displacement.

Extending from the body or block 10 at points opposite the output end structure 12 are a pair of leading-in conductor assemblies for the cathode. Each of these assemblies comprises a rigid conductor 30 sealed to a vitreous stem 31 which in turn is sealed hermetically to a metallic sleeve 32. The sleeves 32, as shown in Fig. 3 may be threaded into the body or block 10 and brazed thereto, as indicated at 33, to form a hermetic seal therewith. The leading-in conductors 30 mount rigid metallic supports or rods 34*a* and 34*b* which are affixed to the conductors 30 as by sleeves or couplers 35 welded to the respective conductors and supports.

The supports or rods 34 mount a cathode, which, as shown in Figs. 2 and 3, is positioned coaxially within the anode member 14 and, as shown most clearly in Fig. 4, comprises a cylindrical metallic sleeve 36 having thereon a coating 37 of electron emissive material. One end of the sleeve 36 has fixed therein a metallic closure member or cap 38 and the other end of the sleeve is fitted slidably upon an insulating disc 39, for example of a ceramic. The closure or cap 38 is fixed, as by welding, to the support or rod 34*a*, one end of which, as shown at 40 in Fig. 5, may be flattened to provide a large area of contact with the closure or cap 38. The outer face of the disc 39 is provided with a diametral channel or groove 41, V-shaped in section, in which the support or rod 34*b* is locked by a wire 42. It will be appreciated, then, that the closure or cap 38 and the disc 39 are mounted in fixed relation to one another. The sleeve 36, being secured to the closure or cap, is fixed at one end while the other end is slidable upon the disc 39. In the assembly of the device, the sleeve is positioned in such relation to the transverse median plane of the anode portion 14 that it is unsymmetrical with respect to this plane. When the device is operated,

the cathode sleeve 36 expands and slides on the disc 39 so that it becomes symmetrical with respect to the plane noted.

Inasmuch as the cathode sleeve is free to expand longitudinally, it will be appreciated that distortion or buckling of the sleeve is prevented. Thus, as will be apparent, when the device is operated the cathode sleeve remains in accurate coaxial relation with the anode faces 16 and, furthermore, is symmetrical longitudinally with respect to these faces. Thus, exact mechanical and electrical symmetry of the anode and cathode during operation of the device is realized.

The cathode sleeve 36 has affixed to opposite ends thereof a pair of dished metallic shields 43 which serve to prevent flow of electrons from the emissive surface 37 to beyond the ends of the anode faces 16 or, viewed in another way, to confine the electrons to the region between the cathode and the anode surfaces 16.

The cathode sleeve 36 is heated during operation of the device by a heater element which comprises a helical filament 44 coated with insulating, e. g., ceramic, material and mounted upon a plurality, for example three, of tubular insulating, e. g., ceramic, posts or supports 45. The posts or supports 45 are threaded upon wires 46 which are affixed at one end, as by welding, to tabs 47 on the closure or cap 38 and are locked at the other end to the insulating disc 39 by wire strips 48 welded to the posts at this end. As shown in Fig. 4, the insulating supports 45 are fitted at one end in apertures in the insulating disc 39.

One end of the heater filament 44 is connected, as by welding, to the support or rod 34*b*; the other end of the filament is affixed, as by welding, to a tab 49 integral with the cap 38 and, thus, is connected electrically to the cathode sleeve 36 and to the support or rod 34*a*.

It will be noted that the heater element is mounted in proximity to but spaced from the cathode sleeve 36. The support of the heater filament by the ceramic posts 45 assures good insulation of the body of the heater filament from the cathode sleeve and enables the attainment of such good insulation without deleteriously affecting heat transfer from the heater filament to the cathode. Thus, the cathode structure is both thermally efficient and electrically advantageous. Furthermore, the construction described lends itself to facile fabrication as a unitary assembly which can be mounted readily within the body or block 10.

In the fabrication of the cathode assembly, the shields 43 and closure or cap 38 are affixed to the cathode sleeve 36 and the support or rod 34*a* is affixed to the cap 38. The wires 46 are then inserted into the sleeve and are welded at one end to the tabs 47, after which the tubular ceramic posts 45 are threaded on the wires 46 and the heater filament 44, preformed, is slid in place upon the posts. One end of the heater filament then is welded to the tab 49. The insulating disc 39 is fitted onto the posts 45 and the flange thereon is held in spaced relation to the adjacent end of the cathode sleeve by a suitable spacer or gauge, after which the other end of the heater filament and the wire 42 are affixed to the support or post 34*b*. The wire strips 48 are then welded to the respective wires 46 to lock the insulator 39 in position.

The unitary assembly thus formed is inserted into the body or block 10 and the supports or rods 34 are affixed to the leading-in conductors 30, with the cathode positioned in coaxial rela-

tion with the anode surfaces 16 by a suitable gauge. Subsequently, the closures 11 are affixed to the body or block 10.

The interior of the device is highly evacuated as by way of an exhaust connection including a metallic sleeve 50 hermetically joined to the body or block 10, as by brazing material indicated at 51, and a vitreous closure 52 sealed hermetically to the sleeve 50.

The leading-in conductor assemblies and the exhaust connection may be protected against damage during the handling or use of the device by a metallic guard member 53 affixed to the body 10 and a substantial vitreous cap 54 secured to the guard member 53 and having therein terminals 55 to which the conductors 30 are connected.

Although a specific embodiment of this invention has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. A cathode structure comprising a pair of supports mounted in fixed spaced relation, a pair of disc members each fixed to a respective support, a cylindrical cathode member having one end fixed to one of said disc members and its other end slidably fitted upon the other of said disc members, and a heater element within said cathode member.

2. A cathode structure comprising a hollow, elongated cathode member, a pair of closure members at opposite ends of said cathode member, insulating posts extending between and supported by said closure members, and a helical heater filament supported upon said posts in proximity to the inner surface of said cathode member.

3. A cathode structure comprising a cylindrical cathode member, a metallic closure at one end of said cathode member, an insulating closure at the other end of said cathode member, a plurality of insulating posts extending between and supported by said closure members, a helical heater filament within said cathode member and supported upon said posts, said cathode member and one end of said filament being connected electrically to said metallic closure, a leading-in conductor connected to said metallic closure, and a second leading-in conductor connected to the other end of said heater filament.

4. A cathode structure comprising a cylindrical cathode member, a metallic closure at one end of said member and having tabs thereon, an insulating closure at the other end of said member and having apertures therein, a plurality of parallel wires extending between said closures, each of said wires having one end fixed to one of said tabs and its other end portion extending through one of said apertures, means locking said wires in position with respect to said insulating closure, tubular ceramic sleeves threaded on said wires, and a helical heater filament mounted on said sleeves and having one end connected to said metallic closure and its other end extending through said insulating closure.

5. A cathode structure comprising an insulating disc, a metallic disc, a pair of leading-in conductors mounting said discs in fixed, aligned, parallel relation, insulating posts extending between said discs and supported thereby, a heater filament encircling said posts and supported thereon, said filament having its ends connected to said conductors, and a cylindrical cathode sleeve encompassing said filament, one end of said sleeve being fitted upon said metallic disc and affixed thereto and the other end of said sleeve being slidably fitted on said insulating disc.

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The following references are of record in the file of this patent:

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