

July 9, 1946.

J. P. LAICO

2,403,445

ELECTRON DISCHARGE DEVICE

Filed May 31, 1941

2 Sheets-Sheet 1

FIG. 1

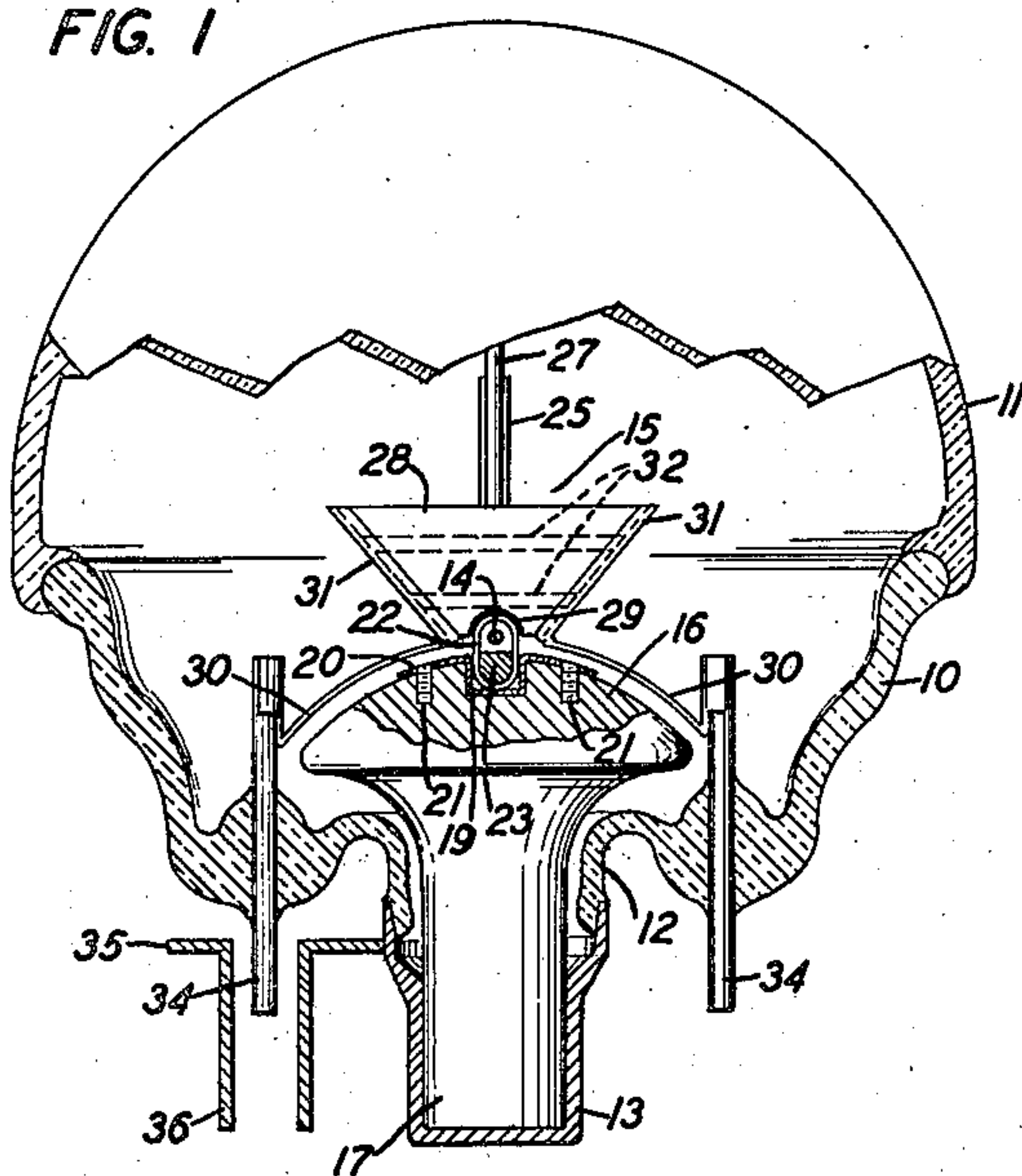


FIG. 2

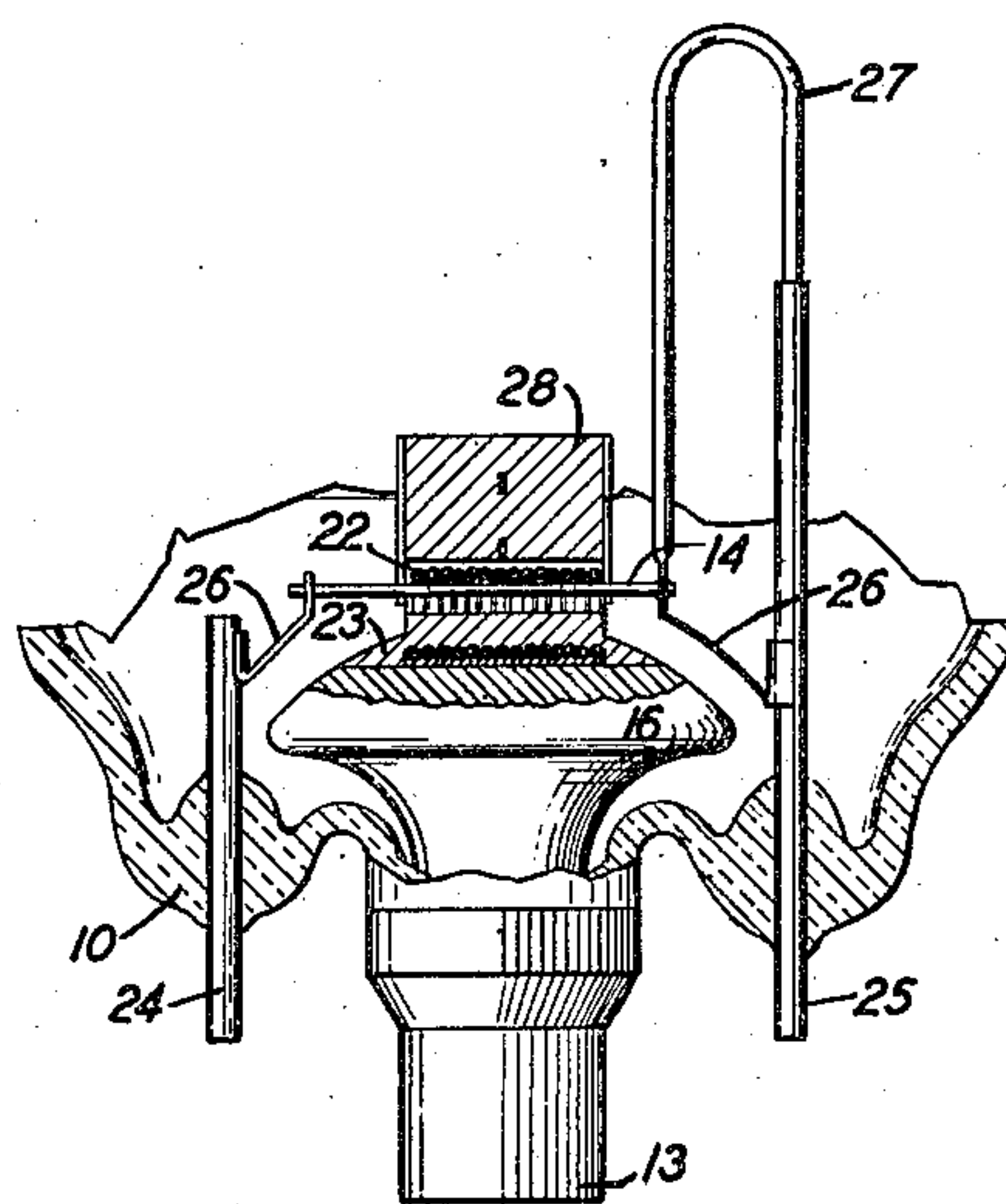
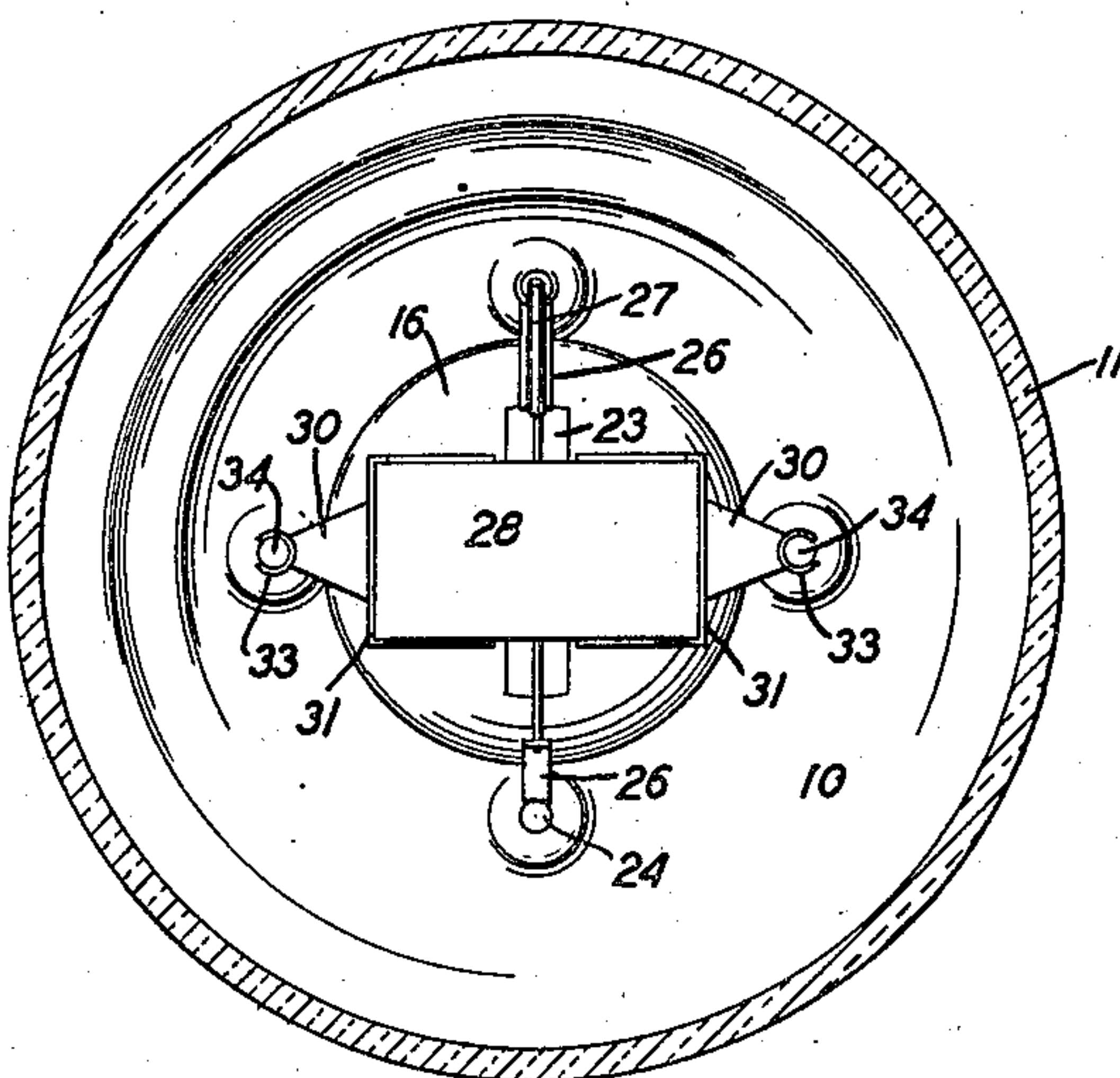


FIG. 3



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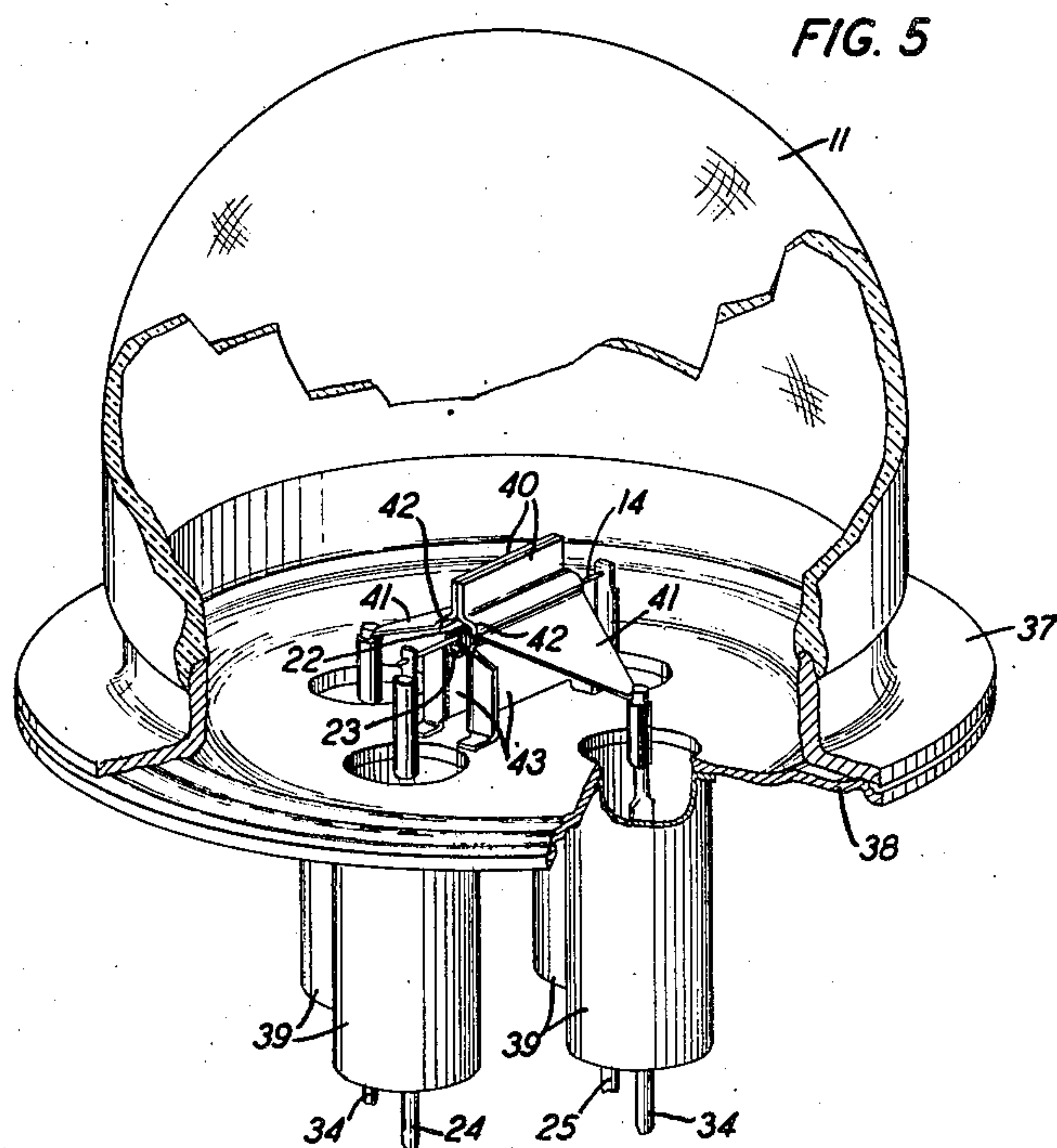
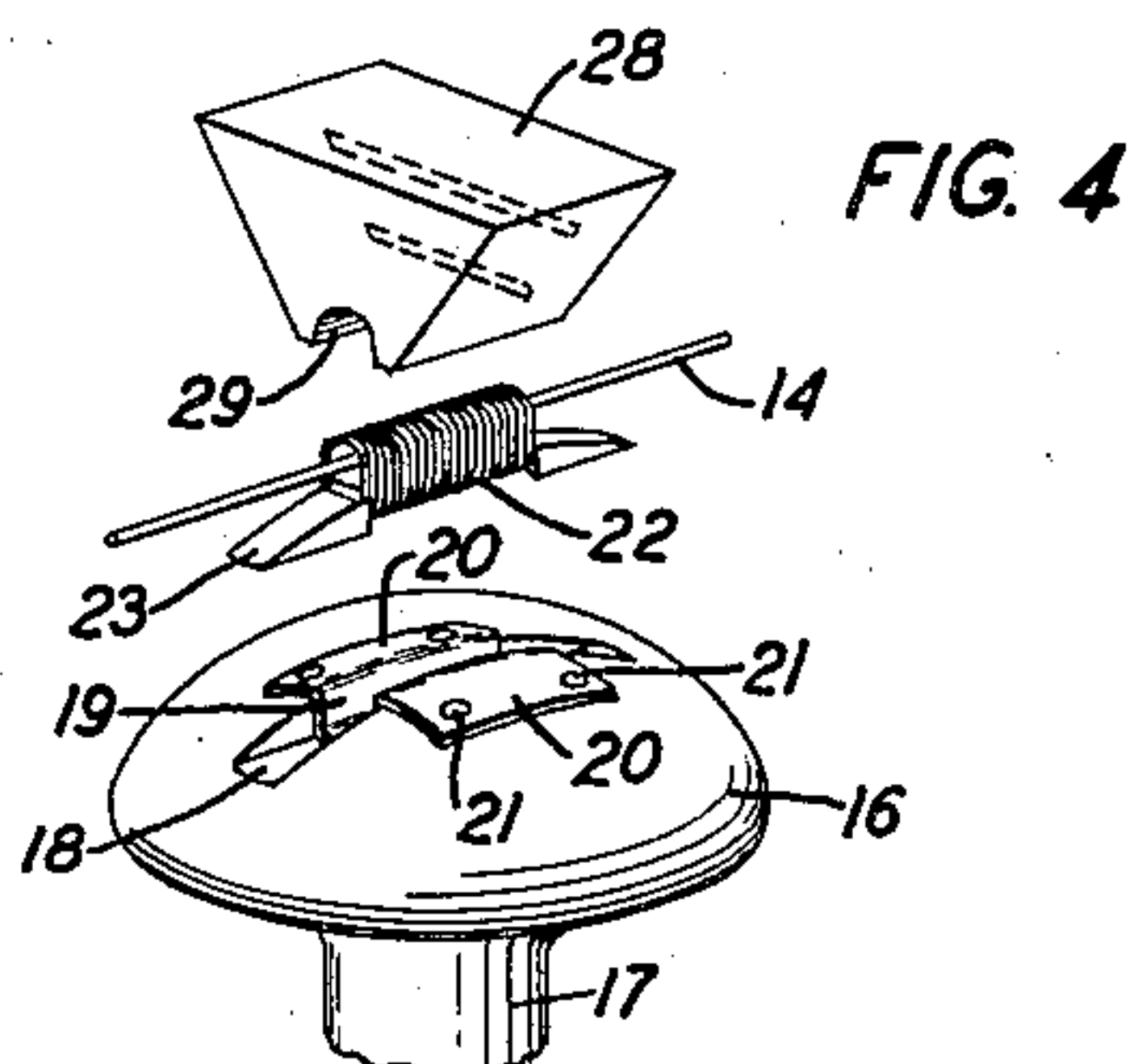
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2 Sheets-Sheet 2



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ELECTRON DISCHARGE DEVICE

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Application May 31, 1941, Serial No. 396,002

13 Claims. (Cl. 250—27.5)

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This invention relates to electron discharge devices and more particularly to such devices operable at ultra-high frequencies, for example frequencies corresponding to wave-lengths in the centimeter range.

In electron discharge devices intended for operation at ultra-high frequencies, the interelectrode spacings, in general, are extremely small and, because of the expansion and contraction of the electrodes with temperature variations thereof during operation, there is danger of contact between two electrodes with consequent failure of the devices. Furthermore, in such devices, due to the necessity of maintaining the interelectrode capacitances small, the electrodes themselves are usually of small dimensions and, hence, are difficult to handle and to mount in such manner that the requisite interelectrode spacings will be maintained with reasonable accuracy and constancy during the operation and life of the device. Also, the interelectrode impedances are largely capacitive in character so that when the electrodes are associated with distributed constant external circuits, such as coaxial lines, discontinuities exist between such external circuits and the internal circuits, that is, the electrodes and their leading-in conductors associated with the external circuits. Such discontinuities may be substantially reduced by matching the characteristic impedances of the internal and external portions of the several circuits, as described in the application Serial No. 395,948, filed May 31, 1941, of Paul L. Hartman.

One object of this invention is to facilitate the attainment of accurate small interelectrode spacings in ultra-high frequency electron discharge devices and the maintenance of such spacings during the operation of such devices.

Another object of this invention is to enable the ready handling and mounting of small electrodes in electron discharge devices and thus to expedite the realization of accurate close spacing of electrodes in such devices.

A further object of this invention is to simplify the construction of electron discharge devices wherein internal elements are of such configuration and so related that the characteristic impedance of the circuit section defined thereby is substantially the same as that of an external distributed constant system associated with the internal elements.

In one illustrative embodiment of this invention, an electron discharge device comprises an enclosing vessel housing a linear cathode, a control electrode or grid encompassing and uniformly spaced from the cathode and an anode in proximity to and uniformly spaced from the control electrode or grid, and leading-in systems for the several electrodes.

In accordance with one feature of this inven-

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tion, the control electrode or grid is mounted in an elongated slot in the head of a mushroom-shaped support the shank of which is secured to a wall of the enclosing vessel whereby the control electrode or grid is securely mounted, may be handled readily and may be accurately positioned in a desired position with respect to other elements of the device. The support serves as the leading-in conductor for the control electrode or grid and also provides a large heat radiating surface so that during operation of the device the control electrode or grid is maintained at a safe temperature.

In accordance with another feature of this invention, the anode comprises an intermediate portion in juxtaposition to and alignment with the control electrode or grid and a pair of similar, laterally extending, flexible outer portions secured at their outer ends to leading-in conductors, the laterally extending portions serving to maintain the intermediate portion in alignment with the control electrode or grid while allowing expansion and contraction of the anode with temperature variations therein during operation of the device.

In accordance with a further feature of this invention, the laterally extending portions of the anode extend adjacent the surface of the head of the mushroom-shaped support for the control electrode or grid whereby the characteristic impedance of the line section defined by these portions and surface may be matched with that of an external line associated therewith.

In accordance with still another feature of this invention, the leading-in system for the cathode includes strip conductive members secured to the ends of the cathode and extending in proximity to the surface of the head of the control electrode or grid support whereby the characteristic impedance of the internal portion of the cathode-grid circuit may be made substantially the same as that of the external portion of this circuit.

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 drawings in which:

Fig. 1 is an elevational view of an electron discharge device illustrative of one embodiment of this invention, portions of the enclosing vessel and of the control electrode structure being broken away to show details of construction more clearly;

Fig. 2 is a side view partly in section of the base and electrode assembly included in the device shown in Fig. 1;

Fig. 3 is a plan view of the electron discharge device illustrated in Figs. 1 and 2, the enclosing vessel being broken away;

Fig. 4 is an exploded perspective view of the

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electrode structure included in the device shown in Fig. 1; and

Fig. 5 is a perspective view of an electron discharge device illustrative of another embodiment of this invention, portions of the enclosing vessel being broken away to show the internal structure more clearly.

Referring now to the drawings, the electron discharge device illustrated in Figs. 1 to 4 comprises an evacuated enclosing vessel, for example of glass, having a generally cup-shaped base portion 10 and a substantially hemispherical portion 11, the two portions 10 and 11 being joined hermetically at their edges. The base portion 10 is provided with a central tubulature 12 to which there is sealed hermetically a cup-shaped metallic terminal 13, for example of copper.

Mounted within the enclosing vessel are a rectilinear filamentary cathode 14, an anode designated generally as 15, and a control electrode or grid structure. The latter includes a generally mushroom-shaped metallic, e. g. copper, support having a smoothly rounded, dome-shaped, axially symmetrical surface 16 and a shank 17 fitted in the terminal 13 and secured thereto, as by a suitable silver solder. The support is provided with a diametrically extending slot 18 in the intermediate portion of which there is fitted the channel-shaped section 19 of a formed metallic, e. g. molybdenum, insert, the insert having flanges 20 conforming to the surface 16 and being affixed to the support by a plurality of screws 21 threaded into the support and arc welded to the flanges. The control electrode or grid 22 is a wire helix, oval in section, carried by a metallic, e. g. nickel, mandrel element 23 which is fitted and secured in the slot 18 and the channeled section 19 of the insert. As shown clearly in Fig. 2, the outer surface of the end portions of the mandrel element 23 conforms to the surface 16.

The cathode 14 extends through and is uniformly spaced from the grid 22 and is supported from a pair of rigid leading-in conductors 24 and 25 by thin metallic strips 26 which, as shown clearly in Fig. 2, conform generally to the surface 16 of the grid support. The linear form of the cathode is maintained by an inverted J-shaped spring 27 secured to one end of the cathode and to the leading-in conductor 25.

The anode 15 comprises a block 28, for example of graphite, provided with a substantially semi-cylindrical channel 29, conforming to and uniformly spaced from the control electrode or grid 22. The block 28 is supported by a pair of metallic, e. g. molybdenum, strips each of which includes a flexible arcuate strip or vane portion 30 conforming to and uniformly spaced from the surface 16 and a flanged portion 31 the flanges of which are bent against the ends of the block 28. The block 28 may be secured in position against the flanged portions 31 by metallic wires 32 extending therethrough and secured to the portions 31 as by welding. The arcuate portions 30 taper gradually, as shown in Fig. 3, and are provided at their outer ends with socket portions 33 secured to rigid leading-in conductors 34 sealed to and extending from the base 10 of the enclosing vessel.

It will be noted that in the construction illustrated in Figs. 1 to 4, inclusive, and described above the grid structure may be assembled readily as a unit and then easily and securely mounted, and accurately positioned with respect to the leading-in conductors for the other electrodes, by securing the shank 17 in and to the cup-

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shaped terminal 13. The relatively large head and shank portions of the grid support, it will be apparent, provide large heat radiating surfaces whereby the grid is maintained at a safe temperature during operation of the device.

It will be appreciated also that the anode construction assures the maintenance of alignment of the channel portion 29 thereof with the grid and cathode during operation of the device, expansion and contraction of the anode with temperature variations being allowed by uniform flexing of the two arcuate portions 30 of the anode so that any movement of the channel portion 29 is substantially rectilinear and in the direction of a line extending through the cathode and the longitudinal axis of the grid.

The device may be mounted on a metallic base or support 35, only a portion of which is shown in Fig. 1, having a plurality of tubular extensions 36, one for each of the leading-in conductors 24, 25 and 34, each tubular extension being coaxial with the corresponding leading-in conductor. The base or support 35 may be connected to the control electrode or grid structure and maintained at ground potential. Suitable tunable coaxial lines may be associated with each leading-in conductor and the corresponding tubular extension 36. Because of the form and relation of the portions 30 of the anode and the surface 16 it will be appreciated that the characteristic impedance of the portions of the anode-grid circuits within the enclosing vessel 10, 11 may be made substantially the same as that of the coaxial lines associated with the grid and anode through the conductors 34 and the corresponding extensions 36, as described fully in the aforementioned application of Paul L. Hartman. Likewise, because of the form and relation of the strips 26 and the surface 16, the characteristic impedance of the portion of the cathode-grid circuit within the enclosing vessel 10, 11 may be made substantially the same as that of the coaxial lines associated with the leading-in conductors 24 and 25 and the corresponding tubular extensions 36.

It will be noted that although the device is single-ended mechanically it is double-ended electrically in that two circuits may be connected to opposite ends of the cathode and two to opposite ends of the anode. Also, the leading-in systems for the cathode are at right angles to the leading-in systems for the anodes so that undesired coupling between the grid-cathode and grid-anode circuits is small.

The electron discharge device illustrated in Fig. 5 also is of a construction suitable for grounded grid operation and comprises an enclosing vessel including a substantially hemispherical vitreous portion 11 hermetically sealed to a flanged, metallic annular member 37 which is joined hermetically to a metallic base 38. The base 38 is provided with a plurality of cylindrical eyelets 39 through which the leading-in conductors 24, 25 and 34 extend coaxially and to which these conductors are sealed hermetically by insulating beads, not shown. The cathode 14 extends parallel to the base 38 and is supported by the conductors 24 and 25. The anode includes two metallic members having joined flanges 40, flexible tapering portions 41 secured to the leading-in conductors 34, and intermediate arcuate portions 42 defining a substantially semicylindrical channel in alignment with the cathode 14.

The control electrode or grid comprises a helix 22 mounted on a mandrel element 23 which is se-

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cured to flanged metallic plate members 43 secured to the base 38.

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

What is claimed is:

1. An electron discharge device comprising a metallic support having an extended surface arcuate in section, a grid mounted on said support, a cathode and an anode in juxtaposition to said grid, and leading-in means connected to said cathode and said anode, one of said means including a metallic strip member in juxtaposition to and substantially conforming in shape to said surface.

2. An electron discharge device comprising a metallic support having a dome-shaped surface, an electrode mounted on said support adjacent said surface, a second electrode in juxtaposition to said first electrode, and leading-in means for said second electrode including a strip-like metallic member extending in juxtaposition to and substantially conforming in shape to said surface.

3. An electron discharge device comprising a metallic support having a dome-shaped surface, an electrode mounted on said support adjacent said surface, a pair of electrodes in cooperative relation with said first electrode, and leading-in means connected to each of said pair of electrodes, each of said leading-in means including a strip-like conductor adjacent and substantially conforming in shape to said dome-shaped surface.

4. An electron discharge device comprising a cathode, a control electrode and an anode mounted in cooperative relation, a support for said control electrode comprising a metallic member having an extended arcuate surface, leading-in means connected to said anode including a metallic element in juxtaposition to and substantially conforming in shape to said surface, and leading-in means connected to said cathode and including a metallic member in juxtaposition to and substantially conforming in shape to said surface.

5. An electron discharge device comprising a metallic support having an extended, axially symmetrical arcuate surface, a grid mounted on said support adjacent a central area of said surface, a cathode in cooperative relation with said grid, leading-in means for said cathode including a metallic strip member connected to one end of said cathode, extending in juxtaposition to said surface and substantially conforming in shape thereto, an anode having a central portion in juxtaposition to said grid and outer vane portions in juxtaposition to said surface and substantially conforming in shape thereto, and leading-in conductors connected to the outer ends of said vane portions.

6. An electron discharge device comprising an enclosing vessel having a base wall, a mushroom-shaped metallic support having its head portion within said vessel and a shank joined to said base wall, a pair of metallic supports sealed to said wall and positioned on opposite sides of said first support, a second pair of metallic supports on opposite sides of said first support and sealed to said wall, a grid mounted on said head portion of said first support, a cathode opposite said grid

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and having its ends connected to said first pair of supports, and an anode opposite said grid and having laterally extending portions connected to said second pair of supports.

7. An electron discharge device comprising an enclosing vessel having a base wall, a metallic support including a shank joined to said base wall and including also a head portion having a circular surface arcuate in section, a grid mounted on said support and extending along a diameter of and adjacent said surface, a cathode adjacent said grid and in alignment therewith, leading-in means for said cathode including a pair of conductors, sealed to said wall, extending adjacent diametrically opposite points of said surface and metallic strip members adjacent said surface and connecting said cathode to said conductors, an anode having a portion in juxtaposition to and in alignment with said grid and having also portions extending laterally at substantially right angles to said grid, and leading-in conductors sealed to said base wall, extending adjacent diametrically opposite points of said surface substantially 90 degrees from said first points, and connected to said laterally extending portions of said anode.

8. An electron discharge device comprising a cathode, a control electrode in cooperative relation with said cathode, an anode having a central portion opposite said cathode and having also elongated flexible portions extending laterally from said central portion, and support members secured to the outer ends of said flexible portions.

9. An electron discharge device comprising an elongated electrode, an anode having a central channeled portion in proximity to and in alignment with said electrode and having also flexible strip portions extending laterally outwardly from said channeled portion, and rigid support members secured to the outer ends of said laterally extending portions.

10. An electron discharge device comprising an enclosing vessel having a base wall, a cathode, a control electrode adjacent said cathode, means supporting said cathode and control electrode substantially parallel to said wall, an anode having a central portion opposite the portion of said control electrode remote from said wall, said anode having also flexible portions extending laterally from said central portion and inclined toward said base wall, and rigid support members extending from said wall and secured to the outer ends of said flexible portions.

11. An electrode assembly for electron discharge devices comprising a metallic support having a shank portion and an enlarged head portion provided with an elongated slot in one surface thereof, a mandrel element secured in said slot, and a grid mounted on said mandrel element.

12. An electrode assembly for electron discharge devices comprising a support having a dome-shaped portion provided with a diametrically extending slot, a channel-shaped insert secured in said slot, and a grid seated in said insert.

13. An electrode assembly for electron discharge devices comprising a metallic support including a shank and a dome-shaped portion, said dome-shaped portion having a diametral slot therein, a channel-shaped insert secured in said slot, a mandrel element, and a helical grid encompassing and mounted on said mandrel element, said mandrel element being seated in said insert.

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