

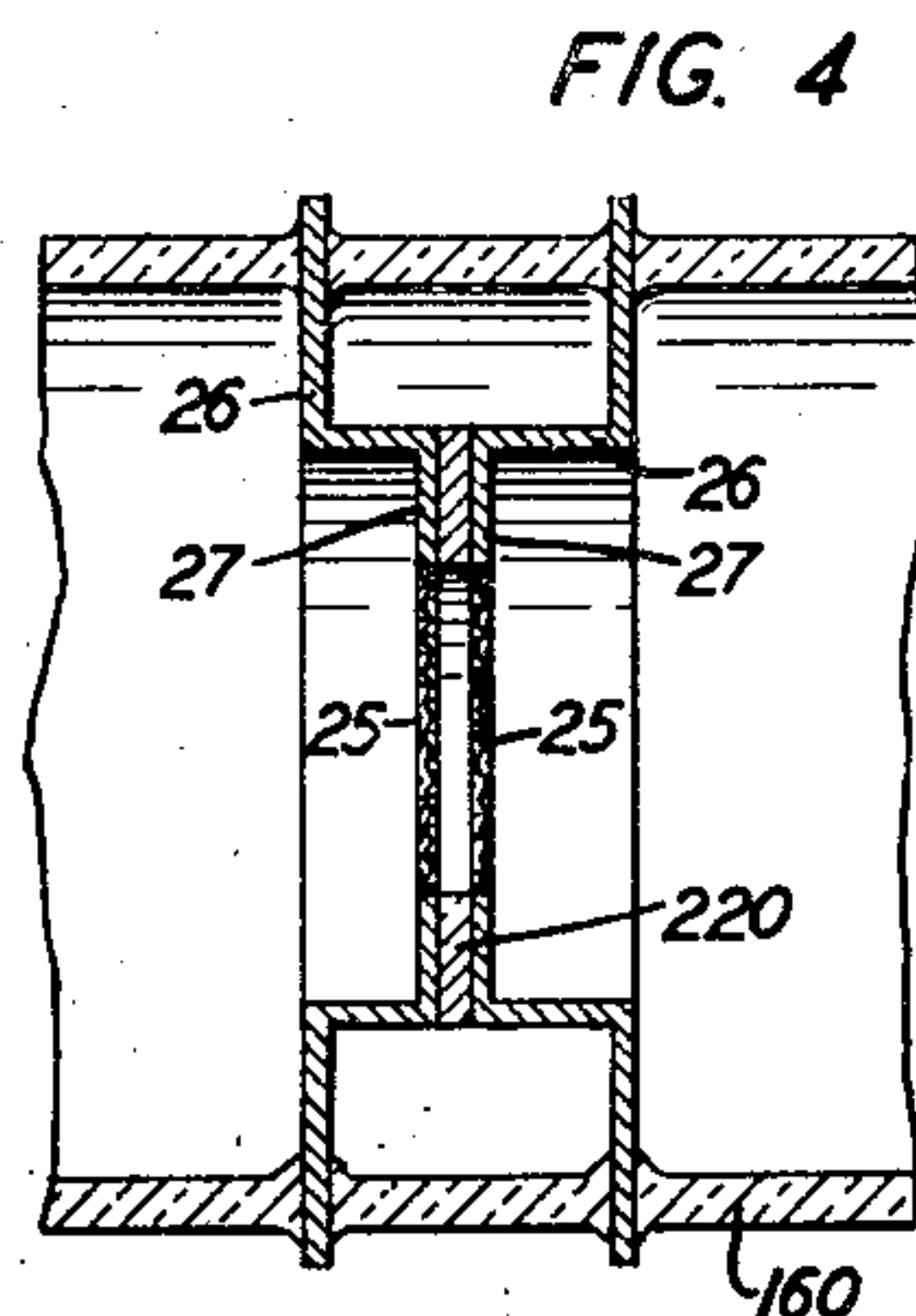
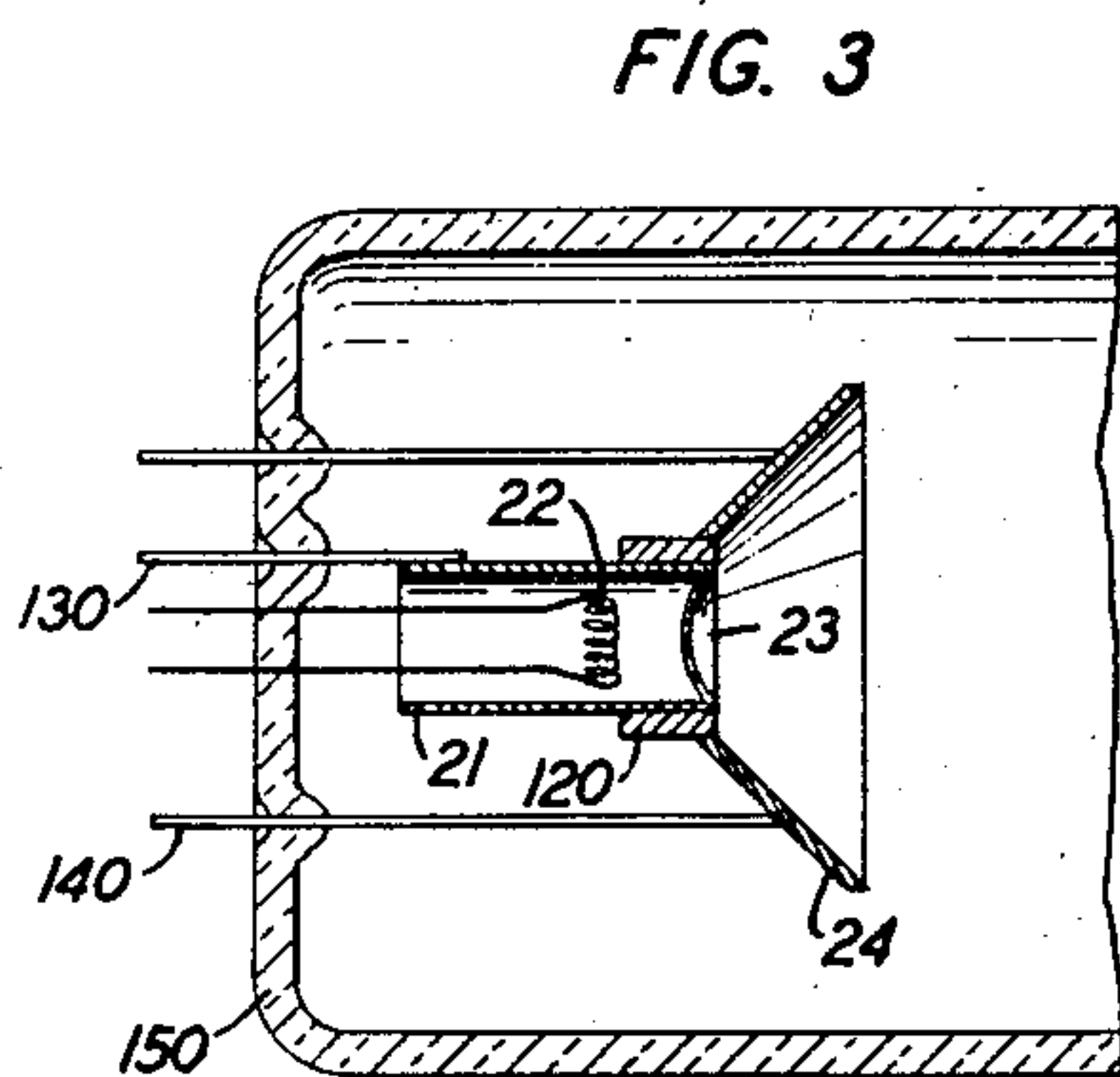
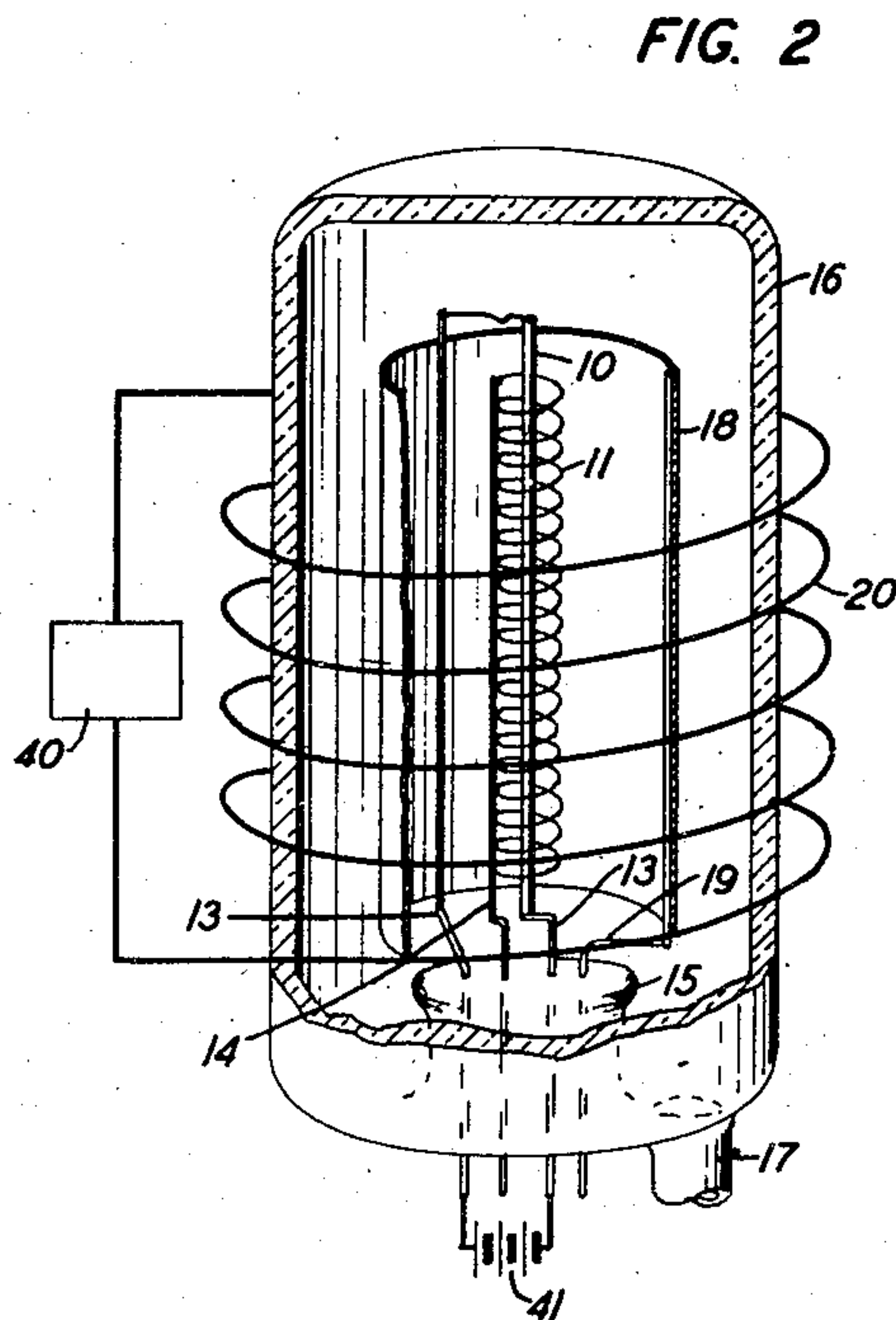
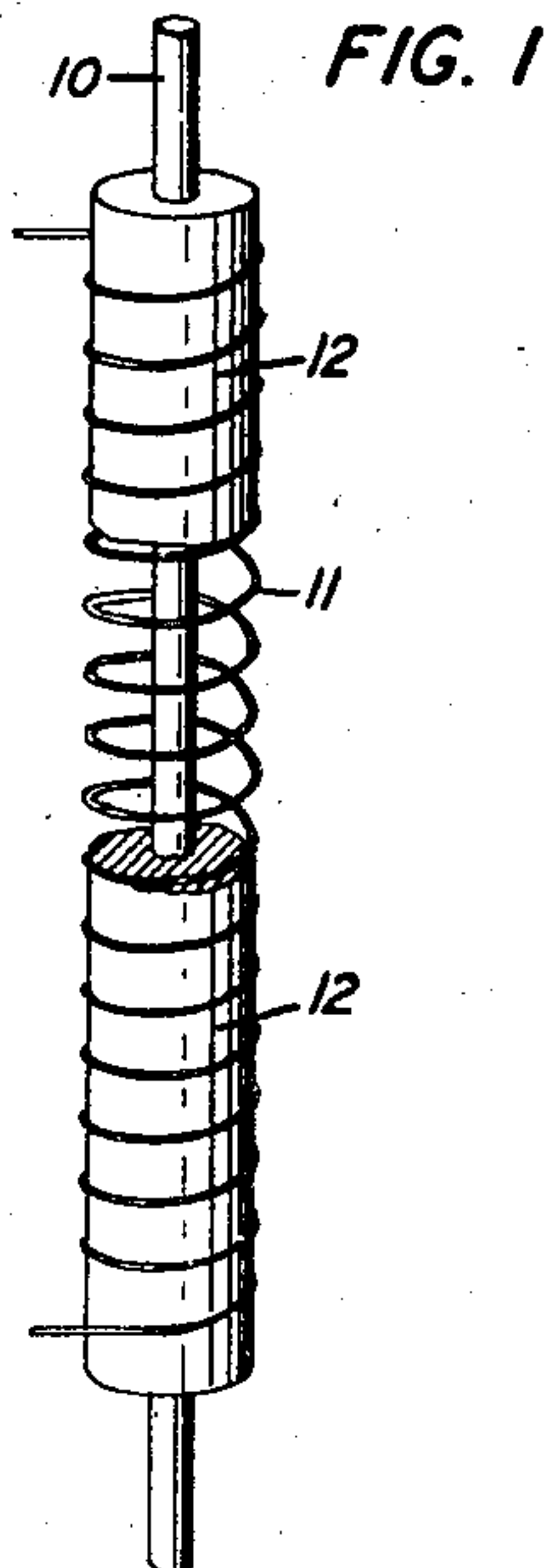
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A. L. SAMUEL

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MANUFACTURE OF ELECTRON DISCHARGE DEVICE

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INVENTOR
A. L. SAMUEL
BY
Walter C. Kiesel
ATTORNEY.

UNITED STATES PATENT OFFICE

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MANUFACTURE OF ELECTRON DISCHARGE DEVICES

Arthur L. Samuel, Summit, N. J., assignor to
Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

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This invention relates to the manufacture of electron discharge devices and more particularly to methods of fabricating electrode assemblies for such devices having very closely spaced electrodes.

One general object of this invention is to enable and to facilitate the realization of accurate, extremely close spacing of electrodes in electron discharge devices.

In accordance with one feature of this invention, in the fabrication of an electrode assembly two electrodes are positioned in engagement with an interposed spacer member of readily fusible or volatilized material and of a thickness corresponding to the desired spacing between the electrodes, the electrodes are then fixedly mounted with the spacer therebetween and the spacer member is subsequently removed.

The spacer member may be, for example, of a wax or resin and removed by heating, or of a metal, such as a metal having a low melting point, and removed by heating or electrolysis. In one embodiment, the electrodes may be a cathode and a grid, the spacer member a coating of magnesium on the cathode over which the grid is wound, and the magnesium vaporized during the evacuation treatment of the device in which the electrodes are mounted.

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 a perspective view of a cathode and grid assembly with an interposed spacer, illustrative of one structure which may be fabricated in accordance with this invention, a portion of the spacer member being broken away;

Fig. 2 is a perspective view of an electron discharge device including a cathode and grid structure constructed in accordance with this invention, portions of the enclosing vessel and anode being broken away to show the internal elements more clearly;

Fig. 3 is a sectional view of a portion of an electron gun illustrative of another structure which may be fabricated in accordance with this invention; and

Fig. 4 is a fragmentary view in section of a grid assembly suitable for use in velocity variation devices, illustrating still another embodiment of this invention.

In all the figures of the drawing the electrodes and especially the spacer member are exagger-

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ated considerably in size for the sake of clarity of illustration.

Referring now to the drawing, there is shown in Fig. 1 a rectilinear cathode 10, for example a filament of thoriated tungsten, a helical wire grid 11, and an intermediate spacer member 12. The spacer member 12 is in the form of a coating upon the cathode 10 and is of a thickness substantially equal to the desired spacing of the cathode and grid. It may be a wax or resin applied to the cathode 10, as by dipping or spraying, or may be of a metal applied as by electrodeposition, sputtering or in other ways. The metal may be one having a low melting point, for example magnesium.

In the fabrication of the assembly illustrated in Fig. 1, the spacer member 12 is applied in the form of a coating to the cathode 10 and the grid 11 is wound on the coating so that the cathode-to-grid spacing desired is obtained. The cathode 10 and grid 11 are then secured to rigid supports or leading-in conductors 13 and 14 therefor which, as shown in Fig. 2, may be embedded in the stem 15 of an enclosing vessel 16 having an exhaust tubulature 17. The supports 13 and 14 fixedly mount the cathode and grid in relation to each other. The vessel encloses an anode 18 which may be supported from the stem 15 by a rigid support 19 and is encompassed by a high frequency induction coil 20. Although not shown in Fig. 2, it will be understood that when the cathode and grid are mounted on the vessel 16 and before the vessel is evacuated, the spacer member 12 is therebetween.

In the exhaust treatment of the device, the tubulature 17 is connected to a vacuum pump and high frequency current is supplied to the induction coil 20, as from a source 40. The anode 18 is thus heated by high frequency induction to remove occluded gases therefrom and the cathode and grid assembly, including the spacer member 12, is heated by radiation from the anode 18. Consequently, the spacer member material is melted or vaporized, leaving the cathode and grid in the desired space relation.

Although, as described above, high frequency induction heating may be employed to effect melting or vaporization of the spacer member material, the heating may be accomplished by passing a current through the cathode, as from a battery 41. Also a combination of induction and cathode heating may be utilized.

For example, if the spacer member is of magnesium, the anode may be heated by high frequency induction so that the anode is raised to

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a high temperature before the cathode and grid become heated to any great extent by radiation. Continuation of the high frequency heating results in gradual increase of the temperature of the grid and gradual vaporization of the magnesium until only a very thin coating of magnesium remains upon the cathode. The magnesium vaporized acts as a getter and accelerates the evacuation of the device. When all but the very thin coating upon the cathode of the magnesium has been vaporized, a current is passed through the cathode to flash the cathode and vaporize the remaining part of the magnesium which, of course, also acts as a getter. The tubulature 17 is then sealed.

It will be appreciated that the spacer member 12 may be extremely thin and of great uniformity of thickness. Hence, very accurate and extremely close spacing of the cathode and grid is obtained. Further, it will be noted that inasmuch as the grid may be wound on the spacer member and the latter serves as a protective means for the cathode during handling, the fabrication of assemblies having small electrodes closely spaced is facilitated.

The invention may be utilized also in the fabrication of electron guns, for example, of the construction illustrated in Fig. 3 which comprises a cathode and a beam-forming or modulating electrode. The cathode which is of the indirectly heated type includes a cylindrical portion 21 encompassing a heater filament 22 and a dished end portion 23, the concave surface of which is coated with a thermionic material. The cylindrical portion 21 has thereon a coating 120, for example, of magnesium, which serves to position the smaller end of the frusto-conical beam-forming or modulating electrode 24 in accurate coaxial relation with the cathode. The electrode 24 is fitted upon the coating 120 and then the cathode and this electrode are fixedly mounted in position by rigid supports 130 and 140 sealed in the end wall 150 of an enclosing vessel 160. The assembly is heated subsequently either by high frequency induction or cathode heating as described heretofore in connection with Figs. 1 and 2, whereby the magnesium 120 is vaporized, acting as a getter, and the cathode and electrode 24 are left in the desired close space relation.

As illustrated in Fig. 4, the invention may be employed also to obtain accurate and very close spacing of a pair of grids, such as gap-bounding grids in velocity variation devices. The grids 25 may be of mesh, flat as shown, or dished, and mounted on similar annular metallic, for example copper, members 26 hermetically sealed to and extending through the wall of an enclosing vessel 160. The annular members 26 are provided with juxtaposed parallel flanges 27 between which there is a spacer member 220 fixing the spacing of the grids. The spacer member may be a coating upon one of the flanges 27 and of a readily fusible or vaporizable material such as has been mentioned heretofore.

In the fabrication of the device, the grids 25 are mounted on the respective annular member 26 and the two members are then held in posi-

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tion with the spacer member 220 between the flanges 27 and sealed to the wall of the enclosing vessel 160. The assembly is heated subsequently to remove the spacer member as by melting or vaporization thereof.

Although in the methods described hereinabove, the spacer member is removed by heating, it will be understood that other methods of removing it may be employed. For example, the spacer member may be of a metal different from the electrode material and removed by electrolysis in a bath which will not affect the electrodes or the supports therefor. As an illustration, in the construction illustrated in Fig. 1, the grid 11 could be of molybdenum and the spacer member of aluminum or iron. As another example, the spacer member could be of sodium aluminate and removed by dissolving it with warm water.

It will be understood also that the embodiments of the invention described are 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. In the manufacture of electron discharge devices, the method which comprises positioning a pair of electrode members in contacting relation with an interposed spacer member of a material having a low melting point, fixedly mounting said electrode members with said spacer member therebetween, and heating the assembly thus formed to remove said spacer member.

2. In the manufacture of electron discharge devices, the method which comprises coating an electrode member with a layer of fusible material, positioning a second electrode member in contact with said layer, fixedly mounting said electrode members with said layer therebetween, and heating the assembly thus formed to melt said material.

3. In the manufacture of electron discharge devices, the method which comprises positioning a pair of electrode members in contact with an interposed magnesium spacer member, fixedly mounting said electrode members with said spacer member therebetween, and heating the assembly thus formed to vaporize said spacer member.

4. In the manufacture of electron discharge devices, the method which comprises positioning a pair of electrode members by an interposed spacer member of readily fusible material, mounting said electrode members in fixed relation in an enclosing vessel with said spacer member therebetween, heating said electrode members to melt said material, and evacuating said vessel.

5. In the manufacture of electron discharge devices, the method which comprises coating a cathode with magnesium, positioning an electrode member in contact with the magnesium coating, mounting said cathode and electrode member in fixed relation in an enclosing vessel, heating said electrode member to vaporize a portion of said magnesium, heating said cathode to vaporize the remainder of said magnesium, and evacuating said vessel.

ARTHUR L. SAMUEL.