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Gale et al.

[11] **3,780,332**

[45] **Dec. 18, 1973**

[54] **ELECTRON DISCHARGE DEVICES**

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[73] Assignee: **EMI-Varian Limited,** Middlesex, England

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **313/252,** 315/5.34, 313/256, 313/283

[51] **Int. Cl.** **H01j 1/88,** H01j 19/42

[58] **Field of Search** 315/5.34, 5.35, 252; 313/256, 257, 283, 79

[56] **References Cited**

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Primary Examiner—Rudolph V. Rolinec
Assistant Examiner—Saxfield Chatmon, Jr.
Attorney—Martin Fleit et al.

[57] **ABSTRACT**

An electron discharge device comprises an evacuated envelope in which a component, such as a focusing electrode, is supported. The envelope is provided with an aperture which is hermetically sealed by a closure member and said closure member is arranged to apply pressure, either directly or indirectly, to the component so as to urge the component against another part of the device. By this means, the component is supported in a desired position within the envelope.

5 Claims, 9 Drawing Figures

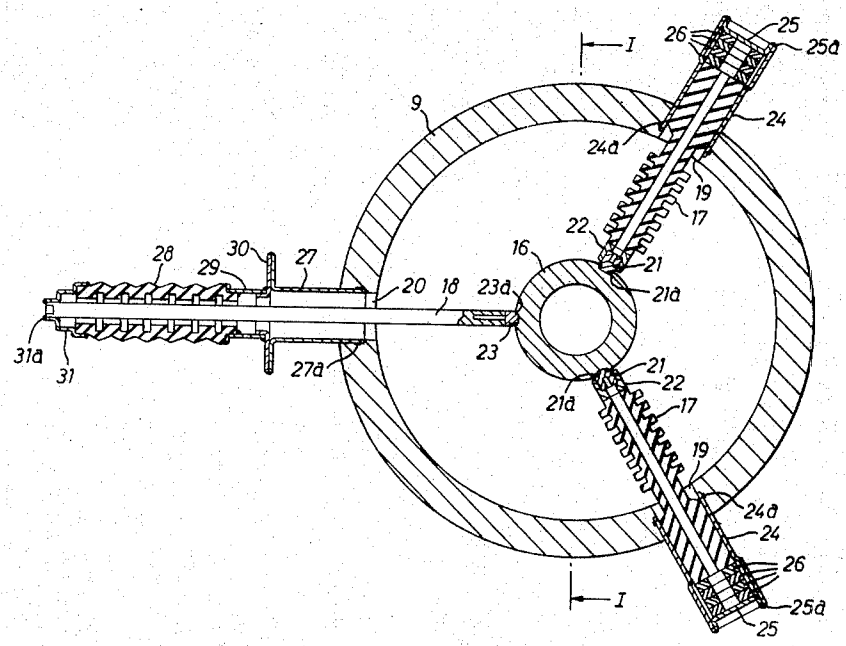
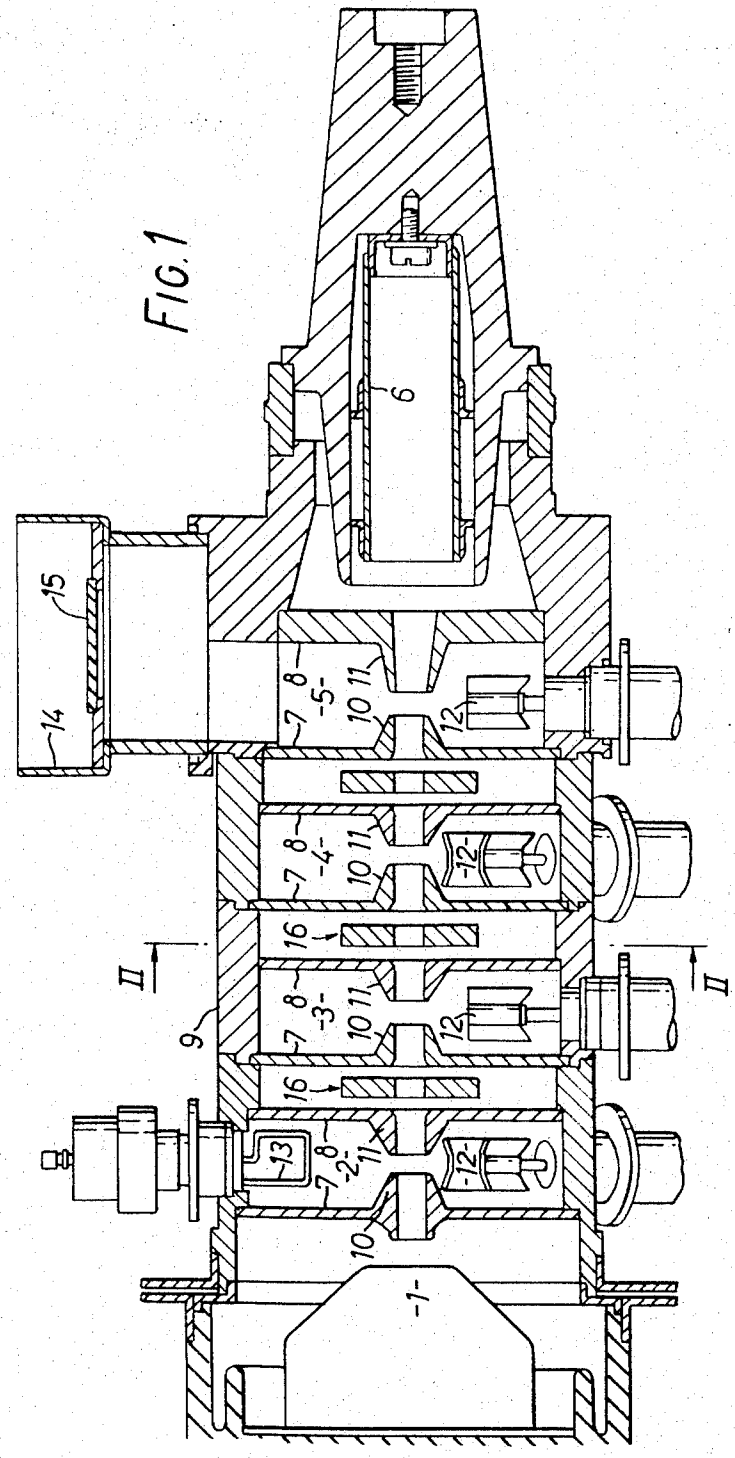


FIG. 1



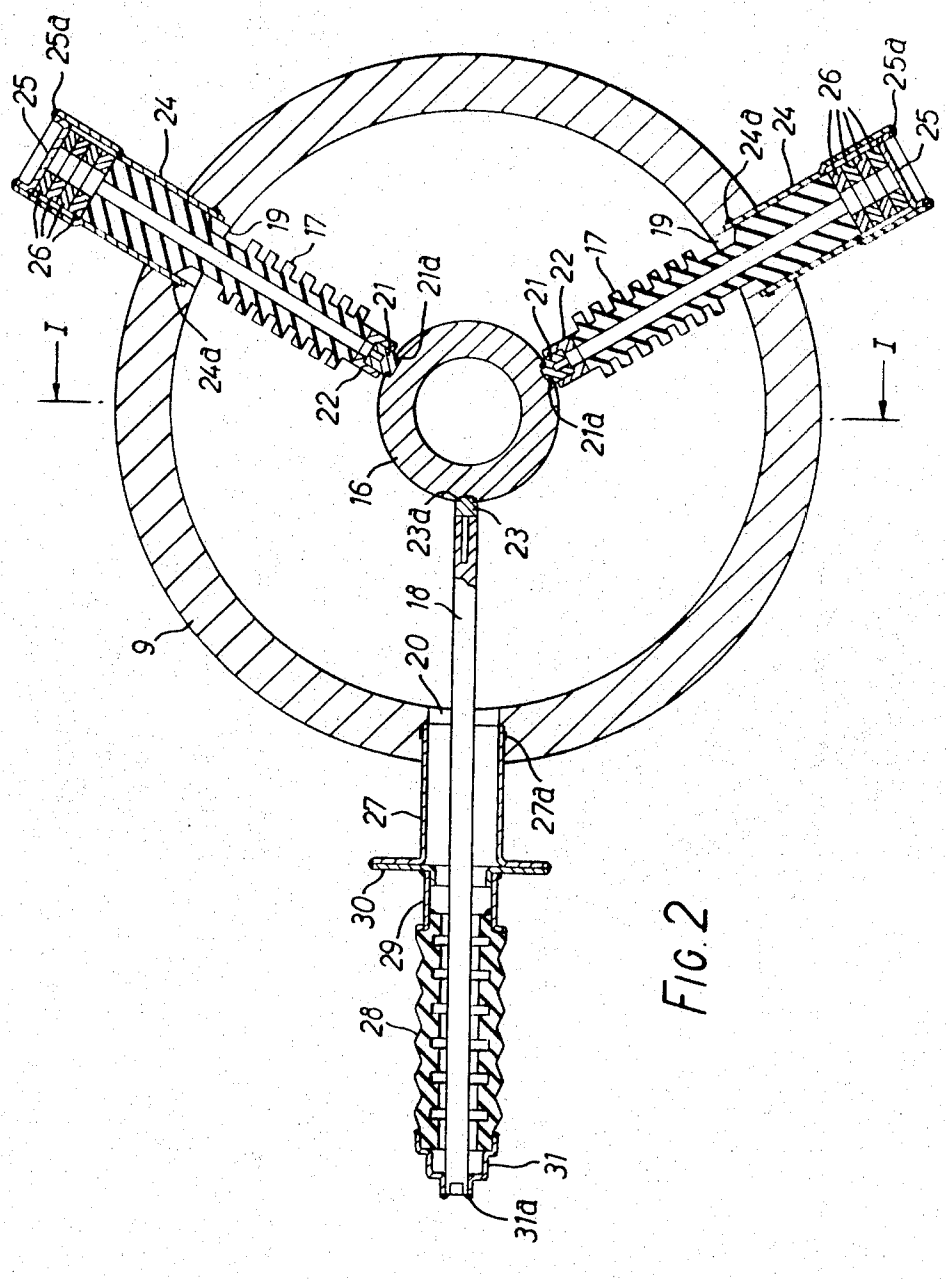

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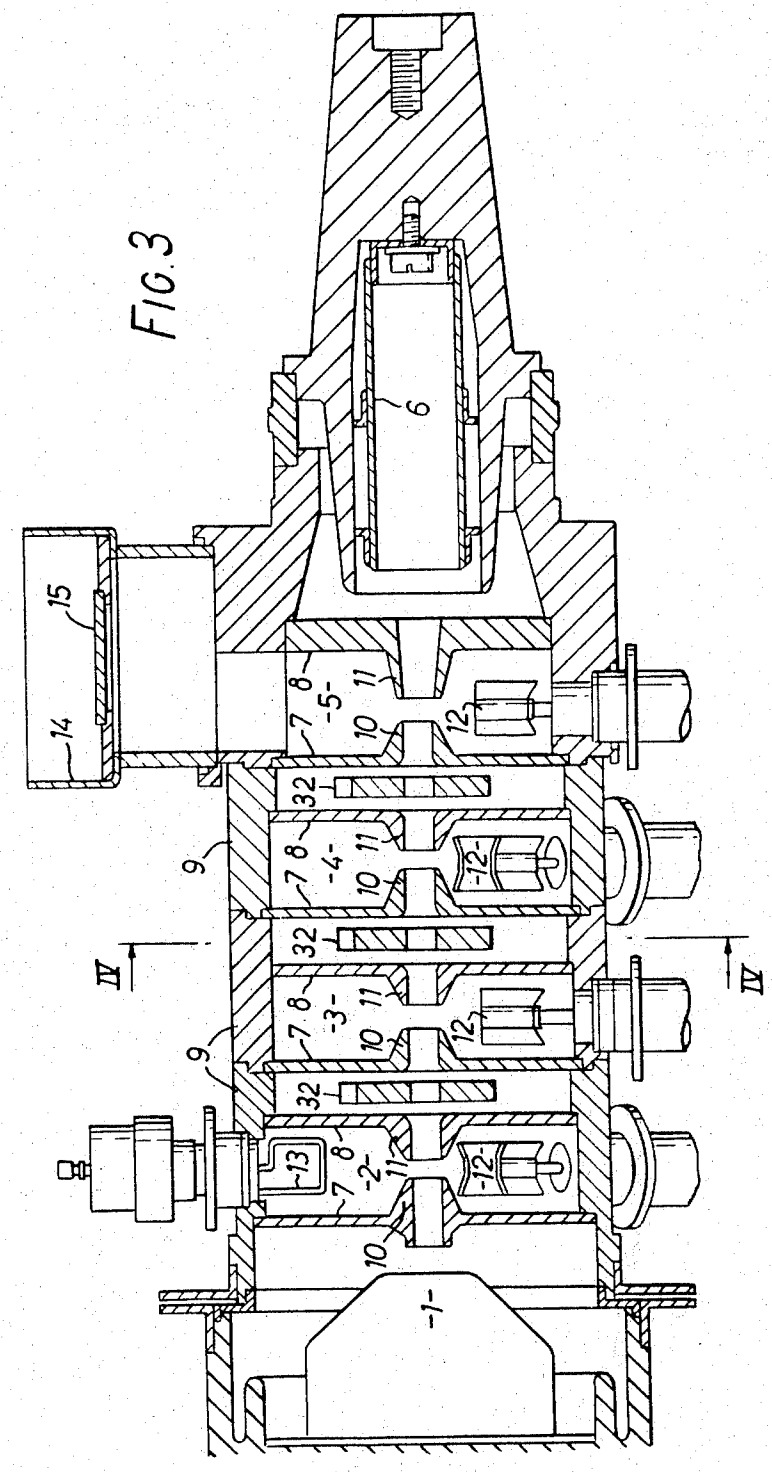
FIG. 2

FIG. 3



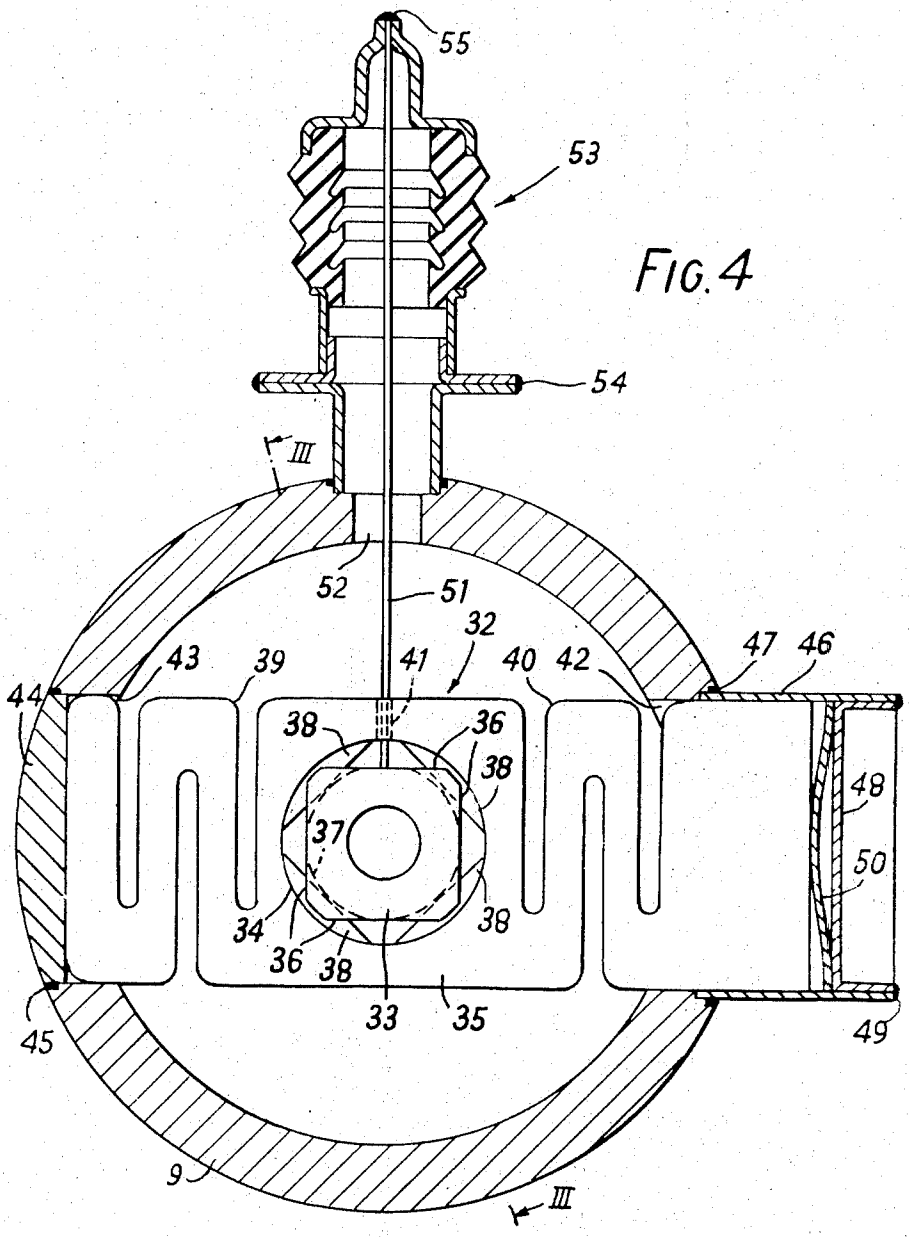

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FIG. 4

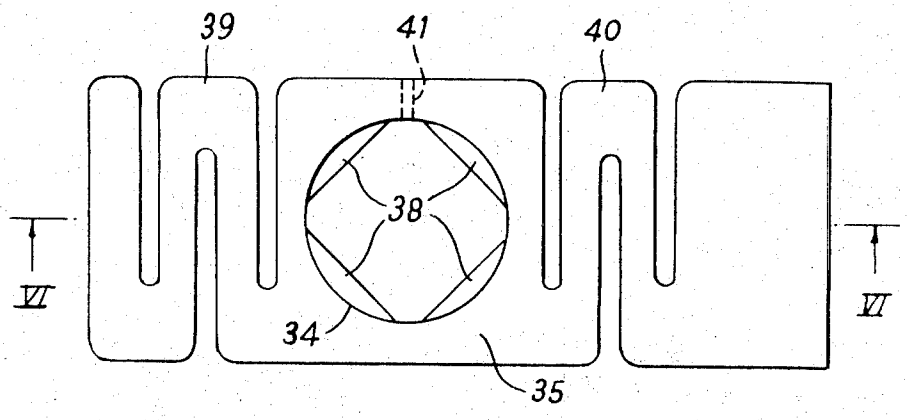

FIG. 5

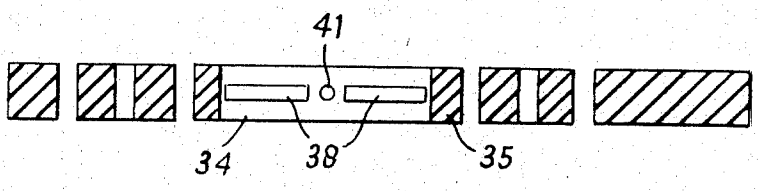

FIG. 6

FIG. 7

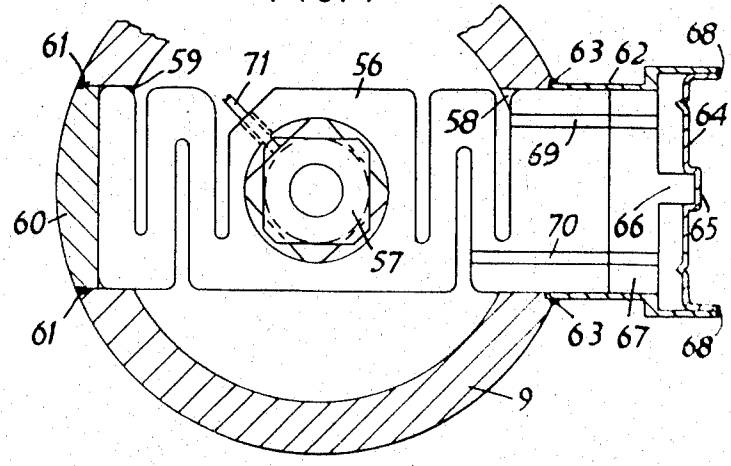
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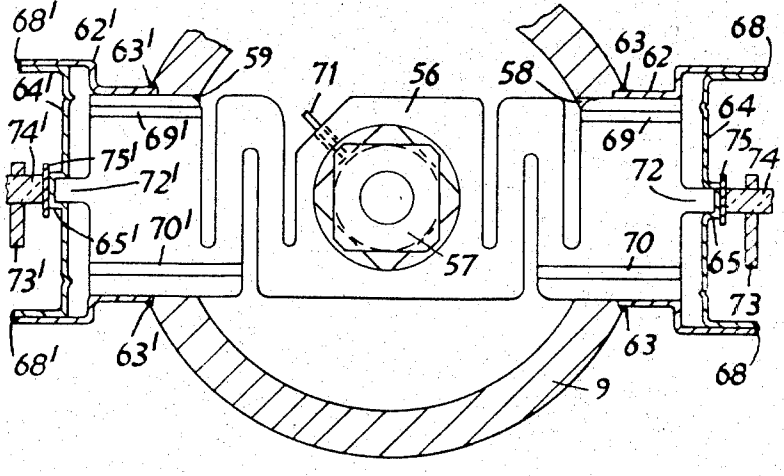
FIG. 8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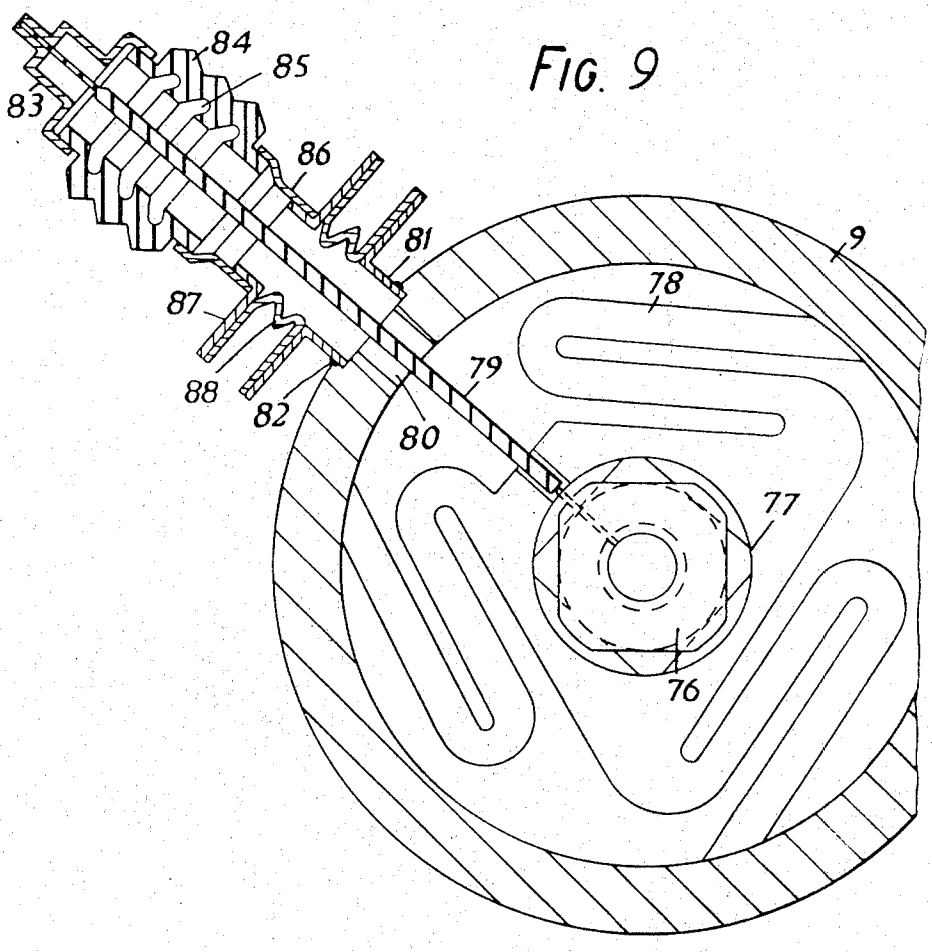

FIG. 9

ELECTRON DISCHARGE DEVICES

This invention relates to electron discharge devices, and it is an object of the present invention to provide an improved electron discharge device.

According to the invention there is provided an electron discharge device having an evacuated envelope, an electrically insulating member and an apertured electrode carried thereby, wherein said insulating member is formed with limbs extending from said electrode with one of said limbs extending into an aperture in said envelope, and a closure member hermetically sealing said aperture in said envelope and being arranged to apply pressure to said insulating member and urge it against another part of said device, said closure member being in the form of a flexible diaphragm which is drawn towards said one limb and applies pressure thereto due to the pressure differential between the inside and the outside of said envelope.

In order that the invention may be clearly understood and readily carried into effect it will now be described, by way of example only, with reference to the accompanying drawings in which:

FIG. **1** illustrates diagrammatically a sectional view of an electron discharge device according to one example of the invention in the form of a klystron,

FIG. **2** illustrates diagrammatically a view in the direction II—II of the klystron shown in FIG. **1**, and illustrates the mounting therein of a component in the form of an electrode supported by an insulating member,

FIG. **3** shows, in similar view to FIG. **1**, an electron discharge device, again in the form of a klystron, in accordance with a second example of the invention,

FIG. **4** illustrates diagrammatically a view on arrows IV—IV of FIG. **3** on an enlarged scale,

FIG. **5** illustrates diagrammatically a plan view of an insulating support member of the device of FIGS. **3** and **4**,

FIG. **6** illustrates a view on arrows VI—VI of FIG. **5**,

FIG. **7** illustrates diagrammatically a view similar to that of FIG. **4** of a device in accordance with another example of the invention,

FIG. **8** illustrates diagrammatically and in similar view to FIG. **7**, a device in accordance with a modification of the device described with reference to FIG. **7**, and

FIG. **9** illustrates diagrammatically and in similar view to FIGS. **7** and **8** a device in accordance with a still further example of the invention.

Referring to FIG. **1**, the klystron which is illustrated comprises an electron gun **1** including a thermionic cathode, four resonant cavities **2, 3, 4** and **5** and a collector electrode **6**, arranged in that order along the axis of the klystron. Each of the cavities is formed by two transverse copper walls and by part of the copper envelope of the klystron, the transverse walls being denoted by the references **7** and **8** in the case of each cavity and the envelope is made of a plurality of wall sections **9**. The walls **7** and **8** are formed with respective drift tubes **10** and **11**, in known manner, having central apertures which are coaxial. Each cavity **2 – 5** has a plunger **12** which can be moved radially within the cavity for the purpose of tuning. The cavity **2** is the input cavity and high frequency signals can be fed to this cavity by way of a coupling loop **13**. The cavity **5**, on the other hand, is the output cavity and is coupled to an output waveguide **14** through a dielectric window **15**.

To enable the electrons from the gun **1** to be focused so as to form a concentrated axial beam which passes through the cavities **2 – 5** and which is finally collected by the collector electrode **6**, an electrode **16** is provided between each pair of cavities. Each transverse wall **7** and **8** and its respective drift tube **10** and **11** is at the same potential as the envelope wall section **9** to which it is connected. The electrodes **16** are at potentials different from that of the transverse walls and form therewith a focussing system comprising a series of electrostatic Einzel lenses.

Referring now to FIG. **2**, only the components of the tube actually intersected by the section line II—II of FIG. **1** are shown for reasons of clarity. The electrode **16** is mounted concentrically within the wall section **9** by means of two insulating supports **17** each having a bore therethrough and a grooved outer surface to increase the current leakage path, and an electrically conductive rod **18** by means of which a potential can be applied to the electrode **16**. The insulating supports **17** extend through apertures **19** in wall section **9** and the rod **18** extends through an aperture **20** in wall section **9**. Members **21** having an external threaded portion and an internal threaded portion are secured to electrode **16** as by welding at **21***a*. Hollow cylindrical members **22** are secured to the insulating supports **17** and have an internal threaded portion whereby they are screwed onto the members **21** and the conductive rod **18** is secured to the electrode **16** by screw threading onto a stud **23** which is secured to the electrode **16** as by welding at **23***a*. The outer end of each insulating support **17** is enclosed in a cover, which comprises a tubular member **24**, in which the insulating support **17** is a sliding fit, hermetically sealed at **24***a* in the aperture **19** in the wall section **9**, and a dished closure member or cap **25** hermetically sealed at **25***a* by welding to the tubular member **24**. The closure member **25** is arranged to apply pressure to the electrode **16** via the insulating support **17** and a set of spacers **26** of, for example, stainless steel, which are provided between the caps **25** and the outer ends of the insulating supports **17**.

The conductive rod **18** extends through a flanged tubular member **27** hermetically sealed at **27***a* in the aperture **20** in the wall section **9**. An insulator **28**, having grooved inner and outer surfaces to increase the current leakage path, is hermetically sealed through the intermediary of members **29** and **30** to the member **27**. An end cap **31** is hermetically sealed to the insulator **28** and welded at **31** to the counterbored end of conductive rod **18**.

The method of assembling the klystron will now be described. Each electrode **16** is supported in its respective wall section **9** by means of the conductive rod **18** and two guide rods (not shown) extending respectively through the tubular members **24**, the guide rods being screwed into the internally threaded portion of the members **21**. The insulating supports **17** are slid over the guide rods and screwed to the externally threaded portions of the members **21**, suitable keying means therefor being provided on the ends of the insulating supports. The guide rods are then removed and the spacers **26** inserted, the spacers fitting loosely in the bores of the tubular members **24** so that no air is trapped when the klystron is evacuated. The conductive rod **18** is then hermetically sealed in position and the end caps **25** are then slid into the tubular members

24, compressed radially so as to apply pressure to the electrode 16 to urge the latter against the conductive rod 18 so as to rigidly secure electrode 16 in position. The end caps 25 are then welded to their respective tubular members 24 as shown at 25*a*.

Should it subsequently be necessary to replace a deflective insulating support 17, the weld 25*a* is broken or the tubular member 24 severed close to the weld 25*a*. A guide rod is inserted and the spacers 26 and the deflective insulating support are removed. A fresh insulating support is screwed into place and the guide rod is then removed. Spacers are inserted and a cap 25 is welded to the tubular member 24 to provide an hermetically sealed enclosure around the replacement insulating support. The use of spacers allows the insulating support at any one position to be replaced several times if necessary during the life of the klystron; the pressure on electrode 16 being reasserted after each such replacement by virtue of the insertion of spacers of the required thickness.

Another advantage provided by the invention is that the insulating supports 17, since they are not subjected to the gases or vapours evolved during the assembling of the envelope, are in a clean condition initially.

An electron discharge device according to another example of the invention will now be described with reference to FIG. 3.

FIG. 3 is generally similar to FIG. 1 and similar numerals are used to denote the same components in the two figures. However, instead of the electrode 16 shown in FIG. 1, a focusing electrode assembly 32 is provided between each pair of cavities. In FIG. 3 these focusing electrode assemblies are represented schematically. Each transverse wall 7 and 8 and its respective drift tube 10 and 11 is at the same potential as the envelope wall section 9 to which it is connected. The electrodes of the assemblies 32 are at potentials different from that of the transverse walls and form therewith a focusing system comprising a series of electrostatic Einzel lenses.

Reference will now be made to FIGS. 4, 5 and 6, of which FIG. 4 illustrates a sectional view taken on line IV—IV of FIG. 3, components lying beyond the electrode assembly 32 adjacent line IV—IV have been omitted for reasons of clarity. Each focusing electrode assembly 32 comprises an apertured metal electrode 33 mounted in an aperture 34 in an insulating support 35. The electrode 33 is formed from a disc having four chordal flats 36 equally spaced around its periphery, and a groove 37 around its edge centrally of its thickness. The groove 37 engages tongues 38 which extend into the aperture 34 centrally of the thickness of the support 35. The electrode 33 is mounted in the support 35 by positioning it so that the edges of the flats 36 are parallel to the tongues 38 of support 35, inserting the electrode into the aperture 34 until the groove 37 is in the plane of the tongues 38 and then rotating the electrode through 45° relative to the support so that the tongues 38 enter the groove 37.

The insulating support 35 employed in this example has a pair of arms 39 and 40, each formed in a meander pattern, whereby the leakage path is much greater than for straight arms. An aperture 41 is provided in support 35 for electrical connection to be made to the electrode 33 as will later be described.

The insulating support 35 carrying the electrode 33 extends through an aperture 42 in the wall section 9 of the envelope and into a diametrically opposed aperture 43. The aperture 43 is closed by a plug 44 brazed to wall section 9 at 45. A cover for aperture 42 comprises a tubular member 46, brazed at 47 to wall section 9, and a closure member 48 welded at 49 to member 46. Pressure is applied to the insulating support 35 by means of a spring 50 so that support 35 is urged against the plug 44, thereby to rigidly mount the support 35 in the envelope.

Electrical connection is made to the apertured electrode 33 by means of a conductive rod 51 which screws into the edge of the electrode. The rod 51 passes through an aperture 52 and is hermetically sealed to envelope 9 by means of a stand-off insulator 53.

The focusing electrode assembly 32 is assembled and mounted in the klystron after the envelope is brazed, thereby avoding a likely source of contamination for the insulating support 35. The insulating support 35 is slid into the tubular member 46 and opening 42, the arm 39 being located in and by the aperture 43 and plug 44, the arm 40 being located in the tubular member 46. The conductive rod 51 is screwed into the electrode 33. The stand-off insulator 53 and spring 50 and closure member 48 are then hermetically sealed in position.

Should it subsequently become necessary to replace a defective focusing electrode assembly 32 or part thereof, welds at 49 and 54 are opened, the conductive rod removed and the focusing electrode assembly withdrawn through aperture 42. A new assembly can then be inserted, the conductive rod screwed in and the device hermetically sealed again.

It will be appreciated that since the focusing electrode assembly 32 is not subjected to the gases or vapours evolved during the assembling of the envelope, for example during brazing, it is in a clean condition initially and therefore less likely to require replacing. It can, however, be replaced without disassembling the klystron envelope.

FIG. 7 illustrates, in view similar to that taken in FIG. 4, a section through an electron discharge device in accordance with another example of the invention.

An insulating support 56, which is similar to the support 35 shown in FIG. 4, carries an apertured electrode 57, which is similar to the electrode 33 shown in FIG. 4. Support 56 extends through an aperture 58 in the wall section 9 of the envelope and into a diametrically opposed aperture 59. The aperture 59 is closed by a plug 60 brazed to wall section 9 at 61. A cover for aperture 58 comprises a stepped, rectangular member 62, brazed to wall section 9 as shown at 63, and a closure member in the room of a flexible diaphragm 64. In this example, the diaphragm 64 is provided with a central boss 65 to which a prong 66 of a spacer member 67 is attached. Of course the right hand edge of the insulating support 56 could be formed with a prong such as 66 provided that the dimensions of support 56 and/or member 62 are suitably adjusted. Such an arrangement will be described later with reference to FIG. 8.

Referring back to FIG. 7, however, the closure member 64 is welded to member 62 as shown at 68 to form an hermetic seal and both the right hand end of support 56 and the spacer member 67 are formed with surface grooves such as 69 and 70 to prevent entrapment of gas between closure member 64 and spacer member 67.

After assembly, the device is evacuated and by virtue of the resulting pressure differential across closure

member 64 and the flexibility of said closure member, the spacer member 67 and hence support 56 are urged toward plug 60, thus securing the electrode 57 rigidly in position in the device. It will be noted that part of a conductive rod 71, similar to the rod 51 of FIG. 4, is shown connected to electrode 57 and extending towards the wall portion 9 at an angle of approximately 45° to the direction of such rod 51 in FIG. 3. It will be appreciated that the conductive rod can, in any of the examples herein described, be arranged at any suitable direction, having due regard for the physical construction of the device in respect of the positions of internal and external components thereof.

FIG. 8 shows part of a device which comprises a modification of the device described with reference to FIG. 7 and so components common to both Figures have been allocated similar reference numerals in each. The support 56 is formed as a double-ended device, and one end extends through each of apertures 58 and 59. These two apertures are provided with identical covers and closure members, thus only the components associated with the right hand end of support 56 will be described; the similar components associated with the left hand end thereof will be denoted by primed numerals.

As indicated above, the right hand end of support 56 is formed with a prong 72 adapted to be secured to the boss 65 of the flexible diaphragm which constitutes the closure member 64. If desired, of course, the prong 72 could be omitted and a spacer such as 67 with a prong such as 66 could be used as shown in FIG. 7. Referring again to FIG. 8, an apertured member 73 is rigidly attached by means not shown to the envelope wall portion 9. The aperture is screw threaded so as to permit a screw 74 to be turnable therein. Screw 74 is provided with a disc 75 on the left hand end thereof, and disc 75 can be brought to bear on support 56 via boss 65 and prong 72.

When the device has been assembled and is evacuated, the pressure differential across closure member 64 urges the support 56 to the left against closure member 65', and likewise the pressure differential across the closure member 64' urges the support 56 to the right against closure member 64, thus holding the support member rigidly in position in the device.

The arrangement including adjustment assemblies 73, 74, 75 and 73', 74', 75' enables eccentricities in the positioning of electrode 57 with respect to the device to be compensated for during operation of the device. Such compensation is achieved by urging the support 56 to the left or to the right by manipulation of the screws 74, 74' of the respective adjustment assemblies.

The movement of support 56 required is generally slight so that no provision for movement of the electrically conductive part 71 need be made. Of course, such provision could be made if larger movement were required.

It will be appreciated that the construction of the devices described with respect to both FIG. 7 and FIG. 8 are such that the support 56 and electrode 57 need not be inserted in the device until after processing, thereby avoiding possible contamination of the insulating support by particles generated during such processing. Moreover the support 56 can be replaced without disassembling the entire envelope by breaking weld 68 (FIG. 7) or welds 68 and 68' (FIG. 8).

Moreover, in any of the devices described thus far in this specification, the conductive rod can be omitted, since it is known that the electrode can be caused to attain a desired potential by impingement of electrons thereon and the mechanism of secondary emission.

Reference will now be made to FIG. 9 which shows, in similar view to FIGS. 4, 7 and 8 part of an electron tube device in accordance with another example of the invention.

An apertured electrode 76 is mounted in an aperture 77 of an insulating support 78, in a manner similar to that described with reference to FIG. 4 for mounting electrode 33 in support 35. The insulating support 78 is shown as having three limbs, but it may alternatively be of the form shown in any of FIGS. 4, 7 or 8. Because the electrode 76 is made of different material than the support 78, the former cannot be made as tight a fit inside the latter as is desirable because relative thermal expansion has to be taken into account. Thus, in order to restrict relative movement between the electrode 76 and envelope wall 9, a conductive rod 79, used to apply potential to the electrode 76, is inserted through an aperture 8, the aperture being closed by a closure member which is capable of urging the rod 79 radially within the device so as to tend to urge electrode 76 against support 78, which in turn engages with the envelope wall 9 of the device.

In this example, a flanged, tubular member 81 is welded to the wall portion 9 at 82 so as to lie coaxially with the aperture 80. The upper end of rod 79 is hermetically sealed to a closure member in the form of a cap 83 which, in turn, is sealed to the upper end of a stand-off insulator 84 which is formed with a corrugated outer surface and is provided with reentrant grooves such as 85 on its inner surface in order to present long leakage paths between closure member 83 and envelope wall portion 9. The lower end of the stand-off insulator 84 is sealed, via a coupling member 86, to a flanged member 87. Between members 82 and 87 is sealed a flexible coupling member 88 in the form of a bellows. In operation, when the tube is evacuated, the closure member 83 tends to move radially inwards and tends to urge the rod 79 radially inwards, thus urging the electrode 76 against the insulating support 78, which in turn, engages with the envelope wall 9.

What we claim is:

1. An electron discharge device having an evacuated envelope, an electrically insulating member and an apertured electrode carried thereby, wherein said insulating member is formed with limbs extending from said electrode with one of said limbs extending into an aperture in said envelope, and a closure member hermetically sealing said aperture in said envelope and being arranged to apply pressure to said insulating member and urge it against another part of said device, said closure member being in the form of a flexible diaphragm which is drawn towards said one limb and applies pressure thereto due to the pressure differential between the inside and the outside of said envelope.

2. A device according to claim 1 in which another of said limbs of said insulating member extends into a second aperture in said envelope, and in which a second closure member hermetically seals said second aperture, said second closure member comprising a second flexible diaphragm.

3. A device according to claim 2 in which adjustment means are provided outside said envelope for applying

a bias pressure to one of said diaphragms whereby the position of said electrode can be adjusted.

4. An electron discharge device having an evacuated envelope, an apertured electrode supported within said envelope, an aperture in said envelope and a closure member hermetically sealing said aperture in said envelope, wherein an electrically conductive rod has one end secured to said electrode with the other end thereof extending through said aperture, and wherein said closure member has a flexible part whereby the pressure differential between the inside and the outside of said envelope causes said rod to apply pressure to said electrode and urge it against its support.

5. An electron discharge device having an evacuated envelope, an electrically insulating member and an apertured electrode carried thereby, wherein said insulating member is formed with limbs extending from said electrode with one of said limbs extending into an aperture in said envelope, a closure member hermetically sealing said aperture in said envelope, and flexible means associated with said closure member and arranged to apply pressure to said insulating member and urge it against another part of said device.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,780,332 Dated December 18, 1973

Inventor(s) Frederick Henry Gale and Roy David Cooper

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the title page, under Foreign Application Priority Data,

"Jan. 10, 1972" should read -- Feb. 10, 1972 --

Signed and sealed this 4th day of June 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.