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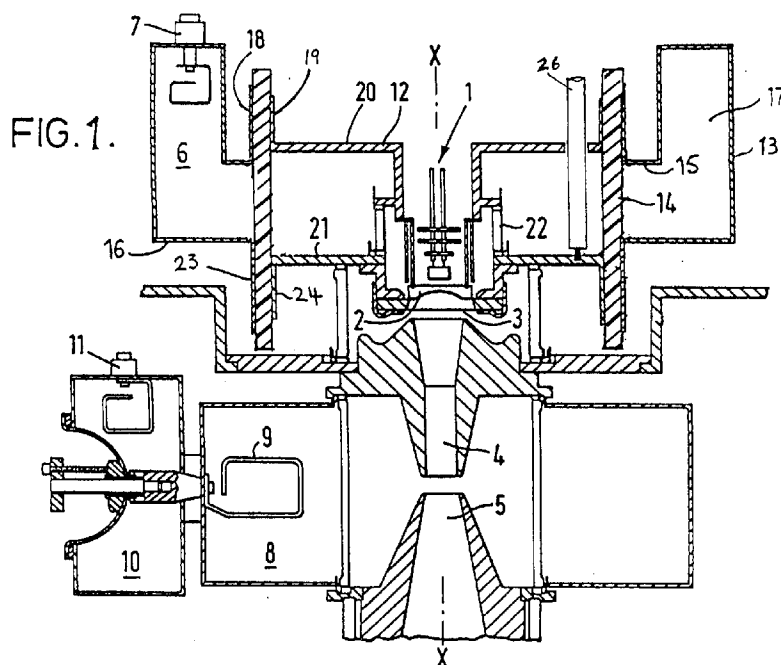
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(54) **Electron beam tubes**

(57) A linear electron beam tube such as an IOT includes an input cavity (6) formed from an inner body portion (12) and an outer body portion (13) which are joined together by a ceramic cylinder (14.) The input cavity (6) surrounds an electron gun (1) and permits electrical connection to be made to the cathode (2) and grid (3) via parts (20 and 21) of the inner body portion (12).

Metallisation layers (18,19,23 and 24) in conjunction with the intervening ceramic material of the cylinder (14) define rf chokes. The construction enables high voltage parts of the arrangement to be insulated from the low voltage outer body portion whilst presenting a low leakage path for r.f. energy within the cavity (6).



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Description

This invention relates to electron beam tubes and more particularly to input resonator cavities of such tubes at which high frequency energy is applied.

The present invention is particularly applicable to inductive output tetrode devices (hereinafter referred to as "IOT's") such as those referred to by the trade name Klystrode (Registered Trade Mark, Varian Associates Inc.)

An IOT device includes an electron gun arranged to produce a linear electron beam and an input resonant cavity at which an r.f. signal to be amplified is applied to produce modulation of the beam at a grid of the electron gun. The resultant interaction between the r.f. energy and the electron beam causes amplification of the high frequency signal which is then extracted from an output resonant cavity.

During operation of the tube, electrodes of the electron gun must be operated at relatively high voltages, of the order of tens of kilovolts, and this may cause problems, especially as the input cavity may form an external part of the IOT and therefore be handled during normal usage of the device. The present invention arose from an attempt to provide an improved IOT input cavity arrangement but is also applicable to other types of linear electron beam devices having input resonant cavities.

According to the invention, there is provided a linear electron beam tube comprising: an input cavity which is substantially cylindrical about a longitudinal axis and arranged to receive, in use, a high frequency signal to be amplified;

an electron gun arranged to produce an electron beam in a substantially longitudinal direction; and

an output cavity from which the amplified high frequency signal is extracted; wherein

the input cavity substantially surrounds the electron gun and comprises an inner body portion electrically connected to part of the electron gun and an outer body portion electrically insulated from the inner body portion, the inner body portion being maintained at a relatively high voltage compared to that of the outer body portion, and

wherein the inner and outer body portions each include an axially extensive metallic portion substantially coextensive in an axial direction with ceramic material being located between the metallic portions.

By "high voltage" it is meant of the order of tens of kilovolts.

The use of the invention enables parts of a linear electron beam tube which operate at relatively high voltages to be located such that they are not readily accessible during normal operation of the tube. In addition, the arrangement of the metallic portions of the inner and outer body portions and the ceramic material located between them acts as an rf choke. This enables the two body portions to be separated to achieve the desired electrical isolation between them whilst permitting the

input cavity to be such that there is low rf leakage from it, thereby affording efficient operation.

The use of ceramic material as part of the r.f. choke in accordance with the invention offers a number of important advantages. The ceramic material maintains its shape even at very high temperatures, of the order of 1000°C or more, and remains rigid at these high temperatures. The ceramic material may be readily machined or otherwise fabricated into the desired shape, which in one particularly advantageous embodiment is substantially cylindrical being located coaxially with the longitudinal axis of the tube. The ceramic provides good voltage hold-off over the range of temperatures encountered during operation. The ceramic material also provides a surface onto which the metallic portions can be fixed. These portions may advantageously comprise metallised regions of the ceramic surface but in some embodiments they may be formed as separate components fixed to the ceramic surface. The ability to metallise the ceramic surface allows high accuracies to be achieved in positioning the metallic portions relative to one another. Also, if for any reason it is necessary to remove or replace the ceramic tube during servicing, metallisation of its surfaces enables this to be relatively easily carried out.

The structural integrity offered by the use of the ceramic material allows the tube to undergo thermal cycling without significant distortion of the choke, offering good lifetimes for the tube as a whole.

As the ceramic material maintains its configuration during operation of the tube, even at higher temperatures, it does not require the metallic portions to offer support to hold it in shape. Again, this allows a metallisation layer to be used rather than a separate metal component to define the choke, with the consequent advantages in accuracy of the choke dimensions and fabrication as mentioned previously. In a particularly advantageous embodiment of the invention, the ceramic material is extensive in the axial direction beyond the choke. This may be used for example as a shield against arcing in the tube between parts which are at different electrical potentials.

In one advantageous embodiment of the invention, electrically insulating material of a different type covers at least some of the ceramic material. This may be, for example, silicone rubber. This may also be included over at least some of the metallic portions to provide additional shielding. It is supported in position by the ceramic material.

The metallic portions of the r.f. choke extend in substantially the same direction and hence are substantially parallel to each other. This is particularly advantageous as it reduces electrical stresses and therefore the tendency of voltage breakdown to occur between the inner and outer body portions, even at high voltages.

It is preferred that the metallic portions are substantially cylindrical, as this is a symmetrical configuration which is usually desirable in linear electron beam tubes as it gives good electrical characteristics and results in a mechanically robust arrangement.

Preferably, each of the inner and outer body portions includes two metallic portions extensive in an axial direction outwardly from the input cavity, there thus being two pairs of co-extensive metallic portions. Such an arrangement minimizes r.f. losses in the region between the inner and outer body portions. Although the input cavity could alternatively comprise only one such pair, this would tend to result in an r.f. leakage path being present between other parts of the cavity.

It is preferred that the inner body portion comprises two sections which are electrically separate from one another. Again, this facilitates manufacture and assembly and advantageously also permits different voltages to be applied to different parts of the electron gun via the inner body portion. In one preferred embodiment of the invention, the inner body portion is electrically connected to a cathode and a grid of the electron gun. Where two sections are included, one of them may be physically and electrically connected to the cathode and the other to the grid.

Where two pairs of rf chokes are included in the arrangement, the ceramic material may be present as two separate rings, for example, one ring being interposed between one pair of metallic portions and the other between the other pair. Alternatively, and preferably, the electrically insulating material is a unitary member which is extensive between both pairs of metallic portions. Advantageously, the inner and outer body portions are physically joined together by the ceramic material.

Preferably, the outer body portion is at ground potential.

Some ways in which the invention may be performed are now described by way of example with the reference to the accompanying drawings in which:

Figure 1 is a schematic sectional view of an IOT in accordance with the present invention, some parts of which have been omitted for sake of clarity; and

Figure 2 schematically illustrates part of another IOT in accordance with the invention.

With reference to Figure 1, an IOT comprises an electron gun 1 which includes a cathode 2 and grid 3 arranged to produce an electron beam along the longitudinal axis X-X of the arrangement. The IOT includes drift tubes 4 and 5 via which the electron beam passes before being collected by a collector (not shown). A cylindrical input resonant cavity 6 is arranged coaxially about the electron gun 1 and includes an input coupling 7 at which an r.f. signal to be amplified is applied. An output cavity 8 surrounds the drift tubes 4 and 5 and includes a coupling loop 9 via which an amplified r.f. signal is extracted and coupled into a secondary output cavity 10 and an output coupling 11.

During operation of this device, the cathode 2 and grid 3 are maintained at potentials of the order of 30kV, the grid 3 being maintained at a dc bias voltage at about

100 volts less than the cathode potential. The input high frequency signal applied at 7 results in an r.f. voltage of a few hundred volts being produced between the cathode 2 and the grid 3.

The input cavity 6 is defined by an inner body portion 12 and an outer body portion 13 with ceramic material in the form of a cylinder 14 between them, the inner body portion 12 being electrically insulated from the outer body portion 13 by the intervening ceramic material 14. The outer body portion 13 is maintained at substantially ground potential, thus facilitating safe handling of device, whilst the inner body portion 12 is maintained at much higher voltages.

The outer body portion includes two annular plates 15 and 16 arranged parallel to one another and transverse to the longitudinal axis X-X with a cylindrical outer section 17. The inner body portion 12 comprises two sections. The first section 20 is mechanically and electrically connected to the cathode 2 and the second section 21 is mechanically and electrically connected to the grid 3. In the embodiment shown, a ceramic cylinder 22 is located between the sections 20 and 21 to give additional mechanical support to the assembly.

The ceramic cylinder 14 provides electrical insulation between the inner body portion 12 and the outer body portion 13 and also forms part of rf choke means to substantially prevent leakage of high frequency energy from the cavity 6. The plate 15 of the outer body portion 13 is arranged adjacent a metallised layer 18 on the outer surface of the ceramic cylinder 14 extending around it in the circumferential direction. The section 20 of the inner body portion 12 is arranged adjacent the inner surface of the cylinder 14 and also is in contact with metallisation 19 extending circumferentially within the cylinder 14. The metallisation layers 18 and 19 and the intervening part of the ceramic cylinder 14 together define an rf choke. Similarly, the annular plate 16 of the outer body portion 13 is in contact with metallisation 23 and the section 21 with metallisation 24 to define a second rf choke. The metallisation layer on the outer surface of the ceramic may be longer or shorter in the longitudinal axial direction than the corresponding metallisation layer on the inner surface of the cylinder 14.

In other embodiments of the invention, one or more of the metallisation layers may be replaced by a separately formed metal cylinder which is located adjacent the ceramic cylinder 14.

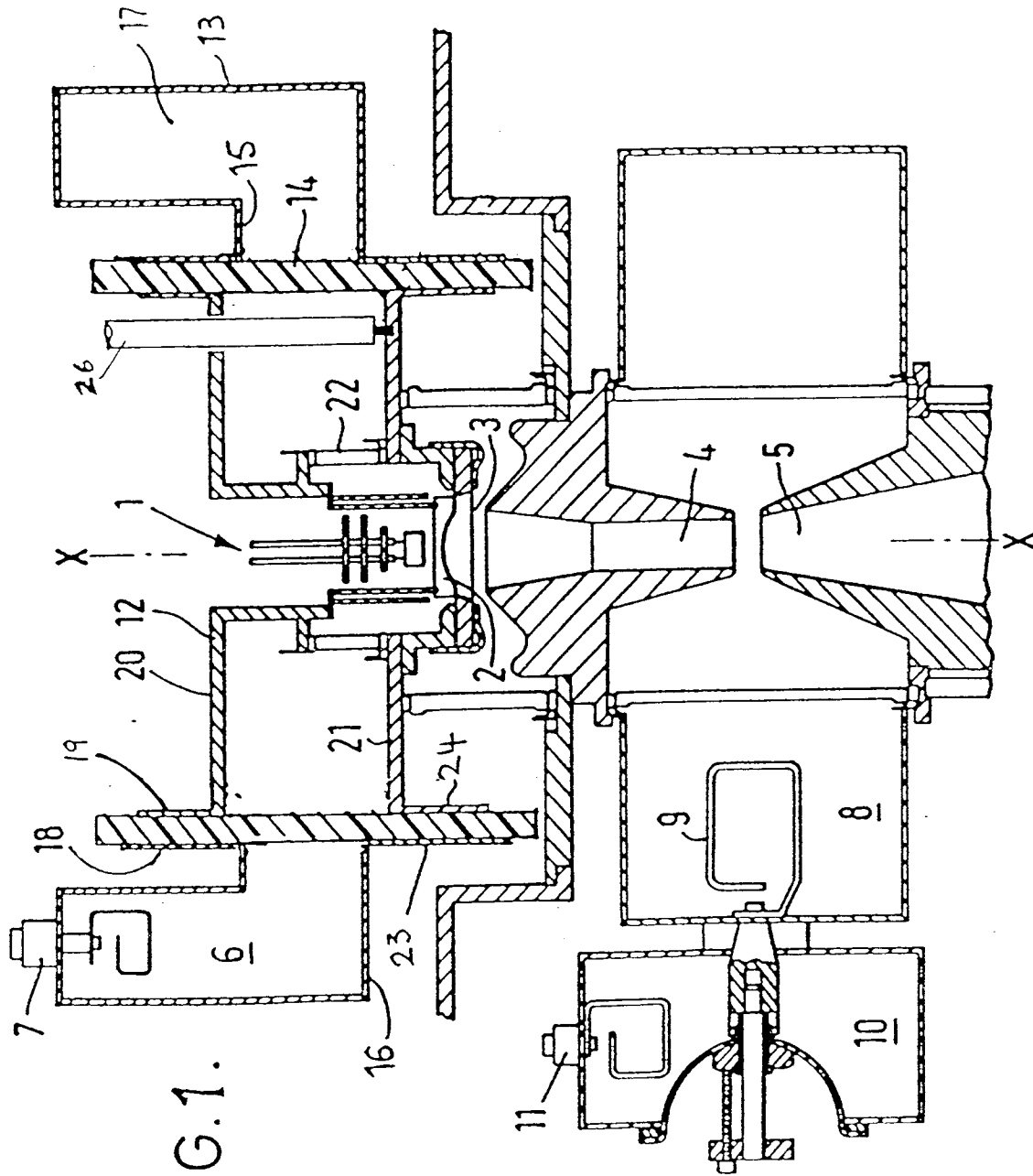
A power lead 26 is routed via an aperture in the section 20 to supply the grid 3 with the appropriate bias voltage, the connection being made via the lead 26 to the section 21.

Part of another IOT similar to that of Figure 1 is shown in Figure 2. In this embodiment, a single ceramic cylinder 27 similar to that of the Figure 1 embodiment is used and again, metallisation is laid down on the surfaces to define two rf chokes. At one end of the ceramic cylinder 27, a layer of silicone rubber 28 is arranged to cover the end of the cylinder and its inner and outer surfaces and part of the metallisation layers. The inner sur-

face of the silicone rubber 28 includes a plurality of circumferential grooves 29 to improve voltage hold-off ability.

Claims

1. A linear electron beam tube comprising:
 - an input cavity (6) which is substantially cylindrical about a longitudinal axis and arranged to receive, in use, a high frequency signal to be amplified;
 - an electron gun (1) arranged to produce an electron beam in a substantially longitudinal direction; and
 - an output cavity (8) from which the amplified high frequency signal is extracted; wherein the input cavity (6) substantially surrounds the electron gun (1) and comprises an inner body portion (12) electrically connected to part of the electron gun (1) and an outer body portion (13) electrically insulated from the inner body portion (12), the inner body portion (12) being maintained at a relatively high voltage compared to that of the outer body portion (13), and wherein the inner and outer body portions (12, 13) each includes an axially extensive metallic portion (18, 19, 23, 24) substantially co-extensive in an axial direction with ceramic material (14) being located between the metallic portions.
2. A tube as claimed in claim 1 wherein the metallic portions (18, 19, 23, 24) are substantially cylindrical.
3. A tube as claimed in claim 1 or 2 wherein at least one of the metallic portions comprises a layer of metallisation (18, 19, 23, 24) on the ceramic material (14).
4. A tube as claimed in claim 1, 2 or 3 wherein each of the inner and outer body portions (12, 13) includes two metallic portions (18, 19, 23, 24) extensive in an axial direction outwardly from the input cavity (6).
5. A tube as claimed in claim 4 wherein the ceramic material is in the form of a single member (14) which is extensive between both pairs of metallic portions (18, 19, 23, 24).
6. A tube as claimed in any preceding claim wherein the ceramic material is a cylinder (14) coaxially arranged about the longitudinal axis.
7. A tube as claimed in claim 6 wherein the cylinder (14) has a substantially uniform wall thickness over its whole length.
8. A tube as claimed in any preceding claim wherein the ceramic material (14) is of greater longitudinal axial extent than the metallic portions.
9. A tube as claimed in any preceding claim wherein the ceramic material (27) is at least partially covered by a different electrically insulating material (28).
10. A tube as claimed in claim 9 wherein the different electrically insulating material comprises silicone rubber (28).
11. A tube as claimed in claim 9 or 10 wherein said electrically insulating material (28) covers at least part of one or more of the metallic portions.
12. A tube as claimed in any one of claims 9 to 11 wherein said electrically insulating material (28) is present in the region between the cathode and anode of the electron gun.
13. A tube as claimed in any one of claims 9 to 12 wherein, where the ceramic material (27) is substantially cylindrical, said electrically insulating material (28) covers inner and outer surfaces of the cylinder and an end surface.
14. A tube as claimed in any one of claims 9 to 13 wherein a surface of said electrically insulating material (28) is undulating (29).
15. A tube as claimed in any preceding claim wherein the inner body portion comprises two sections (20, 21) which are electrically separate from one another.
16. A tube as claimed in any preceding claim wherein the inner body portion is electrically connected to a cathode (2) and a grid (3) of the electron gun (1).
17. An arrangement as claimed in any preceding claim wherein the inner and outer body portions (12, 13) are physically joined together by the ceramic material (14).
18. A tube as claimed in any preceding claim wherein the outer body portion (13) is at ground potential.
19. A tube as claimed in any preceding claim wherein electrical connection is provided via a lead (26) extensive through part of the inner body portion (12) to an electrode (3) of the electron gun (1).



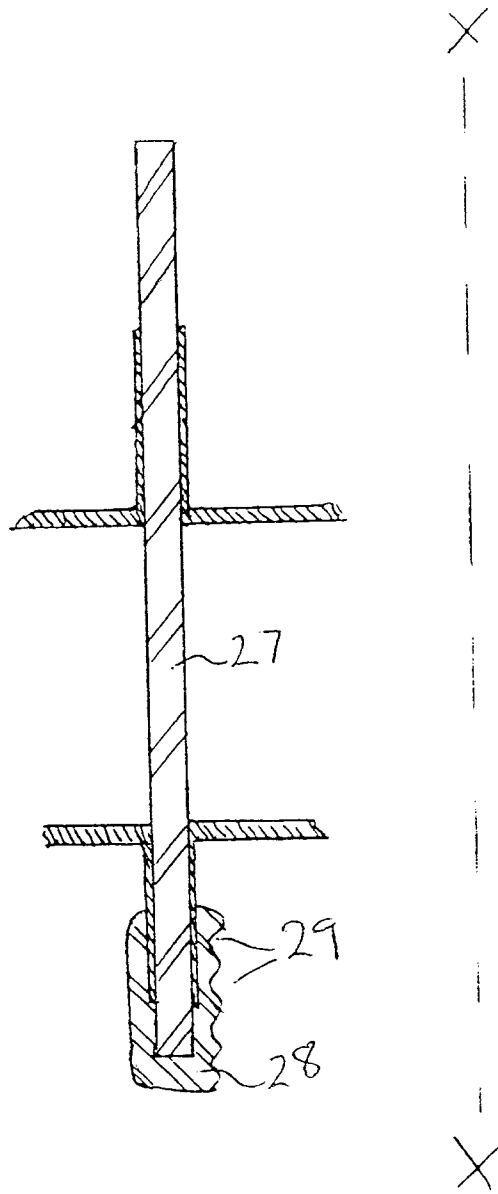


Fig.2.



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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 6635

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	DE-A-41 07 552 (EEV LTD) 12 September 1991 * the whole document *	1	H01J23/38 H01J25/04 H01J23/54
P,Y	GB-A-2 277 193 (EEV LTD) 19 October 1994 ---	1-10,12, 14-19	
P,A	* the whole document *	11	
P,Y	EP-A-0 652 580 (EEV LTD) 10 May 1995 * abstract * * column 1, line 56 - column 2, line 16 *	1-10,12, 14-19	
P,Y	EP-A-0 632 481 (EEV LTD) 4 January 1995 * abstract; figures 2,4 * * column 4, line 37 - line 43 *	1-10,12, 14	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H01J
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		17 January 1996	Martín Vicente, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, hut published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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