

Dec. 13, 1949

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2,490,845

HIGH-FREQUENCY CAVITY RESONATOR APPARATUS

Filed Jan. 20, 1945

2 Sheets-Sheet 1

Fig. 2.

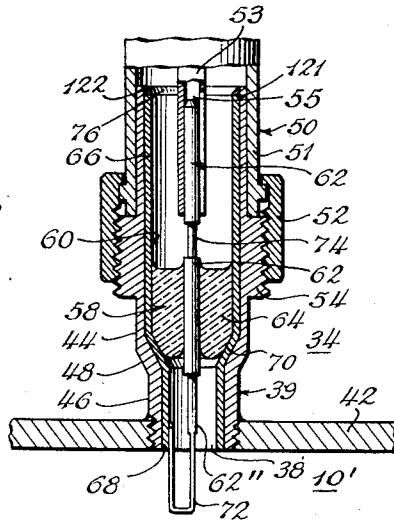


Fig. 1.

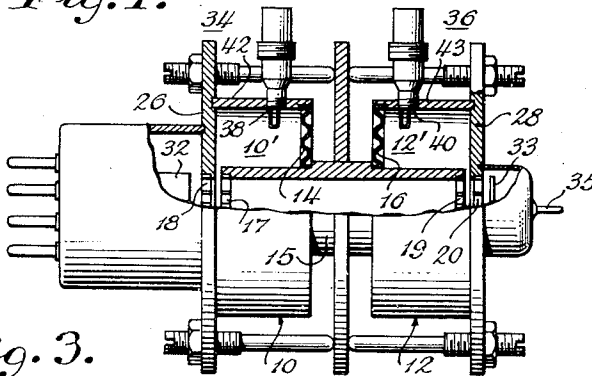


Fig. 3.

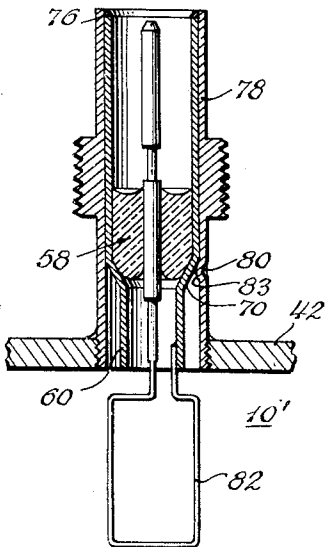


Fig. 4.

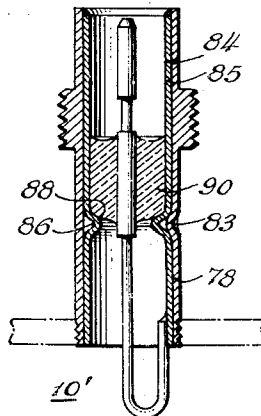
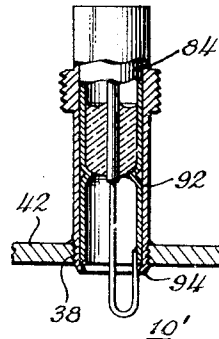


Fig. 5.



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2 Sheets-Sheet 2

Fig. 7.

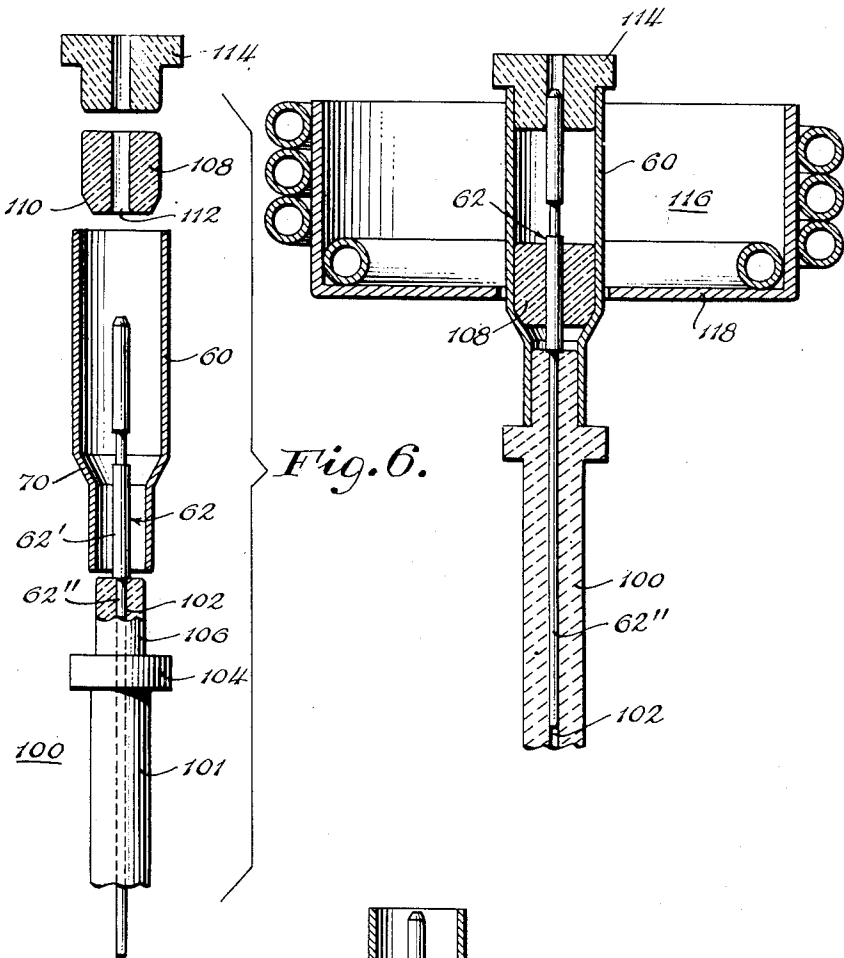
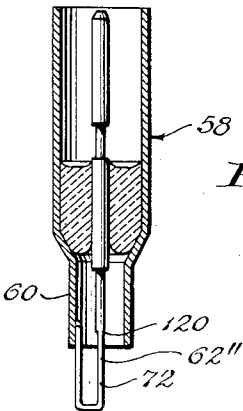


Fig. 6.

Fig. 8.



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UNITED STATES PATENT OFFICE

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HIGH-FREQUENCY CAVITY RESONATOR
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Sperry Corporation, a corporation of Delaware

Application January 20, 1945, Serial No. 573,734

19 Claims. (Cl. 315—39)

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The present invention relates, generally, to high frequency tube structures having enclosed oscillatory circuits of the type disclosed in Patent No. 2,242,275 issued May 20, 1941, in the name of Russell H. Varian, and the invention has reference, more particularly, to novel improvements in this type of structure operating at frequencies of the order of 10^9 cycles per second and in methods of fabricating such structures.

The invention in another of its aspects relates to novel features of the instrumentalities and methods described herein for achieving the principal objects of the invention and to the novel principles employed in those instrumentalities and methods, whether or not these features and principles are used for the said principal objects or in the same field or art.

The principal object of this invention is to provide a high frequency tube structure having hollow resonators provided with concentric line terminals having energy transfer means extending into the interior of said resonators for selectively removing energy therefrom or delivering energy thereto, said concentric line terminals being adapted to have concentric lines removably attached thereto for effecting use of this tube structure as an oscillator, amplifier, detector, etc., as desired.

Another object of this invention is to provide a novel tube structure wherein various metal components of the tube may be assembled and sealed together, on a mass production basis, while glass-bearing components of the tube are separately fabricated as subassemblies, said subassemblies, thereafter, being inserted and sealed in the assembled tube by the application of localized heat thereby minimizing the danger of injury to said glass-bearing components during such sealing operations.

A further object of the present invention is to provide a novel tube structure having a concentric line terminal wherein means are provided for controlling the positioning of energy transfer means in the resonator during construction thereby minimizing the danger of over- or under-coupling between the resonator and external circuits employed therewith.

Still another object of the invention lies in the provision of a novel concentric line terminal structure designed generally to simplify tube manufacture and to prevent injury to the line terminal.

Still another object of the present invention is to provide a method of manufacturing high frequency tubes having a novel concentric line terminal structure which makes it possible to manu-

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facture such a structure in extremely small size and, at the same time, economically, efficiently and with minimum effort.

A feature of the invention lies in the relatively short coaxial line structure which is herein provided.

Another feature of this invention lies in the provision of a novel concentric line terminal structure having a glass bead seal between an inner conductor and an outer conductor, said seal being adapted to connect the inner and outer conductors as a preformed subassembly which may thereafter be inserted in a terminal post provided on the wall of the resonator and sealed thereto, at a point remote from the glass-to-metal seal, thereby minimizing the danger of straining or fracturing said seal.

Still another feature of the invention is to provide a novel coaxial line terminal device having a hollow terminal post and a preformed coaxial line terminal assembly and positioning means associated therewith which serve to hold the assembly in proper alignment with respect to surrounding parts when the assembly is inserted in the post during manufacture.

A further object of the invention is to provide improved apparatus, instrumentalities, and methods embodying novel features and principles, adapted for use in realizing the above objects and also adapted for use in other fields.

The above and other objects and advantages of my invention will be apparent from the particular description thereof made in connection with the accompanying drawings in which:

Fig. 1 is a view in side elevation, partly in section, of the novel tube structure of the present invention;

Fig. 2 is an enlarged, fragmentary, sectional view showing a complete concentric line terminal structure;

Figs. 3 to 5, inclusive, are sectional views of several modified forms of concentric line structures;

Fig. 6 is an exploded view, partly in elevation and partly in longitudinal section, of an assembling device for the concentric line terminal shown in Figs. 2 or 4;

Fig. 7 is a longitudinal sectional view of an assembling device illustrating an additional step in the process of making the terminal unit shown in Fig. 2; and

Fig. 8 shows a completed concentric line terminal unit subassembly.

Similar reference characters are used in all of the above figures to indicate corresponding parts.

Referring now to the drawing, and particularly Fig. 1 thereof, a novel tube structure is shown as comprising a pair of spaced, cylindrical, evacuated, concentric shells 10, 12, having opposed resilient inner end walls 14, 16 that are centrally apertured and secured on a drift tube 15. The drift tube 15 has its end portions projecting into the interiors of shells 10, 12 which end portions terminate adjacent, though somewhat spaced from, rigid, transverse partitions 26, 28. The ends of the drift tube 15 are provided with grid structures 17, 19 which may be of the type disclosed in Figs. 8 or 9 of Letters Patent No. 2,345,642, issued April 4, 1944, in the names of Sigurd F. Varian and Russell H. Varian, or of any other suitable type.

A second pair of grids 18, 20, similar to grids 17, 19 are contained in aligned central apertures provided for this purpose in the partitions 26, 28. The grids 17, 19 and 18, 20 and the axis of the drift tube 15 are preferably coaxial with each other and with the axis of the shells 10, 12. The wall 14 and the partition 26 together with the cylindrical side wall 42 of the shell 10 and the projecting end of the drift tube 15 define a hollow resonator 10'. A similar hollow resonator 12' is defined within the shell 12, said resonators being adapted to contain standing electromagnetic waves.

A suitably mounted cathode or electron gun assembly 32 is aligned with the resonator grids for projecting a beam of electrons therethrough. A collector electrode 35 connected to an external lead 35 is likewise suitably mounted in the tube for collecting electrons traversing the tube.

For the purpose of coupling the resonators 10' and 12' to external circuits in ultra high frequency fashion, novel loop and coaxial line structures 34, 36 are provided. The structures 34, 36 communicate with the interior of the resonators 10', 12' through threaded openings 38, 40 which are formed radially in side walls 42, 43 respectively. Inasmuch as the coaxial line structures employed are of similar construction, a full description of either one, say the structure 34, may be taken as descriptive of the other.

As illustrated in Fig. 2 the coaxial line structure 34 comprises a substantially cylindrical post member 39 containing a coaxial line terminal unit or subassembly, generally designated by the numeral 53, said unit including an outer conductor or shell 60 and an inner conductor or lead 62 concentrically supported in said outer conductor by a glass bead seal 64 formed therein, in a manner hereinafter to be described in detail.

The post 39 is preferably shaped to provide a portion 44 having a uniform, relatively large diameter and a portion 46 of uniform, relatively reduced diameter with a tapered shoulder portion 48 intermediate and joining said uniform portions 44, 46. The post 39 is rigidly and vacuum sealed to the resonator 10' by inserting the relatively reduced portion 46 thereof in the threaded opening 38, and welding or brazing the post 39 over the opening 38.

The coaxial line terminal unit 53, in accordance with the teaching of the present invention, is a prefabricated subassembly adapted to be snugly received by and sealed into the post 39. Hence, the outer conductor 60 is preferably formed to provide enlarged and reduced portions 66 and 68 respectively, with a tapered intermediate portion 70, in a manner similar and conformable to the said portions 44, 46 and 48 of the post 39. The

tapered portion 48 acts as a stop or motion-limiting means which, by its coaction with the tapered portion 70, serves to limit the inward movement of the terminal unit 53 when said unit is inserted in the post 39. In this manner, I can properly position the terminal unit 53 relative to the resonator 10'.

As hereinbefore described, the inner conductor 62 is concentrically supported in the outer conductor 60 by the glass bead or other insulating seal 64. It will be observed that the location of the seal 64 coincides with the tapered portions 48, 73 thus attributing to said portions the added function of centering the inner conductor 62 relative to the outer conductor 60. The inner conductor 62 extends into the resonator 10' in the form of a coupling loop 72 of any desired shape and in accordance with one of the features of the present invention, the extent to which the loop projects into the resonator, is determined by the above-described motion-limiting means. Hence, the uncertainty commonly involved in the type and degree of coupling which may be effected between the resonator and an external circuit is definitely minimized.

As illustrated in the embodiment of Fig. 2, the loop is substantially J-shaped with the bight portion thereof smaller than the internal diameter of the reduced portion 46 of the post 39. The outer end of the loop 72 is spot-welded or silver-soldered to the inner surface of the outer conductor 60. It will be observed further, that the inner conductor 62 comprises a pair of concentric wires 62', 62'' of unequal diameters axially joined end to end, as by butt-welding or any other suitable method. The portion 62' of larger diameter forms part of the glass-metal seal, hence is preferably made of Kovar, or similar fusible metal or alloy, while the portion 62'' of smaller diameter, of which the loop 72 is fashioned, is preferably of Dumet, a copper-coated iron wire, selected for ease in welding to said Kovar portion 62'. It will be understood that the use of any metal or alloy having the desired properties of Kovar, on the one hand, and Dumet, on the other, is entirely within the scope of the present invention.

The ratio of the diameters of the Kovar portion 62' and the Dumet portion 62'', respectively, are selected so that the ratio of the internal diameter of the outer conductor 60 to the outside diameter of the inner conductor 62 is substantially constant throughout the entire length of the coaxial line terminal unit 53. In this manner, any electrical discontinuity, introduced by the tapered portions and the uniform portions of unequal diameters, is effectively nullified.

To minimize the danger of injuring the glass-to-metal seal by bending forces or torques experienced by the inner conductor 62 during normal handling, I provide a weakened portion 74 in said inner conductor to permit the conductor to bend thereat and thereby absorb the force or torque which might otherwise be transmitted, with injurious results to the seal. As a precaution against injury or breaking of the inner conductor 62, the latter is preferably disposed within the outer conductor 60 so that the outer end of said inner conductor 62 terminates interiorly of the outer end of the outer conductor 60. Thus the inner conductor 62 is completely shielded from mechanical forces by the side walls of both the outer conductor 60 and the post 39.

After insertion in the post 39, the coaxial terminal unit 58 is rigidly and permanently secured thereto, and vacuum sealed, as by brazing, welding, or the like, at a region 76 adjacent the outer ends of the terminal unit 58 and post 39, respectively, and spaced from the glass bead seal 64. It will, thus, be observed that the possibility of injury of the glass bead seal, due to heat and pressure accompanying the brazing operation, is substantially reduced.

Connection between the coaxial line structure 34 and an external circuit is made by means of a coaxial transmission line 50 having an internally threaded coupling member 52 adapted to be received on a threaded boss 54 provided for the purpose on the enlarged portion 44 of the post 39. The transmission line 50 further comprises a tubular outer conductor 51 and an inner conductor 53 of which at least the end portion is hollow, as indicated at 55. In coupling the transmission line 50 to the coaxial line terminal structure 34, the line 50 is slipped over the structure 34 so that the inner conductor 52 is snugly fitted into the hollow portion of the inner conductor 53 and the outer conductor 51 slides over the post 39. Satisfactory electrical contact is insured by tightening the coupling member 52 over the boss 54.

A modified coaxial terminal structure, adapted for use with a coupling loop whose bight portion is large compared to the opening provided by the reduced portion 46 of the post 39, is shown in Fig. 3. As shown, a uniform, cylindrical, hollow terminal post 78 is provided with an indentation or dimple 80 in a side wall, said indentation forming in the interior of the post 78 an embossment or detent 83. The indentation 80 is preferably formed by means of a punch or similar tool, hit with a blow of known magnitude so that the depth of said indentation is predetermined and controlled.

The exact location of the indentation 80 and, hence, that of the detent 83, is set with reference to the wall 42 of the resonator 10', such that, when the terminal unit 58 is inserted in the post, the outer portion of the shoulder 70 engages the detent 83 and the inner end of the shell 60 lies flush with the inner end of the post 78 and the wall 42. Clearly, the detent 83 and the shoulder 70 coact to provide stop or motion limiting means which serve to position the assembly 58 relative to the post 78 and the resonator 10'. It will be noted, however, that in assembling the prefabricated assembly 58 and the post 78, said assembly is inserted into the post 78 with the plane of its enlarged loop 82 angularly displaced relative to the plane of the post containing the detent 83, so that the loop 82 may be passed freely through the partial obstruction formed by said detent. After clearing the obstruction, the loop may be oriented in any desired plane before securing the assembly to the post at the region 76, as hereinbefore described in connection with Fig. 2. The amount of insertion of loop 82 into resonator 10' is fixed and kept uniform, corresponding to the position of detent 83.

A modified form of coaxial line terminal unit 94 is illustrated in Fig. 4, and is here shown employed with the type of terminal post 78 shown in Fig. 3. A substantially uniform, thin walled, cylindrical outer conductor or shell 85 is shown having a relatively narrow and shallow circular groove or channel 86 peripherally rolled or otherwise formed therein, said groove or channel

forming, in the interior of said outer conductor 85, an inwardly projecting embossment 88 at a position corresponding to the position of the detent 83 in the post 78. The embossment 88 coacts with the detent 83 to provide stop or motion-limiting means which serves to position the terminal unit 83 relative to the post 78 and the resonator 10'. It will be observed that the embossment 88 also serves as means tending to position a preformed glass bead during the process of making the coaxial line terminal unit 84, as will hereinafter be described. In assembling said terminal unit 84 and the post 78, the unit is sprung or snapped into position and firmly and positively retained therein by the seating of the detent 83 in the groove 86. Thereafter, unit 84 may be sealed to post 78 at its upper edge, remote from seal 90, in a fashion similar to the device of Figs. 2 and 3.

In the event that the outer conductor 85 is fabricated with thick-walled, relatively inflexible, tubular stock, such that the process of springing or snapping the unit 84 into position is undesirable, a modified post structure, shown in Fig. 5 may be used in lieu of the post 78 of Fig. 4. A straight-sided, cylindrical post member 92, having a threaded end inwardly tapered or turned to form a neck 94, is inserted in the threaded opening 38 of the resonator 10' so that said neck 94 extends slightly beyond the inner surface of the wall 42 and into the resonator 10'. The neck 94 forms a stop or motion limiting means for properly positioning the coaxial line terminal unit 84 relative to the post 92 and the resonator 10'. If desired, neck 94 need not protrude into resonator 10', but may terminate flush with the inner surface of wall 42.

There hereinbefore described structure not only incorporates novel and improved structural features but also has been particularly designed for fabrication by novel mass production methods. In particular, the coaxial line terminal units 58 (Fig. 2) and 94 (Fig. 4) are both especially adapted for such production methods and a preferred method is described below with reference to Figs. 6 through 8 wherein the construction of unit 58, taken as an example, is illustrated in detail.

The inner conductor or shell 60, which also may be of Kovar or an equivalent glass-bonding metal, is preliminarily prepared for "glassing," first, by sandblasting the interior surface thereof and, then, by preoxidizing it in an air oven at a temperature of about 1750° F. for a period of approximately three minutes. This preliminary treatment, it has been found, renders the metallic surface more readily fusible to glass. Similar preparatory operations are performed on the inner conductor 62 for the same reason.

In assembling before sealing, the inner conductor 62 is supported in a jig 100 which comprises an elongated cylindrical member 101 whose upper end is terminated in a transversely extending collar 104 which, in turn, supports a cylindrical stud 106 coaxially aligned with collar 104 and cylindrical member 101. The components of the jig 100 are suitably joined to form a rigid structure having an axial bore 102 extending therethrough adapted to receive the unlooped small diameter portion 62' and to support the larger diameter portion 62' of the inner conductor 62 in a substantially vertical position, by virtue of the shoulder formed at the joint of portions 62' and 62'', as illustrated in Fig. 6. The shell 60 is slipped over the upstanding portion 62' of the

inner conductor 62 and is supported in a vertical position, concentric with the inner conductor 62, by means of the collar 104 and the stud 105.

A substantially cylindrical, preformed bead 103 of suitable vitreous material such as glass is adapted to be inserted in the shell 60 to surround the enlarged portion of the inner conductor 62. A type of glass having a desirable thermal coefficient of expansion relative to that of Kovar is produced by and available from the Corning Glass Works and is identified by the type number 704, although any material forming a vacuum-tight seal with conductors 60 and 62 may be used. One end of the bead 103 is chamfered as at 110, to conform with the tapered shoulder 70 of shell 60. The bead is also provided with a longitudinal bore 112 whose diameter is slightly greater than the diameter of the portion 62' of the inner conductor 62, so that the latter may freely be passed through the bore 112. The outside diameter of the bead is somewhat less than the inside diameter of the shell 60 to admit the bead 103 freely into the shell 60, to be positioned therein by shoulder 70 cooperating with chamfer 110. A refractory cap 114 may be placed over the assembled shell, inner conductor and bead whereby the inner conductor 62 is centered and held firmly in position during the subsequent heating operation.

As shown in Fig. 7, the jig 100 and the assembled elements are then placed in radio frequency induction furnace 116 of which a concentrator ring 118 is directed toward that portion of the assembly containing the bead 103 and the metal surfaces to be fused thereto. Heat generated by the furnace 116 is thus uniformly applied to the glass and the metal surfaces adjacent to the glass under time-temperature controlled conditions. It will be observed that heat is substantially uniformly distributed throughout the glass bead, since induction takes place at both the shell-glass surface and the inner conductor-glass surface, resulting in a satisfactory, vacuum tight seal.

After the seal has been made, the terminal unit 58 may be removed from the jig and annealed in an air furnace to relieve any strains that may exist in the glass. After the annealing process has been completed the smaller portion 62'' may be formed into a loop 72 of any desired size and shape, with the outer end of the loop spot-welded or silver-soldered to the inner surface of the outer conductor 60. If desired, the end portion of the wire 62'' may be flattened, as at 120, in a press before forming the loop, to facilitate forming the loop in desired shape and size.

As shown in Fig. 2, the coaxial line structure 34 is assembled by inserting the terminal unit 58 into the hollow post 39 on the tube, until the tapered shoulder portion 70 is seated firmly in the tapered shoulder portion 48 and the loop 72 is correctly positioned in the resonator 10'. When so seated, it will be noted, that the outer end of conductor 60 terminates interiorly of the outer end of post 39 to provide an annular ledge or projection 121 on which a ring 122 of brazing material such as silver-solder or the like may be placed.

Time-temperature controlled localized heat to seal the conductor 60 to post 39 is applied to the region 76 adjacent the outer ends of conductor 60, post 39 and ring 122 in the presence of a hydrogen atmosphere which serves to prevent the formation of undesirable oxides, the presence of which in an evacuated tube, is known to interfere with satisfactory exhaustion of the tube. A metal-to-metal, vacuum-tight seal between the

terminal unit 58 and the post 39 is thus effected with virtually no harmful effect on the glass-to-metal seal 64. In view of the fact that the heat employed for the metal-to-metal seal is localized and effectively isolated from the glass-metal seal, I can substantially reduce the over-all length of the coaxial line structure 34 with respect to prior known structures of this type.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. High frequency apparatus comprising means defining a hollow resonator chamber adapted to contain an electromagnetic field, a hollow terminal post carried directly by said resonator having an opening affording access to said chamber, limiting means in said post, and means providing electrical coupling to said field from externally of said chamber comprising means conductive to high frequency energy at the inner surface of said post, and extending therealong a substantial distance predetermined by said limiting means, said conductive means being insertable within said post through the opening in said post, and means vacuum sealing said opening.

2. A high frequency structure comprising a hollow resonator adapted to contain an electromagnetic field, a hollow terminal post carried directly by said resonator and communicating with the interior thereof, means in said post for arresting the movement of a body inserted in said post, and a concentric line terminal unit within said terminal post comprising an outer conducting shell and an inner conducting lead, means on said outer shell engaging said arresting means to position said terminal unit in said post, said lead extending inwardly beyond the inner end of said shell and into said hollow resonator to provide coupling with the field within said resonator said outer shell lining at least a substantial portion of the inner surface of said post.

3. High frequency apparatus comprising a hollow resonator, a hollow terminal post carried directly by said resonator, a concentric line terminal within said terminal post comprising an outer conducting shell lining at least a substantial portion of the inner surface of said post and an inner conducting lead, said lead extending inwardly beyond the inner end of the shell and into the hollow resonator to provide coupling with the field within said resonator, and means on said post cooperable with further means on said shell for limiting the degree of extension of said lead within the resonator.

4. The apparatus claimed in claim 3 in which said means comprises a tapered shoulder portion in said post and said further means comprises a conformably-shaped shoulder portion on said shell.

5. The apparatus claimed in claim 3 wherein said means comprises a detent formed at a predetermined portion of said post and said further means comprises a tapered shoulder in said shell.

6. The apparatus claimed in claim 3 wherein said means comprises a first embossment in said

post and said further means comprises a second embossment in said shell.

7. The apparatus claimed in claim 3 wherein said means comprises a neck formed in the end of said post and said further means comprises an adjacent end of said shell in abutment with said neck.

8. High frequency apparatus comprising a hollow resonator, a hollow concentric line terminal post carried by said resonator, at least a portion of said post having tapered side walls, a concentric line terminal within said terminal post comprising an outer conducting shell having a corresponding portion thereof tapered in conformity with the tapered walls of said post and an inner conducting lead, said lead terminating short of the outer end of said shell and extending inwardly in the form of a loop beyond the inner end of the shell and into the hollow resonator, the penetration of said loop in said resonator being fixed by the coaction between the taper of said post and the taper of said terminal, said loop having its doubled-over end connected to the inner surface of said shell, and a vacuum seal between the inner portion of said shell and said lead.

9. High frequency vacuum tube apparatus comprising a hollow resonator, a hollow terminal post carried directly by said resonator and communicating with the interior thereof, means in said post defining a stop, electrically conductive means comprising a coaxial line section unit disposed in part interiorly of said post and in part interiorly of said resonator, said conductive means having means cooperative with said stop for determining the degree of insertion of said conductive means in said resonator, and means vacuum sealing said conductive means to said post at a region remote from said resonator, said coaxial line section unit extending along a substantial portion of the inner surface of said post.

10. High frequency apparatus comprising a hollow resonator, a tubular terminal post vacuum-sealed thereto at an aperture in the wall of said resonator and communicating with the interior thereof, positioning means on said post, a concentric line coupling within said terminal post, comprising an outer conducting shell having means cooperable with said positioning means for disposing said shell within said terminal post so that the inner end of said shell lies flush with the wall of said resonator, and an inner conducting lead vacuum-sealed to said outer conducting shell and connected therewith by a loop beyond the end of said shell and within said hollow resonator.

11. A coaxial line terminal device for coupling to electrical wave energy fields comprising a central conductor having an end loop, a hollow terminal post having a relatively constricted portion, said post being disposed around said conductor and having an open end toward said loop with the loop outside the terminal post, electrically conductive means at the inner surface of said terminal post having a constricted portion adapted to seat on said constricted portion of said terminal post to be positioned thereby, and an electrical connection between the end of said loop and said conductive means.

12. A coaxial line terminal device for coupling to the electrical wave energy fields within an evacuated high frequency resonator device, comprising a central conductor, a hollow terminal post supported by said high frequency device and concentric with and spaced outside said conductor, means forming a partial obstruction in said

terminal post, and an electrically conductive lining member within said terminal post, said lining member being adapted to be positioned in said terminal post by said partial obstruction, and a loop on said conductor contacting said lining member and disposed in the evacuated space of said device.

13. A concentric line terminal device as in claim 12, further comprising means at one end of said post vacuum sealing said terminal post to said resonator and further means at the other end of said post vacuum sealing said post to said lining member.

14. High frequency electron discharge tube apparatus comprising means defining a hollow resonator chamber adapted to contain an electromagnetic field, means for projecting a beam of electrons through said resonator in energy exchanging relation therewith, a hollow post carried directly by said resonator having an opening affording access to said chamber, means in said post restricting the size of the opening, means providing fixed electrical coupling to said field from outside said chamber comprising a section of coaxial transmission line disposed within said post and extending along the inner surface of said post at least a substantial distance predetermined by said restricting means, means vacuously sealing said post to said line section, and means vacuum sealing said opening at a point remote from said resonator.

15. A high frequency structure comprising a hollow resonator adapted to contain an electromagnetic field, a tubular terminal post carried by said resonator and communicating with the interior thereof, motion arresting means within said post, and a coaxial coupling unit within said post, said coupling unit comprising an outer conductor lining at least a substantial portion of the inner surface of said post, said outer conductor being at one end flush to the wall of said resonator, an inner conductor concentrically disposed in said outer conductor, means providing a vacuum seal within said outer and inner conductors, means sealing said outer conductor to said post at the end thereof remote from said resonator, and means on said outer conductor engaging said motion arresting means for positioning said coupling unit within said post, said inner conductor extending beyond said vacuum-sealing means and into said hollow resonator whereby coupling with the field is provided.

16. A high frequency coupling device for a cavity resonator, comprising a hollow post adapted to communicate directly with the interior of said resonator; a coaxial coupling unit within said post comprising an outer conductor having two portions of different inner diameter joined by a tapered section, the larger-diameter portion of said outer conductor extending along the inner surface of said hollow post, an inner conductor coaxially within said outer conductor, and a glass bead vacuum sealed to both said conductors and having a tapered section sealed to the tapered section of said outer conductor, said inner conductor having an end extending beyond the free end of the smaller-diameter portion of said outer conductor and beyond said post and connected to the free end of said outer conductor smaller-diameter portion to form a loop; said post having a detent therein engaging the tapered section of said outer conductor, the extent of said outer conductor along the inner surface of said post being predetermined by the engagement of said detent and said tapered section; and

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hermetical-sealing means joining said post and said outer conductor larger-diameter portion at their ends remote from said loop.

17. A high frequency coupling device for a cavity resonator, comprising a hollow post adapted to communicate directly with the interior of the resonator; a coaxial coupling unit within said post comprising an outer conductor having two portions of different diameter joined by a tapered section, an inner conductor within said outer conductor, and a glass bead sealed to both said conductors; a loop connected to the end of said inner conductor within the smaller-diameter portion of said outer conductor and extending beyond said portion of said outer conductor, said loop also being connected to said outer conductor at its smaller-diameter portion; said post having a detent engaging the tapered section of said outer conductor, and said outer conductor extending along the inner surface of said post a distance predetermined by the engagement of said detent and said tapered section; and a hermetical-sealing means joining said post and said outer conductor larger-diameter portion at their ends remote from said loop.

18. A high frequency coupling device for a cavity resonator, comprising a hollow post adapted to communicate directly with the interior of the resonator; a coaxial coupling unit within said post comprising an outer conductor having two portions of different diameter joined by a tapered section, an inner conductor within said outer conductor, and a glass bead sealed to both said conductors; a loop connected to the end of said inner conductor within the smaller diameter portion of said outer conductor and extending beyond said portion of said outer conductor, said loop also being connected to said

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outer conductor at its smaller diameter portion; said post having a detent engaging the tapered section of said outer conductor, and said outer conductor extending along the inner surface of said post a distance predetermined by the engagement of said detent and said tapered section.

19. A high frequency coupling device for a cavity resonator, comprising a hollow post adapted to communicate directly with the interior of the resonator; a coaxial coupling unit within said post comprising an outer conductor having two portions of different diameter joined by a tapered section, a loop-terminated inner conductor within said outer conductor, and a glass bead sealed to both said conductors at said tapered section; said post having a detent engaging the tapered section of said outer conductor, and means sealing said outer conductor to said post at the ends thereof remote from said loop.

LLOYD F. SORG.

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

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Certificate of Correction

Patent No. 2,490,845

December 13, 1949

LLOYD F. SORG

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 33, for "electrode 35" read *electrode 33*; column 4, line 13, for the reference numeral "73" read 70; column 6, line 38, for the word "There" read *The*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of May, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

Certificate of Correction

Patent No. 2,490,845

December 13, 1949

LLOYD F. SORG

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 33, for "electrode 35" read *electrode 33*; column 4, line 13, for the reference numeral "73" read 70; column 6, line 38, for the word "There" read *The*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of May, A. D. 1950.

[SHAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.