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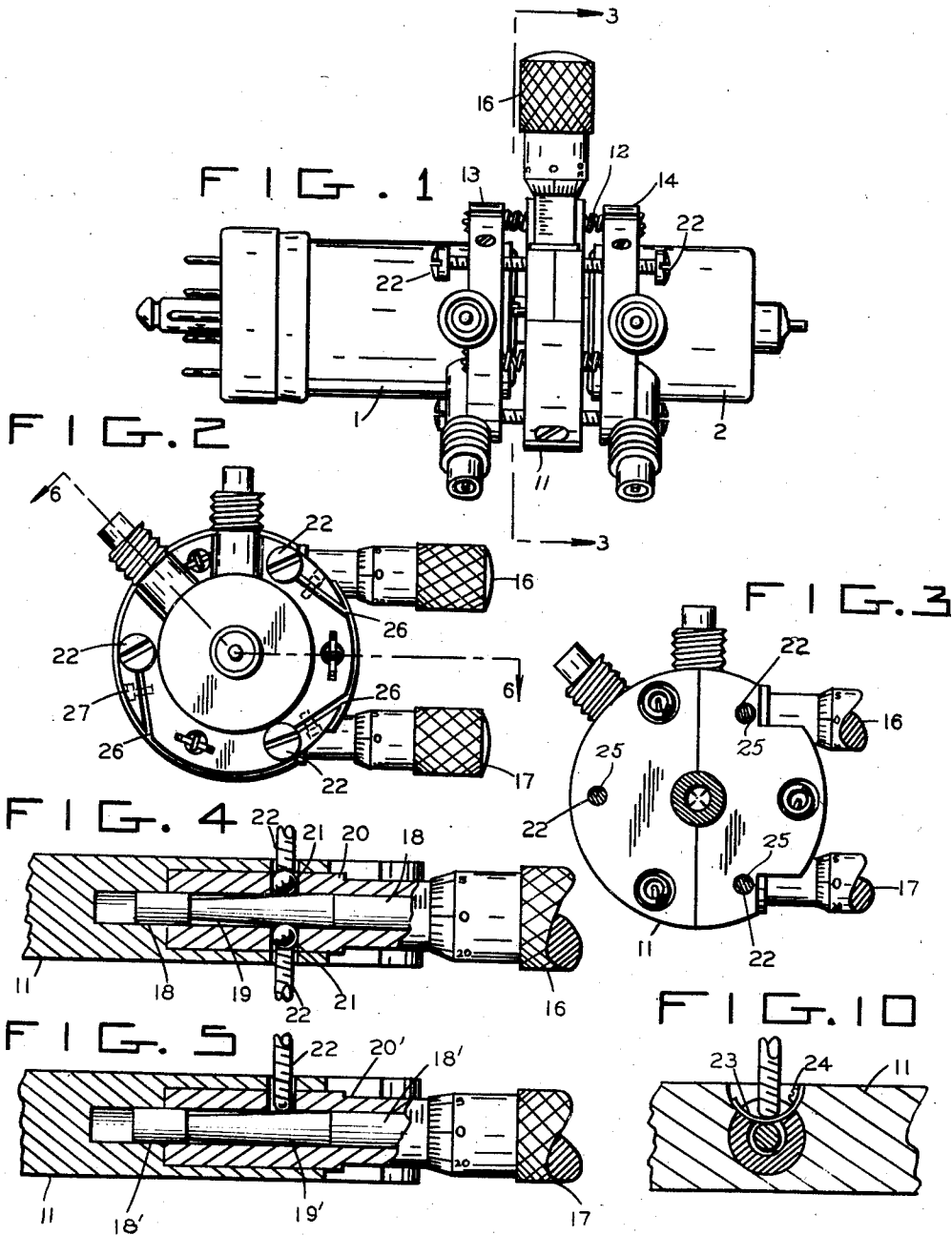
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HIGH FREQUENCY TUBE STRUCTURE

Filed April 24, 1941

2 Sheets-Sheet 1



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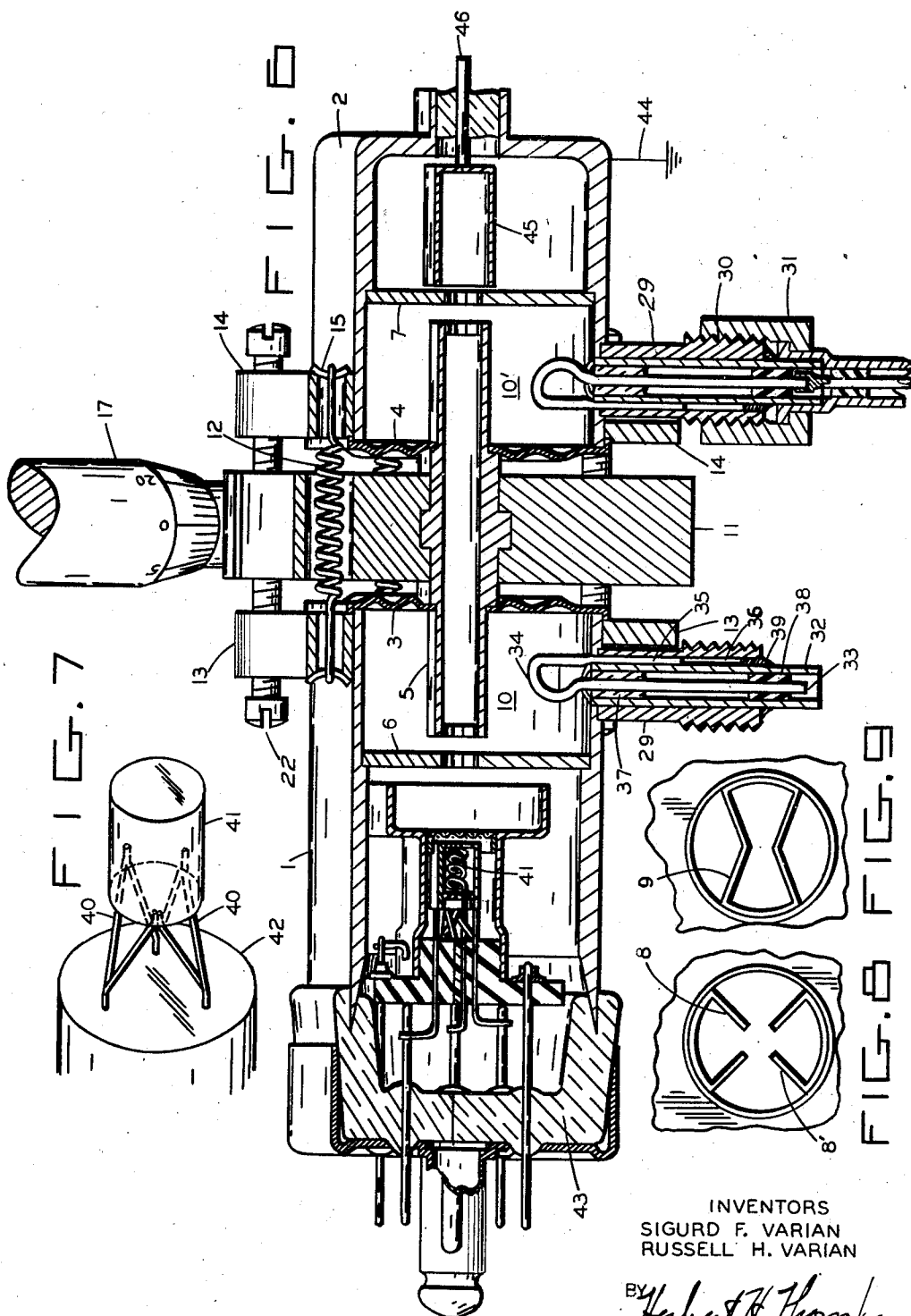
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HIGH FREQUENCY TUBE STRUCTURE

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26 Claims. (Cl. 250—27.5)

This invention relates, generally, to high frequency tube structures having enclosed oscillatory circuits of the general type disclosed in co-pending application Serial No. 168,355, filed October 11, 1937, by Russell H. Varian, one of the inventors herein, now Patent No. 2,242,275, issued January 3, 1942, 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.

The principal object of the present invention is to provide a novel high frequency tube structure utilizing the principles of operation disclosed in the above-identified application and embodying refinements, compactness of design, simplicity of manufacture and ruggedness, thereby particularly adapting the present invention for practical uses.

Another object of the present invention lies in the provision of an ultra high frequency tube structure having a novel tuning arrangement including tapered rod or wedge members adapted by longitudinal movement to effect simultaneous or alternate individual or gang tuning of the hollow resonators of the tube.

Another object of the present invention is to provide a high frequency tube structure having novel concentric line terminals that are designed to simplify manufacture of the tube and to prevent injury to the line terminals or to the tube sealing means in use, the said concentric line terminals being adapted to have concentric lines removably attached thereto for effecting use of the tube structure either as an oscillator, amplifier, detector or other purpose.

Still another object of the present invention is to provide a high frequency tube structure having resonators provided with improved grid means and also having an improved cathode support, the latter serving to prevent deflection of the cathode in use.

Other objects and advantages will become apparent from the specification, taken in connection with the accompanying drawings wherein one embodiment of the invention is illustrated.

In the drawings,

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

Fig. 2 is an end view of the structure of Fig. 1;

Fig. 3 is a sectional view taken along line 3—3 of Fig. 1;

Fig. 4 is an enlarged fragmentary sectional view showing a tapered pin or wedge means used in effecting gang tuning of resonators;

Fig. 5 is a view similar to Fig. 4 but shows means for tuning a single resonator;

Fig. 6 is an enlarged sectional view taken substantially along line 6—6 of Fig. 2;

Fig. 7 is a perspective view showing the novel cathode support;

Figs. 8 and 9 are fragmentary views illustrating grid structures employed; and

Fig. 10 is a fragmentary sectional view of a modified detail of construction.

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

Referring now to the drawings, a novel tube structure is shown as comprising a pair of spaced, cylindrical, evacuated, concentric shells 1 and 2 having opposed flexible inner end walls 3 and 4 that are centrally apertured and secured upon a drift tube 5. The drift tube 5 has its end portions projecting into the interiors of shells 1 and 2, which end portions terminate adjacent, though somewhat spaced from, transverse partitions 6 and 7 within the shells. The ends of the drift tube 5 are provided with grid structures of the type shown in Fig. 8 or Fig. 9. The grid structure of Fig. 8 comprises two similar grid elements 8 and 8' that are of substantially sector shape in outline and are formed by bending a small strip or wire of conducting material into a central arcuate portion fitting the inner cylinder surface of the tube 5 and two spaced inwardly projecting radial portions that terminate short of the center of the tube opening. These grid elements 8 and 8' are shown disposed opposite one another and may be secured in place in the tube 5 as by spot welding or by soldering.

The grid element 9 shown in Fig. 9 is of substantially double keystone shape in outline and is made up by bending a narrow conducting strip or wire into the shape shown, having two opposite arcuate portions fitting the inner surface of tube 5 and spaced transverse connecting portions which are indented toward the center of the tube aperture.

The partitions 6 and 7 are provided with central apertures aligned with the central aperture of tube 5 and also contain grid structures such as shown in Fig. 8 or Fig. 9. The partitions 3 and 6 and the intermediate inner surface of the cylindrical member 1, together with the projecting end of drift tube 5 form a hollow resonator 10, and a similar hollow resonator 10' is formed within the interior of shell 2, said resonators being adapted to contain standing electromagnetic waves.

A support or collar 11 is fixed upon the drift tube 5 intermediate the ends 3 and 4 of resonators 10 and 10'. This collar 11 is shown provided with three angularly spaced transverse apertures through which tension springs 12 extend and have their ends projecting through apertures provided in flanges 13 and 14 formed on the inner ends of shells 1 and 2, the outer ends of these springs being held by anchors 15 bearing on the flanges 13 and 14, whereby these

springs tend to urge the shells 1 and 2 toward each other deflecting the flexible ends 3 and 4.

The novel tuning means of this invention opposes the action of springs 12 and tends to urge the flanges 13 and 14 apart. This tuning means comprises one or more verniers 16 and 17. These verniers have their barrels 20 and 20' secured in recesses provided in the collar 11 and having their stems 18 and 18' provided with tapered intermediate portions 19 and 19'. The tapered portion 19 of the stem 18 of vernier 16 is shown engaged by balls 21 interposed between the tapered portion 19 and thrust screws 22, which screws extend through apertures provided in the barrel 20 of vernier 16 and in the collar 11 and are threaded through the flanges 13 and 14 of shells 1 and 2. Thus, the tension of springs 12 serves to urge the inner ends of screws 22 and cooperating balls 21 against the tapered portion 19 of stem 18 and by turning the knob of the vernier 16 the stem 19 is moved longitudinally so that by wedging action the screws 22 are moved toward or away from each other at a gradual rate, thereby serving to move flanges 13 and 14 toward or away from each other and effecting the flexure of flexible ends 3 and 4 of the resonators and in this way gang tuning these resonators. The tapered portion 19 thus serves as a cam having a bearing surface.

If it is desired to merely tune one of the resonators 10 or 10', for example resonator 10, then but one of the thrust screws will be employed as shown in Fig. 5 in connection with vernier 17. Thus, the thrust screw 22 may be threaded through flange 13, for example, so that turning of the knob of vernier 17 serves to move tapered stem 19' longitudinally causing screw 22 to move longitudinally of the tube structure and deflect the flexible end wall 3 of resonator 10 to tune this resonator, as where it is desired to tune this resonator to resonator 10'. In Fig. 5 the ball 21 is omitted and the screw 22 is shown bearing directly upon the tapered portion 19' of stem 18'. Other means than the balls 21 may be employed for transmitting the thrust between stems 19 or 19' and the screws 22. For example, in Fig. 10 a flat spring 23 is shown employed for this purpose, the same being secured in place as by screw or screws 24.

It will be noted by special reference to Fig. 2 that the thrust screws 22 are shown disposed angularly substantially 120° apart around the flanges 13 and 14, one of these screws being shown in Fig. 2 as cooperating with vernier 16 and another with the vernier 17. There is no screw 22 carried by flange 14 engaging the tapered stem of vernier 17 since individual tuning of resonator 10 is provided by this vernier. The third pair of screws 22 are adapted to bear in sockets 25 (see Fig. 3) provided in the collar 11. The flanges 13 and 14 are shown provided with slots 26 and lock screws 27 for locking the thrust screws 22 in adjusted positions. The screws 22 engaging sockets 25 and those engaging the verniers 16 and 17 are adapted to be initially adjusted by a screw driver before effecting the final tuning of the resonators and then these screws 22 may be locked in place by use of lock screws 27. Gang tuning of the resonators 10 and 10' is thereafter accomplished by vernier 16 and individual tuning of resonator 10, for example, is thereafter accomplished by use of vernier 17. Obviously, either vernier 17 or 16 may be omitted, if desired, in which case the screws 22 engaging the tapered shank of such

vernier would engage in sockets similar to 25 provided in the collar 11.

The resonators 10 and 10' are shown provided with one or more hollow cylindrical concentric line terminal posts 29 having their outer end portions threaded at 30 for receiving disconnectable concentric lines 31. Contained within each of the terminal posts 29 is a concentric line terminal comprising an outer conducting tube 32 adapted to be slid into the conforming cylindrical hollow interior of the terminal post. Contained within the tube 32 is a central lead or wire 33 that terminates short of the outer end of the tube 32, whereby the outer end of this tube serves to protect the central lead 33 from mechanical injury. Central lead 33 extends into the associated hollow resonator and has a loop 34 formed on its inner end projecting into such resonator, the doubled-over end 35 of this loop lying exteriorly of tube 32 and extending for a distance therealong. The hollow cylindrical interior of the post 29 is provided with a longitudinal slot 36 for accommodating the turned-over portion 35 of the lead 33. A glass or other seal 37 is provided at the inner end of the concentric line terminal between the tube 32 and lead 33. An insulating bead 38 is preferably included between the outer portion of lead 33 and tube 32 for firmly supporting this lead within tube 32. Thus, in using this construction all of the major joints of the assembly, such as the joints between the ends 3 and 4 and their associated shells 1 and 2, the joints between partitions 6 and 7 and their shells, etc., may all be sealed with solder before inserting the concentric line terminals 32—33 into the terminal posts 29. In this way the glass seal 37 is not injured by the heat of soldering. After inserting the line terminals 32—33 the same is sealed in as by solder 39, some of which enters the slot 36.

As especially shown in Fig. 7, a novel construction of cathode mounting is employed, said mounting comprising a kinematically rigid three-point support for said cathode. This mounting comprises six inclined struts or wire members 40, said struts being so disposed that the ends of adjoining struts are secured together both at the cathode 41 and at the insulating supporting button 42. Thus, at the button 42 the meeting ends of each pair of struts are secured together and the pairs of such ends are mutually spaced apart substantially 120° providing a truss arrangement having a three-point connection to the button and a similar condition obtains at the cathode 41 although the points of connection to the cathode 41 of the pairs of joined strut ends is substantially 60° displaced from the corresponding points of connection of the struts to button 42. Thus, the cathode 41 is fully restrained against all degrees of freedom by the truss support so that this button is held rigidly in place and is not allowed to sag or become misaligned with respect to the resonators and drift tube 5 in use. The cathode and other leads are taken out through the vitreous tube base 43 and in the shell 2 is mounted at electron collector 45 connected to an external lead 46.

In use, an accelerating voltage is supplied between the cathode 41 and the partition 6 by use of the tube terminals, ground 44 and a suitable potential source, thereby producing a beam of electrons that traverses the resonators 10 and 10' and the drift tube 5 as explained in the aforementioned patent. Where the tube is to be used as an oscillator a concentric line terminal post

29 of the resonator 10 is connected to a similar post of resonator 10' to effect feed-back. Where it is desired to supply an antenna another post of resonator 10' will be connected to such antenna. Where the tube is used as an amplifier the signal to be amplified will be supplied to a concentric line terminal 32-33 connected to resonator 10.

As 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. A high frequency tube structure comprising a pair of hollow resonators having relatively movable flexible walls, and tuning means for producing relative motion between said flexible walls to effect the tuning of said resonators, said tuning means comprising a longitudinally adjustable tapered rod and a thrust member engaging said rod and one of said resonators.

2. A high frequency tube structure comprising a pair of hollow resonators having opposed flexible walls, a drift tube interconnecting said walls, and tuning means carried by said drift tube, said tuning means comprising an adjustable tapered member and thrust means interposed between said tapered member and said resonators, whereby the adjustment of said tapered member effects relative movement of said resonators and distortion of said flexible walls.

3. A high frequency tube structure comprising a pair of hollow resonators having opposed flexible walls, a drift tube interconnecting said walls, spring means interconnecting said resonators and tending to flex said flexible walls toward each other, a support carried by said drift tube and tuning means carried by said support, said tuning means comprising an adjustable tapered member, and struts extending between said tapered member and said resonators for opposing the tension of such springs, whereby the adjustment of said tapered member serves to flex said springs and said flexible walls.

4. High frequency apparatus comprising a hollow resonator, a hollow concentric line terminal post carried by said resonator, and a concentric line terminal within said terminal post comprising an outer conducting tube within said terminal post and an inner conducting lead, said lead terminating short of the outer end of said tube and extending inwardly in the form of a loop beyond the inner end of the tube and into the hollow resonator.

5. High frequency apparatus comprising a hollow resonator, a hollow concentric line terminal post carried by said resonator and a concentric line terminal within said terminal post comprising an outer conducting tube and an inner conducting lead, said lead terminating short of the outer end of said tube and extending inwardly in the form of a loop beyond the inner end of the tube and into the hollow resonator, said loop having its doubled-over end overlying said tube, said terminal post having a longitudinal slot within the cavity thereof accommodating the doubled-over end of said loop, and a seal between the inner portion of said tube and said lead.

6. A mounting for an electrode in a tube struc-

ture comprising a plurality of inclined struts having their ends contiguously joined together in succession, thereby forming a truss having one end connected to said electrode and the other to a part of said tube structure.

7. A mounting for an electrode in a tube structure comprising a plurality of inclined struts having their ends contiguously joined together in succession, thereby forming a truss having one end connected to said electrode and the other to a part of said tube structure, the ends of said truss each providing three points of connection spaced substantially 120 degrees apart, the points of connection of one end of said truss being spaced substantially 60 degrees from corresponding points of connection of the other end thereof.

8. A high frequency tube structure comprising a hollow resonator having a flexible wall portion, means for tuning said hollow resonator comprising an adjustable tapered member, adjusting means in said tube structure for adjusting said member in a plane substantially parallel to said flexible wall portion, and force transmitting means interposed between said tapered member and said wall portion, whereby the adjustment of said tapered member serves to deflect said flexible wall portion to vary the tuning of said resonator.

9. A high frequency tube structure comprising a hollow resonator having a rigid wall and a flexible wall, means for tuning said resonator comprising an adjustable tapered member connected to one of said walls, and thrust means disposed substantially perpendicular to said member and interposed between said tapered member and the other of said walls, whereby the adjustment of said tapered member serves to deflect said walls and vary the tuning of said resonator.

10. A high frequency tube structure comprising a pair of hollow resonators having opposed flexible walls connected by a drift tube, and tuning means for producing relative motion between said flexible walls to effect the tuning of said resonators, said tuning means comprising a longitudinally adjustable tapered rod supported by said drift tube and a thrust member engaging said rod and one of said resonators.

11. A high frequency tube structure comprising a pair of hollow resonators having relatively movable flexible walls and tuning means for producing relative motion between said flexible walls to effect tuning of said resonators, said tuning means comprising an adjustable tapered member and a thrust member engaging said tapered member and one of said flexible walls.

12. A high frequency structure comprising a hollow resonator, a hollow concentric line terminal post carried by said resonator, and a concentric line terminal within said terminal post comprising an outer conducting tube and an inner conducting lead, said lead extending inwardly in the form of a loop beyond the inner end of said tube and into said hollow resonator and being folded back to contact said tube.

13. High frequency terminal means comprising a hollow terminal post having an opening, electrically-conductive means at the inner surface of said terminal post and extending a substantial distance therealong, and means vacuum sealing said opening.

14. High frequency apparatus comprising means defining a hollow resonator chamber adapted to contain an electromagnetic field, a

hollow terminal post on said resonator having an opening affording access to said chamber, 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 a substantial distance therealong, said conductive means being mounted within said post by insertion through the open end of said post, and means vacuum sealing said opening.

15. A coaxial line terminal device for conducting electrical wave energy, comprising a central conductor having an end loop, a hollow terminal post around said conductor having an open end toward said loop and with said loop outside said terminal post, and electrically conductive means at the inner surface of said terminal post bridging the length thereof, and having connection with the end of said loop.

16. A coaxial line terminal device for coupling electrical wave energy with a high frequency device, comprising a central conductor, a hollow terminal post supported by said high frequency device and concentric with and spaced outside said conductor, and an electrically conductive lining member within said terminal post, said conductor, and an electrically conductive lining member within said terminal post, said conductor having a loop contacting said lining member.

17. A concentric line terminal device as in claim 16 further comprising means vacuum sealing said terminal post.

18. High frequency apparatus comprising a hollow resonator, a hollow tubular terminal post carried by said resonator and communicating with the interior thereof, and a concentric line terminal within said terminal post, comprising an outer conducting tube engaged within said terminal post and an inner conducting lead held concentrically of said outer conducting tube and connected therewith by a loop beyond the end of said tube and within said hollow resonator.

19. A high frequency tube structure comprising a hollow resonator having a pair of parallel electron permeable grids, one of said grids being adjustably supported with respect to the other to permit variation of the separation between said grids, and means for tuning said hollow resonator comprising a tapered member mounted on said tube structure for longitudinal adjustment in a plane substantially parallel to said grids, and force transmitting means interposed between said tapered member and said grids, whereby the adjustment of said tapered member serves to vary the separation of said grids to vary the tuning of said resonator.

20. A high frequency tube structure comprising a hollow resonator having a rigid wall portion and a flexible wall portion, an electron permeable grid carried by each of said portions, said grids being disposed in substantially parallel planes, means for projecting a beam of electrons successively through said grids, and means for tuning said hollow resonator, comprising an elongated member having a variable cross-section, means supporting said member rigidly with respect to one of said grids, means in said structure for moving said member with respect to said supporting means in a plane substantially parallel to said grid planes, a flange rigidly connected to the other of said grids, and a thrust member interposed between said flange and said

elongated member and disposed substantially perpendicular to said planes, whereby the adjustment of said first member serves to deflect said flexible wall portion to vary the tuning of said resonator.

21. A high frequency tube structure comprising a hollow resonator having a rigid wall portion and a flexible wall portion, a grid carried by each of said wall portions, and means for relatively varying the separation of said grids, comprising a flange fixed to one of said grids, a tapered member adjustably supported for longitudinal motion in a plane substantially parallel to one of said grids, and a thrust member interposed between said flange and said tapered member for transmitting motion of said tapered member to vary the separation of said grids.

22. A coaxial line terminal device comprising a hollow terminal post and a coaxial line section supported within and contacting substantially the entire portion of the length of said terminal post.

23. A high frequency tube structure comprising a hollow resonator having a rigid wall portion and a flexible wall portion, means for tuning said hollow resonator comprising an adjustable tapered member, adjusting means in said tube structure for adjusting said member in a plane substantially parallel to said flexible wall portion, and force transmitting means interposed between said tapered member and said wall portions and substantially perpendicular to said member, whereby the adjustment of said tapered member serves to deflect said flexible wall portion to vary the tuning of said resonator.

24. High frequency apparatus comprising a hollow resonator having a wall portion movable in a predetermined direction, and means for tuning said resonator, comprising a tuning control member supported on said apparatus for motion in a direction at a substantial angle to said predetermined direction and having a cam bearing surface, and force transmitting means interposed between said surface and said wall portion.

25. High frequency apparatus comprising a hollow resonator having a wall portion movable in a predetermined direction, and means for tuning said resonator, comprising a tuning control member supported on said apparatus for motion in a direction at a substantial angle to said predetermined direction and having a cam bearing surface with portions at differing distances from said wall portion, and force transmitting means interposed between said surface and said wall portion and adapted to transmit a force in a direction substantially perpendicular to the direction of motion of said control member.

26. High frequency apparatus comprising a hollow resonator having a pair of electron permeable wall portions relatively adjustable along a predetermined direction, and means for tuning said resonator, comprising a tuning control member supported on said apparatus for motion in a direction at a substantial angle to said predetermined direction and having a cam bearing surface, and force transmitting means interposed between said surface and one of said wall portions.

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CERTIFICATE OF CORRECTION.

Patent No. 2,345,642.

April 4, 1944.

SIGURD F. VARIAN, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, lines 25, 26 and 27, claim 16, strike out "and an electrically conductive lining member within said terminal post, said conductor,"; and second column, line 21, claim 22, strike out "portion of the"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of June, A. D. 1944.

Leslie Frazer

(Seal)

Acting Commissioner of Patents.