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P. L. SPENCER

ELECTRONIC DISCHARGE DEVICE OF THE CAVITY RESONATOR TYPE

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FIG. 1.

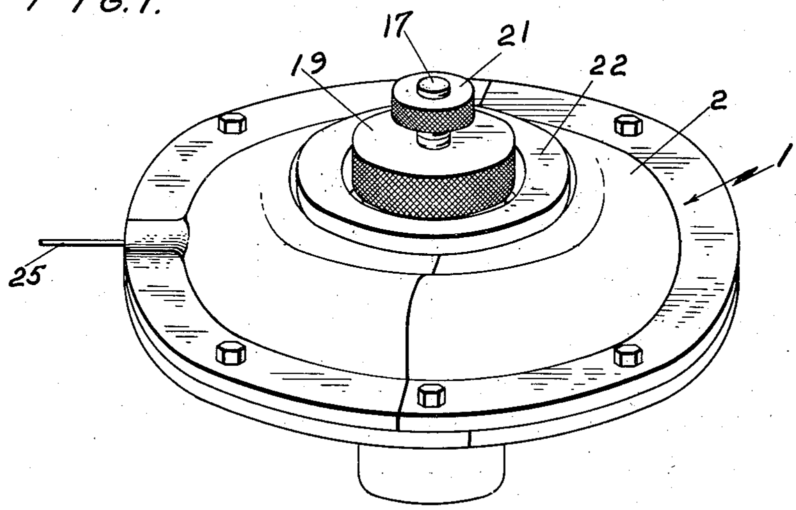
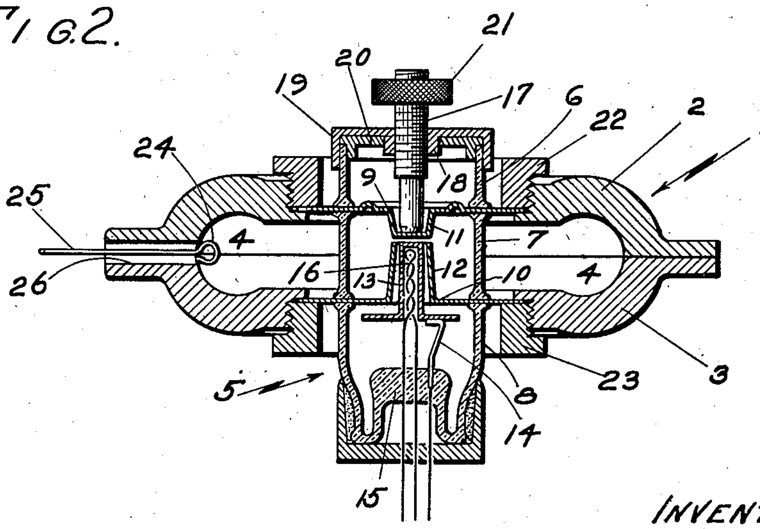


FIG. 2.



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ELECTRONIC DISCHARGE DEVICE OF THE CAVITY RESONATOR TYPE

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13 Claims. (Cl. 315—5)

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This invention relates to electronic discharge devices, and more particularly to devices of the resonant cavity type for generating, detecting and amplifying ultra high frequency oscillations.

In devices of the type to which the invention relates, the electron emission of the cathode is controlled by the oscillations of the cavity to produce spaced groups of electrons. In such devices the electron transit time should not be greater than one-half of the oscillation period, and preferably less than this. The electron transit time depends upon the distance to be traveled by the electrons and the potential of the anode relative to the cathode. Within the range permitted by the limitation upon the electron transit time to one-half the oscillatory period, I have found it desirable to adjust the distance between the cathode and anode and accordingly alter the capacity therebetween and thereby control within said limits the frequency at which the tube is resonant.

A further object of the invention is to provide an improved tube of the type described in which the space required to be evacuated is greatly reduced.

Further objects of the invention are to provide a tube of the type described which is simple in construction and which may be manufactured on a mass production basis with a minimum of skilled labor and which will nevertheless avoid material variations in the operating characteristics, as between tubes of the same design.

The above and other objects and features of the invention will be made fully apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawing in which:

Fig. 1 shows in perspective a tube constructed in accordance with the invention; and

Fig. 2 shows a longitudinal section through the tube of Fig. 1.

Referring to the drawing, the illustrative embodiment of the invention therein shown comprises an annulus 1 of conductive material, which for convenience of manufacture and assembly may be formed in two or more parts including an upper section 2 and a lower section 3. The sections may be secured together in any suitable manner, such as by the bolts shown or by soldering. The sections define therebetween a portion of a resonant cavity 4. Extending through the central opening in the annulus 1 is a glass envelope 5 formed of a plurality of sections 6, 7 and 8. The upper section 6 is separated from

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the intermediate section 7 by a diaphragm 9 of conductive material, such as copper, to which the glass sections 6 and 7 are fused or otherwise rigidly connected. The joint between the intermediate section 7 and the diaphragm 9 constitutes an hermetic seal. The joint between the upper section 6 and the diaphragm 9 is not necessarily an hermetic seal, it being sufficient to provide a rigid connection therebetween. The intermediate section 7 is separated from the lower section 8 by a diaphragm 10, also of conductive material, to which the glass of the sections 7 and 8 is fused to form hermetic seals on each side thereof. The upper diaphragm 9 has a central reentrant portion in the form of a boss 11 projecting downwardly into the intermediate section 7 and terminating in a flat surface to form an anode face. The diaphragm 10 has a central reentrant in the form of a sleeve 12 projecting upwardly into the intermediate section 7 so that the inner end of the sleeve 12 is in close proximity to, but not contacting, the flat face of the boss 11. Within the sleeve 12 is a cathode 13 in the form of a thimble having a flat end face opposing the anode face formed by the boss 11 and having lateral surfaces spaced from the internal walls of the sleeve 12 and forming a capacitance therewith. The lower end of the cathode 13 may also have an outwardly projecting flange parallel with the lower surface of the diaphragm 10 to provide additional capacitive coupling therebetween. A support and cathode lead-in connection 14 is secured to the cathode 13, as by welding, to the flanged end thereof and extends through and is sealed in a press 15 in the lower section 8 to provide an electrical connection between the cathode 13 and the external circuit. A heater filament 16 is provided within the cathode 13 and supported by its lead-in wires, which also extend through and are sealed by press 15.

The distance between the anode face formed by the boss 11 and the cathode 13 may be adjusted by means of an adjustable rod 17 having a reduced end portion rigidly secured within the boss 11 to the diaphragm 9, as by welding. Longitudinal movement may be imparted to the rod 17 by means of a screw-threaded portion on the upper end thereof adapted to coact with internal screw threads and an inwardly projecting annular boss 18 formed on a rotatable end cover 19. The boss 18 is free to rotate in a central opening in an end cap 20, which end cap closes the upper end of the upper section 6 of the envelope 5. The end cover 19 is provided with a knurled rim projecting downwardly therefrom so that the cover may be angularly adjusted by hand. The threads on the rod 17, and the coacting threads in the boss 18, may be relatively fine so that a comparatively large angular movement of the end cover 19 results in only a small longitudinal movement of the rod 17. The diaphragm 9 may be provided with an annular corrugation surrounding the boss 11 to facilitate deformations thereof during the adjustment of the rod 17. When the rod has been adjusted to the desired position, it may be locked in such position by means of a knurled locking nut 21.

An annular clamping nut 22 is provided with external screw threads adapted to coact with internal screw threads in the central opening of the upper section 2 of the annulus 1 to clamp the diaphragm 9 securely against an internal shoulder in the upper section 2. A similar clamping nut 23 is provided for clamping the diaphragm 10 in the lower section 3 of the annulus 1.

A coupling loop 24 is provided in the resonant chamber 4 having one end thereof secured to the interior wall of the chamber, and the other end connected to a wire 25 extending through an opening 26. The wire 25 may be either an input transit line for ultra high frequency oscillations in case that the tube is used as a detector, or it may be an output line when the tube is used as a generator. A concentric line, constructed in the manner known in the art, may be provided, or an open line may be used. Only that portion of the tube enclosed in the lower section 8 and the intermediate section 7 of the envelope 5 need be evacuated. Since by this construction the resonant cavity 4 is not evacuated, the opening 26 need not be sealed.

In the operation of devices of this type, it will be understood that when the device is used as a detector or amplifier, modulated radio frequency energy is received from the line 25 and the coupling loop 24, and is transferred to the resonant cavity 4 to cause the standing waves therein to be correspondingly modulated.

It will be understood that the diaphragms 9 and 10, being electrically connected to the annulus 1, together with the reentrant portions 11 and 12 thereof constitute a part of the oscillatory circuit of the resonant cavity 4. The cathode 13, being capacitively coupled to the diaphragm 10, is also a part of the cavity circuit, and the lines of electric force of the standing waves are at their greatest intensity in the space between the opposing faces of the cathode and anode and in a direction parallel to the path of the electrons therebetween. Variations in the standing waves, due to modulation of the received signal, therefore produce variations in the anode-cathode current, which in turn produce modulation frequency output currents in the external anode-cathode circuit.

As is well-known, the electron transit time in such a device must be less than a half period of the oscillations of the standing waves, and preferably is less than this. It is therefore necessary that the distance between the cathode and the opposed anode face be so correlated to the anode voltage that the electron transit time does not exceed the permitted value. It will be evident that the distance between the cathode and the opposing anode face also affects the capacitance therebetween, and since the cathode is capacitively coupled in the oscillation cavity the distance between the cathode and anode also affects the characteristics of the resonant

cavity. I have found that, by adjusting the distance between the anode face and the cathode, within the limits permitted by the limitation upon the electron transit time, the frequency at which the cavity is resonant may be adjusted.

The construction provides a means for making fine adjustments of the anode face relative to the cathode, and accordingly permits close adjustments of the resonance frequency of the device.

It will be observed that by providing a construction in which that portion of the wall of the resonant cavity electrode which forms the anode face also forms one of the walls enclosing the evacuated space of the tube, the adjustments described in the foregoing may be effected entirely from the exterior of such evacuated space. Tuning rods or other mechanisms within the evacuated space are obviated, as well as the complicated mechanisms and expedients required to effect the movement of such rods within the sealed space from the exterior of the tube.

As is well-known in this art, it is frequently required that two or more tubes, comprising a system or involved in a transmitter and one or more receivers, have substantially identical characteristics. Since slight variations in the manufacture of such devices result in material variations in resonance frequency of the tubes, the manufacture of such devices in quantity ordinarily requires high skill and precision. This greatly retards quantity production and increases the cost of the product.

Devices of the present invention do not require such high precision in the manufacture thereof, particularly with respect to the anode-cathode spacing, but may be constructed of parts requiring relatively little machining and none of this to close tolerances. It is sufficient that the dimensions of the members forming the annulus 1 and the diaphragms 9 and 10 provide an easy approximation to the desired resonance frequency of the cavity defined thereby and, after assembling, the device may be adjusted to the precise resonance frequency desired and locked in the adjusted position.

While the invention has been described by means of a specific embodiment, other embodiments within the scope of the appended claims will be obvious to those skilled in the art from a consideration of the embodiment shown. It will be understood that the parts comprising the annulus 1 may be formed by casting, or since this member need not have the relative thickness shown, the parts thereof may be formed of stampings or in similar manner. The diaphragms 9 and 10 may be attached to the annulus 1 by other means than the clamping nuts shown. It is sufficient that they be electrically connected to the annulus, which connection may be effected by brazing, welding or otherwise.

It will be apparent that certain features of the invention possess utility entirely apart from the important feature of tuning, and that the tuning means possesses utility in connection with some tubes other than the simple diode shown.

What is claimed is:

1. An electronic discharge device comprising a glass envelope, a diaphragm extending transversely through said envelope and having a circumferential portion projecting externally thereof, said envelope being hermetically sealed to said diaphragm on both sides thereof, said envelope having an hermetically sealed space on one side

of said diaphragm, a second diaphragm extending across said envelope on the opposite side of said first-mentioned diaphragm from said space and hermetically sealed to said envelope on the side thereof facing said first-mentioned diaphragm.

2. An electronic discharge device comprising a glass envelope, a diaphragm extending transversely through said envelope and having a circumferential portion projecting externally thereof, said envelope being hermetically sealed to said diaphragm on both sides thereof, said envelope having an hermetically sealed space on one side of said diaphragm, a second diaphragm extending across said envelope on the opposite side of said first-mentioned diaphragm from said space and hermetically sealed to said envelope on the side thereof facing said first-mentioned diaphragm, and means exterior of said space connecting said first-mentioned diaphragm peripherally to said second diaphragm.

3. An electronic discharge device comprising a glass envelope, a diaphragm extending transversely through said envelope and having a circumferential portion projecting externally thereof, said envelope being hermetically sealed to said diaphragm on both sides thereof, said envelope having an hermetically sealed space on one side of said diaphragm, a second diaphragm extending across said envelope on the opposite side of said first-mentioned diaphragm from said space and hermetically sealed to said envelope on the side thereof facing said first-mentioned diaphragm, a cathode positioned in an opening in said first-mentioned diaphragm, and an anode face on said second diaphragm projecting toward said cathode.

4. An electronic discharge device comprising a glass envelope, a diaphragm extending transversely through said envelope and having a circumferential portion projecting externally thereof, said envelope being hermetically sealed to said diaphragm on both sides thereof, said envelope having an hermetically sealed space on one side of said diaphragm, a second diaphragm extending across said envelope on the opposite side of said first-mentioned diaphragm from said space and hermetically sealed to said envelope on the side thereof facing said first-mentioned diaphragm, a cathode positioned in an opening in said first-mentioned diaphragm and capacitively coupled thereto, an anode face on said second diaphragm projecting toward said cathode, and means exterior of said space connecting said first-mentioned diaphragm peripherally to said second diaphragm.

5. An electronic discharge device comprising a glass envelope, a pair of diaphragms extending transversely through said envelope, one of said diaphragms being imperforate and providing an anode face projecting toward the other of said diaphragms, said other diaphragm having an open ended sleeve projecting toward said anode face, a cathode within said sleeve having a face opposing and in close proximity to said anode face, and means electrically connecting said diaphragms exteriorly of said envelope and defining therewith a cavity resonator.

6. An electronic discharge device comprising a glass envelope, a pair of diaphragms extending through said envelope, one of said diaphragms being imperforate and providing an anode face projecting toward the other of said diaphragms, said other diaphragm having an open ended sleeve projecting toward said anode face, a cathode within said sleeve having a face opposing and in close proximity to said anode face, means electrically connecting said diaphragms exteriorly of said envelope and defining therewith a cavity resonator, and means coupled to said imperforate diaphragm for moving said anode face toward and away from said cathode.

7. An electronic discharge device comprising a glass envelope enclosing an evacuated space, a pair of diaphragms extending transversely through said envelope, one of said diaphragms being imperforate and providing an anode face projecting toward the other of said diaphragms, said other diaphragm having an open ended sleeve projecting toward said anode face, a cathode within said sleeve having a face opposing and in close proximity to said anode face, and means electrically connecting said diaphragms exteriorly of said envelope and defining therewith a cavity resonator, said imperforate diaphragm forming one of the walls of the evacuated space of said envelope.

8. An electronic discharge device comprising a glass envelope encircling an evacuated space, a pair of diaphragms extending transversely through said envelope, one of said diaphragms being imperforate and providing an anode face projecting toward the other of said diaphragms, said other diaphragm having an open ended sleeve projecting toward said anode face, a cathode within said sleeve having a face opposing and in close proximity to said anode face, means electrically connecting said diaphragms exteriorly of said envelope and defining therewith a cavity resonator, said imperforate diaphragm forming one of the walls of the evacuated space of said envelope, and means coupled to said imperforated diaphragm exteriorly of said evacuated space for flexing said imperforate diaphragm to move said anode face toward and away from said cathode.

9. An electronic discharge device comprising a glass envelope providing an evacuated space, a pair of spaced electrode elements in said envelope, a cavity resonator surrounding said envelope and providing an enclosed space exterior of said evacuated space of said envelope, said electrodes being electrically connected through said cavity resonator, and means coupled to one of said electrode elements for altering the distance between said spaced electrode elements.

10. An electronic discharge device comprising a glass envelope providing an evacuated space, a pair of spaced electrode elements in said envelope, a cavity resonator surrounding said envelope and providing an enclosed space exterior of said evacuated space of said envelope, said electrodes being electrically connected through said cavity resonator, and means coupled to one of said electrode elements externally of said evacuated space for altering the distance between said spaced electrode elements.

11. An electron discharge device including an evacuated container enclosing means for developing an electron stream, means defining a cavity resonator for modulating said electron stream, said cavity resonator having a wall exterior of said evacuated chamber and a second wall constituting a wall of said evacuated chamber, and means coupled to said wall of said evacuated chamber on the exterior of said evacuated chamber for flexing said wall of said evacuated chamber to tune the cavity resonator.

12. In combination with an elongated hollow conductive structure adapted to function as a guide for electricity of ultra-high frequency, an

electron discharge device coupled to said guide structure and comprising a hollow body resonator, opposed anode and cathode elements enclosed thereby, and means for flexing a wall of said resonator to simultaneously tune the same and adjust the gap between said electrode anode and cathode elements.

13. An electron discharge device comprising a hollow body resonator, opposed anode and cathode elements enclosed thereby, means for flexing a wall of said resonator to simultaneously tune the same and adjust the gap between said anode and cathode elements, and means adjacent one of said elements for initiating the passage of current therebetween.

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