June 29, 1948. H. J. McCARTHY 2,444,303

ULTRA HIGH FREQUENCY ELECTRONIC TUBE

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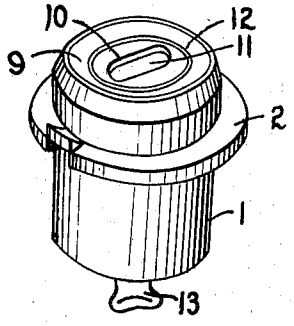


Fig. 1

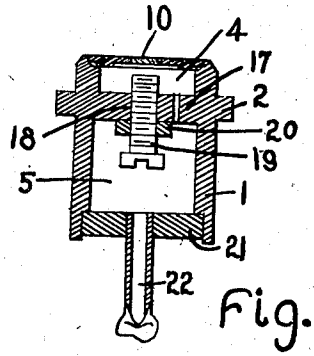


Fig. 4

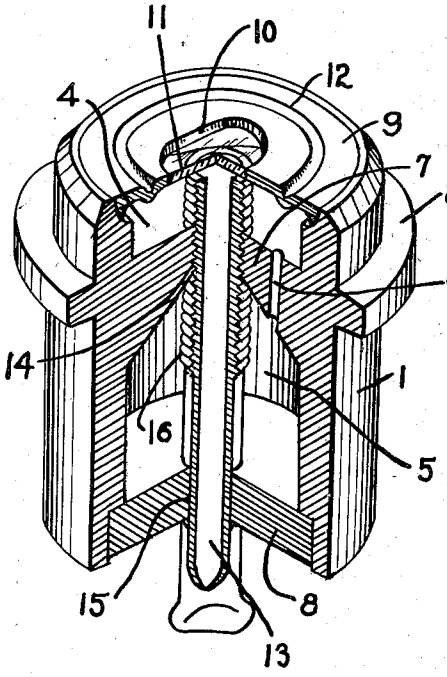


Fig. 2

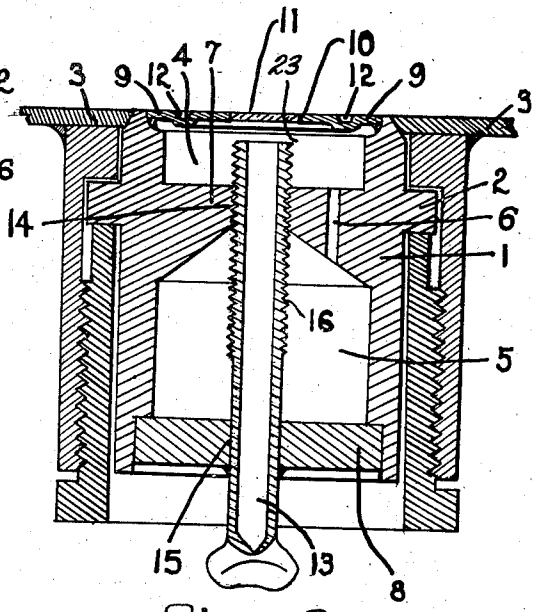


Fig. 3

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ULTRA HIGH FREQUENCY ELECTRONIC TUBE

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6 Claims. (Cl. 315—5)

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This invention relates to electronic tubes of the type known as resonators or gas switching tubes and more particularly to tubes of this type particularly adapted for mounting directly in the wall of a wave guide or for coupling with other circuit elements of small dimensions.

An object of the invention is to facilitate production of tubes of the type indicated, economically in large volume with a uniformly high degree of precision.

A further object of the invention is to provide a tube in which an accurate mechanical adjustment is provided for obtaining preadjustment of tuning to the required frequency.

A further object of the invention is to provide a tube in which the resonating elements are of small dimensions and may readily be received within the limited confines of a wave guide system or other restricted space.

A further object of the invention is to provide a tube in which the coupling window is built into the tube in rigid gas tight relationship and thereafter is never subjected to disrupting shocks or stresses as might be encountered in a subsequent tuning or other operation.

Other objects and features of the invention will appear more fully from the following description in connection with the accompanying drawings and will be particularly pointed out in the claims.

To present a better understanding of the invention a particular embodiment thereof will be described and is illustrated in the drawings in which:

Figure 1 is a perspective view of a preferred embodiment of the invention;

Figure 2 is a detail perspective partly in section;

Figure 3 is a central vertical section through the tube; and

Figure 4 is a central vertical section illustrating a different embodiment of the invention.

The tube desirably is generally cylindrical in shape and its envelope 1 is provided with an attaching flange 2 for convenience in mounting. The method of mounting the tube in the wall of a wave guide 3 is illustrated in Figure 3. The tube may, however, be coupled in any suitable manner to its associated circuit elements.

The envelope 1 may be made of any suitably conductive metal and may be electroplated upon at least a portion of its surface with a highly conductive metal such as silver. The envelope is divided into two chambers, a resonator chamber 4 and a gas reservoir chamber 5 both of

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which desirably are cylindrical in form and concentric with the axis of the tube. In the completed and adjusted tube both chambers are evacuated and charged with a small amount of argon or other similar gas. Communication between the chambers is established by a small aperture 6 formed in the wall 7 between the chambers 4 and 5.

The chamber 5 is closed at its end by a metallic plug 8 for example, of copper which is sealed into the end of the body 1 by a brazing operation or other similar sealing means. The chamber 4 is closed by a metallic plate 9 having a coupling channel 10 therein which is in turn made impermeable to gas and permeable to electromagnetic waves by fusing a glass window 11 therein.

The construction of the plate 9 and window 10 may desirably follow that disclosed in a copending U. S. application Serial No. 537,145, filed May 24, 1944, by the present applicant, entitled Ultra high frequency electronic tube. The plate 9 is provided with an annular expansion area 12 wherein excessive stresses developed by thermal expansion in the tube are absorbed thus protecting the glass window from rupture.

The resonating system of which the chamber 4 is a part is completed by a hollow conductor 13 which projects into the chamber in substantial axial alignment with the aperture 10 and close to it.

The conductor 13 desirably is disposed axially in the chamber 4 and passes through an aperture 14 in the dividing wall 7 and also through an aperture 15 in the plug 8 from where it projects a short distance externally of the tube thus providing for connection to a pump for exhausting the tube. Other means may be provided, however, for exhausting the tube.

Mechanical means are provided for tuning the tube by adjusting the separation between the conductor 13 and the plate 9. Any suitable means may be employed for this purpose. The means shown in the drawings has been found to be very satisfactory. The conductor 13 is provided with screw threads 16 and the aperture 14 is provided with complementary threads. By rotating the tube within the aperture therefore accurate tuning of its resonant system may be obtained.

To complete the tube it is connected in a suitable testing circuit and its resonant frequency is adjusted to the desired degree by rotating the conductor 13. The conductor is then soldered or otherwise tightly sealed into the plug 8. An

exhaust pump is then connected to the conductor to obtain the required degree of vacuum in the chambers after which a small quantity of argon or similar gas is introduced. The conductor is then sealed off as in the case of a conventional exhaust tube.

The mechanical means employed to tune the tube may be of any suitable construction. A desirable modified structure is shown in Figure 4. In this form of the invention the envelope 1 is substantially the same as that described above, and a similar coupling window 10 is provided in one end thereof. The space within the envelope is divided into a resonating chamber 4 and a gas reservoir chamber 5 by a dividing wall 17 having a threaded aperture 18 therein within which is received an adjustable electrode in the form of a screw 19 having a locknut 20 thereon which bears against the wall.

A plug of metal such as a copper disc 21 is provided for closing the outer end of the tube.

In this form of the device the tube is first assembled with the exception of the disc 21. The tube is then tuned to the desired frequency by adjusting the screw or electrode 19 and when correct tuning is obtained the lock nut 20 is tightened to fix the screw or electrode 19 in position. The disc 21 is then sealed in position to close the envelope after which the tube is exhausted. The exhausting operation may be carried out in any manner. As shown in the drawing an exhaust pipe 22 extends through the disc 21 and provides the means for evacuating the tube. After properly exhausting and gassing, the tube is completed by sealing off the pipe 22 in the usual manner.

In operation the end of the tube containing the resonating chamber is coupled to a wave guide or other circuit element in the usual or any suitable way. As shown in Figure 3 the tube is fixed in position with its coupling window flush with the wall of a wave guide 3.

When a tube thus installed is subjected to a microwave electric current having a frequency corresponding to its resonant frequency, oscillations are set up in its resonating system. The fundamental factors determining the resonant frequency of the tube are the dimensions of its coupling window and the depth of the cavity in the chamber 4. In designing a tube for a predetermined purpose these factors are so chosen that without its tuning electrode 13 the tube's resonant frequency will be slightly higher than that desired. When the tuning electrode 13 is subsequently installed and adjusted the overall frequency of the tube is reduced to that which is desired.

One of the valuable functions of the tube is its ability to pass a high powered charge of current and to stop a relatively minute current. This feature is used in an apparatus wherein a high-powered charge of ultra high frequency current is projected into a wave guide or other conductor to be radiated into the atmosphere for detection of a distant reflective object. In which case it is desired to stop the reflected wave in the wave guide. When the high power current reaches the tube its oscillating system becomes ionized and a discharge takes place across its discharge gap 23. The discharge amounts to a substantial short circuit of the tube which renders it inoperative. A relatively minute reflected impulse of current however, fails to ionize the tube which consequently functions to effectively stop the impulse.

What I claim is:

1. An ultra high frequency resonator tube comprising a body of conductive material having a cavity resonator therein, one wall of said resonator having an aperture therein for coupling with other devices, a window in said aperture permeable to electromagnetic waves and impermeable to gas, a combined conductor and exhaust tube passing through and electrically conductive with said body and projecting into said resonator, said tube terminating closely adjacent the wall containing said aperture and being adjustable longitudinally to vary its distance from said wall and means locking said tube permanently in adjusted position.

2. An ultra high frequency resonator comprising an envelope of electrically conductive material having a cavity resonator therein, a coupling channel in one wall of said envelope communicating with said resonator, a window in said channel pervious to electromagnetic waves and impervious to gas, a metallic combined conductor and exhaust tube extending into said resonator through said envelope terminating closely adjacent said wall and coacting therewith to form the capacitive portion of the resonator and being adjustable toward and from said wall thereby to vary the resonant frequency of the resonator.

3. An ultra high frequency resonator tube comprising an envelope of electrically conductive material having a cavity resonator therein, a coupling channel in said envelope leading into said resonator, a window in said aperture pervious to electromagnetic waves and impervious to gas, a combined metallic electrode and exhaust tube extending from outside the envelope through its wall into said resonator and terminating adjacent said coupling aperture, said exhaust tube being axially adjustable, means sealing said tube in gas tight relation to said envelope in its adjusted position and means sealing off the outer end of said tube.

4. An ultra high frequency resonator tube comprising an envelope of electrically conductive material having a cavity resonator at one end, a coupling channel in the wall of said resonator, a window in said channel pervious to electromagnetic waves and impervious to gas, a combined metallic electrode and exhaust tube extending from outside said envelope through its wall opposite said aperture into said resonator and terminating adjacent said aperture, screw threads on said tube coacting with complementary threads in the wall through which it passes to provide axial adjustment of the tube, means sealing the tube in the envelope and locking it in adjusted position and means sealing off the outer end of the said tube.

5. An ultra high frequency resonator tube comprising a cylindrical envelope of electrically conductive material having a cavity resonator therein, a coupling channel in one end face of said envelope communicating with said resonator, a window in said channel pervious to electromagnetic waves and impervious to gas, a combined conductor and exhaust tube extending from outside said envelope, through its other end wall, into said resonator and terminating adjacent said channel, screw threaded means on said exhaust tube for axially adjusting said conductor, means sealing the conductor in said envelope and in adjusted position and means sealing off said tube at its outer end.

6. An ultra high frequency resonator tube comprising an envelope of electrically conductive material substantially cylindrical in form, a cavity

resonator in one end thereof and a gas reservoir in its other end, said resonator and said reservoir being both filled with inert gas, a metallic separating wall between said resonator and said reservoir, a coupling channel in the outer wall of said resonator, a window in said channel pervious to electromagnetic waves and impervious to gas, a combined metallic electrode and exhaust tube extending from outside said envelope, through said separating wall, into said resonator and terminating adjacent said window, screw-threads on said exhaust tube where it passes through said separating wall for axially adjusting said electrode, means sealing said electrode in said envelope in adjusted position and means sealing off its outer end.

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