

Aug. 22, 1944.

E. G. LINDER

2,356,414

TUNABLE RESONANT CAVITY DEVICE

Filed Feb. 26, 1941

Fig. 1.

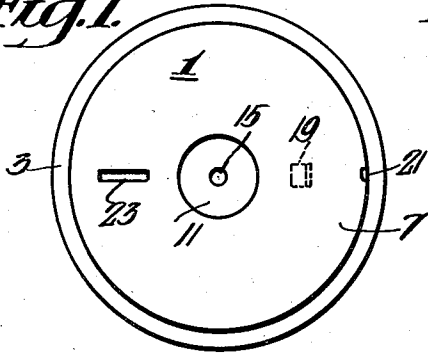


Fig. 3.

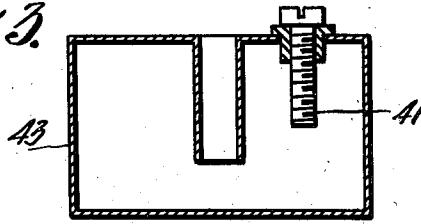


Fig. 2.

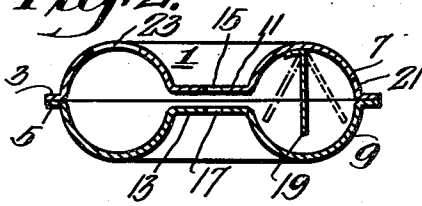


Fig. 4.

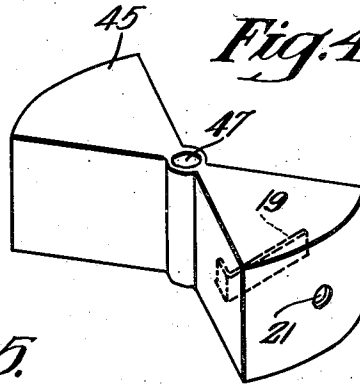


Fig. 5.

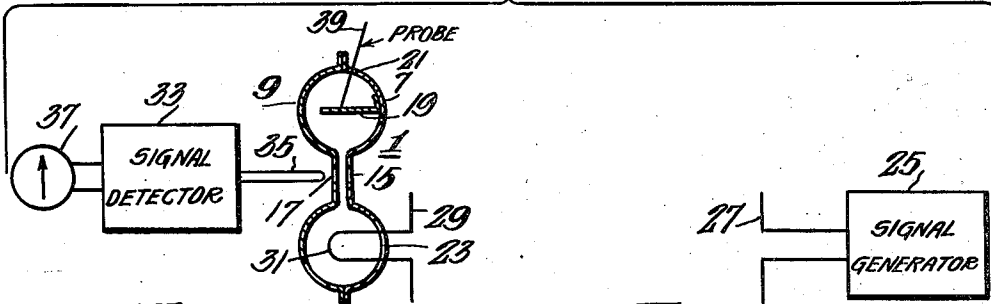


Fig. 6.

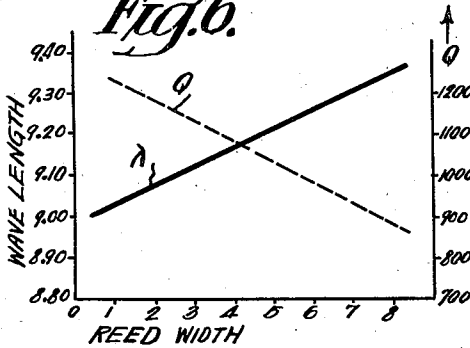
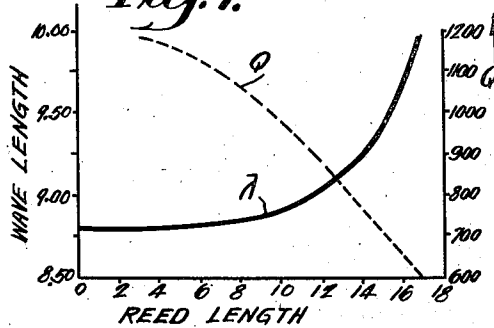


Fig. 7.



Inventor

Ernest G. Linder

33

J. J. Juff
Attorney

UNITED STATES PATENT OFFICE

2,356,414

TUNABLE RESONANT CAVITY DEVICE

Ernest G. Linder, Philadelphia, Pa., assignor to
Radio Corporation of America, a corporation of
Delaware

Application February 26, 1941, Serial No. 380,675

4 Claims. (Cl. 178-44)

This invention relates to resonant cavity devices and especially to tunable resonant cavity devices and the method of adjusting said devices to a predetermined resonant wave length or frequency.

Resonant cavities have been made in the form of a hollow torus with provision for deforming the torus to adjust its resonant frequency. Resonant cavities of hollow cylindrical form have been made with a movable end wall for frequency adjustment. In either case, if the form of the cavity has been designed for a maximum ratio of reactance to resistance (which is known as Q), the deformation may substantially decrease the Q and thereby render the cavity less efficient.

The present invention has for one of its objects the provision of means for tuning a resonant cavity. Another object is to provide means for adjusting the Q and the resonant frequency of a cavity. Another object is to provide means for adjusting the frequency of a resonant cavity without altering its external dimensions or shape. An additional object is to provide an improved method of adjusting a resonant cavity to a predetermined frequency.

The invention will be described by referring to the accompanying drawing in which Figures 1 and 2 are elevational and sectional views, respectively, of a resonant cavity embodying the invention; Figs. 3 and 4 are sectional and perspective views, respectively, of modifications of the invention; Fig. 5 is a schematic diagram illustrating the method of adjustment; and Figs. 6 and 7 are graphs illustrating characteristics of the resonant cavities of the invention. Similar reference characters are applied to similar elements in the drawing.

Referring to Figs. 1 and 2, a hollow torus 1 is formed by welding, brazing, soldering or otherwise joining the outer flanges 3, 5 of a pair of conductive shells 7, 9. The inner flanges 11, 13 are spaced apart and include apertures 15, 17. A conductive reed 19 is secured to the inner wall of the cavity. The reed is preferably positioned so that its broader side is normal to the radius of generation of the torus. The width and breadth of the reed are substantially less than the length of the waves to be resonated within the carrier.

By way of example, if the maximum internal diameter of the torus is 4.5 centimeters and the internal cross sectional diameter 1.7 centimeters, the reed may be about .4 centimeters wide, 1.7 centimeters long, and 0.1 millimeter thick. The area of the reed is of the order of 2% of the area of the cavity. A small hole 21 is pierced in the

shell near the reed so that a probe may be inserted to adjust the reed as hereinafter described. Appropriate coupling means, shown in Fig. 5, may be inserted through an aperture 23.

The method of adjusting the cavity to a predetermined frequency or Q will be described by referring to Fig. 5. A signal generator 25 including an antenna 27 is arranged to induce currents of the desired frequency in a receiving antenna 29. The receiving antenna includes a coupling loop 31 which is inserted into the cavity of the device 1 to be adjusted. A detector element 33 is coupled by a probe antenna 35 inserted in the central aperture 17 of the cavity. The detector, which may be a thermocouple, is connected to an indicator 37.

Having adjusted the signal generator so that waves of the desired frequency are applied to the cavity, the reed 19 is bent back and forth by means of a probe 39 until the maximum indication shows that resonance is established. By way of example, in a device of the dimensions given above, the resonant wave length may be varied from 9.2 centimeters to 10.1 centimeters by bending the reed to the left and right of the position shown in Fig. 2, as indicated by the broken lines. In practice, the reed may be bent at the hinge or bent on itself.

Instead of employing a reed, a metallic screw 41 may be threaded within the cavity as shown in Fig. 3. It should be understood that the cavity cross-section is not limited to any specific form. The cavity may have a rectangular cross-section 43 as shown in Fig. 3. Or the cavity may consist of two or more sector-shaped elements 45 connected to a split cylinder 47 as shown in Fig. 4.

The theory of operation is not easily explained and, although not necessary to an understanding of the invention, the following is offered as a tentative explanation: The reed or other adjustable element is a part of a circuit which is very closely coupled to the inner shell of the cavity. The circuit including the adjustable element, being closely coupled and having a wave length of the general order of the natural period of the cavity, will react on the cavity to change its resonant response. The graphs of Figs. 6 and 7 show respectively the effect of varying the width and length of the adjustable element upon the Q and wave length of the cavity.

Thus, the invention has been described as a resonant cavity device in which the wave length or frequency response is adjusted by a movable element which is adjusted within the cavity. By energizing the cavity with waves of the desired

length, the element is moved, bent, or lengthened or otherwise adjusted until the maximum response is obtained. The method is applicable to cavities of different shape and may be used to adjust the response over a range of wave lengths or to a desired Q.

I claim as my invention:

1. A tunable resonant cavity device including a pair of conductive shells joined together to form a hollow torus, and a conductive reed including a hinge portion secured to the inner wall of one of said shells and having its width dimension normal to the axis of rotation of said torus and movable about said hinge portion within said torus to vary the field distribution therein and thereby adjust its resonant frequency of response to applied radio waves.

2. A resonant cavity device including a conductive shell bounding a cavity of substantially toroidal shape, and a conductive reed member electrically contacting said shell and adjustable by bending within said toroidal cavity for varying the field distribution therein and thereby adjusting the resonant response to a predetermined frequency within a range of radio frequencies.

3. A resonant cavity device including a conductive shell having the shape of a surface of revolution of substantially toroidal form, a conductive reed element secured to the inner wall of said shell and extending in its major dimension substantially parallel to the directrix of said surface of revolution and lying in a plane perpendicular to a line from said directrix to said reed, said shell having an aperture adjacent said reed whereby a probe member may be inserted to deform said reed and thereby adjust the frequency of resonance of said resonant cavity.

4. A resonant cavity device including a conductive shell, means for applying radio frequency energy to said shell to establish a radio frequency field therein, a conductive reed including a hinge portion secured to the wall of said shell and extending within said shell with its longitudinal dimensions parallel to the electric vector of said field adjacent said reed, and means for adjusting the position of said reed about said hinge portion to vary the resonant characteristics of said cavity device.

ERNEST G. LINDER.