March 21, 1961 L. A. BROCKWELL ET AL 2,976,500

TUNING SECTION

Filed Oct. 29, 1957

2 Sheets-Sheet 1

Fig. 1.

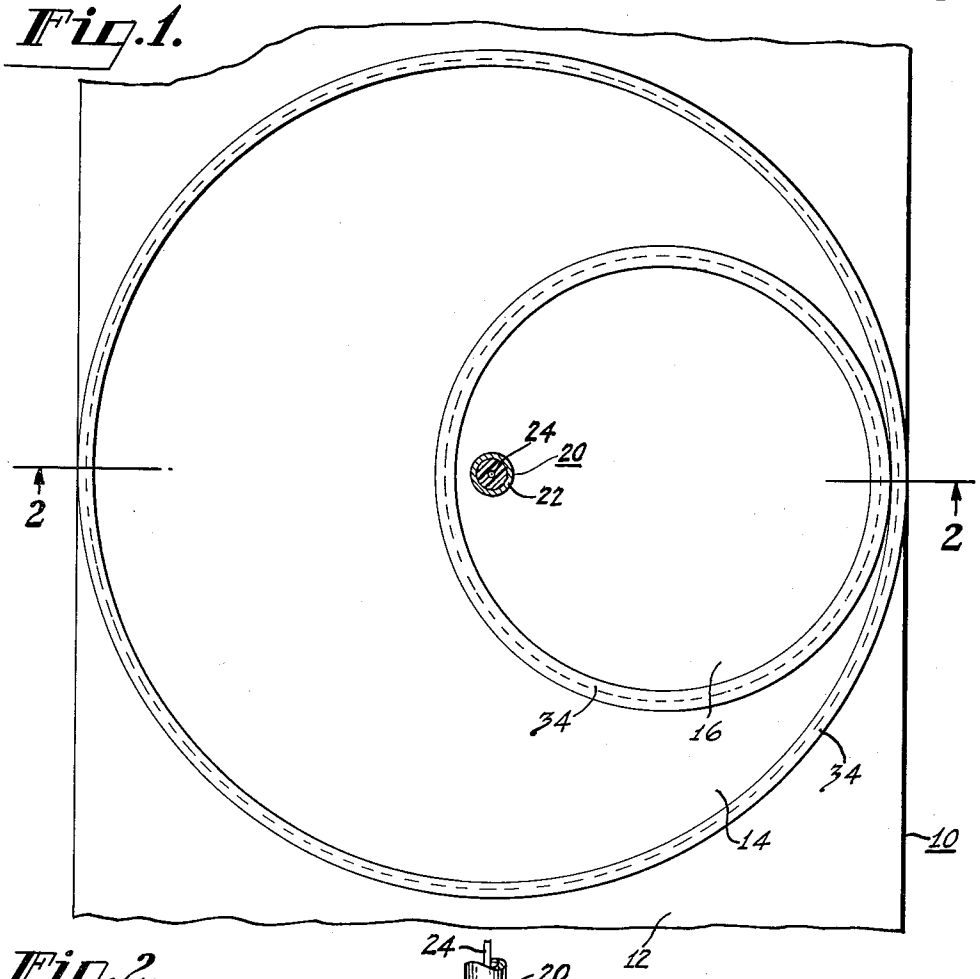
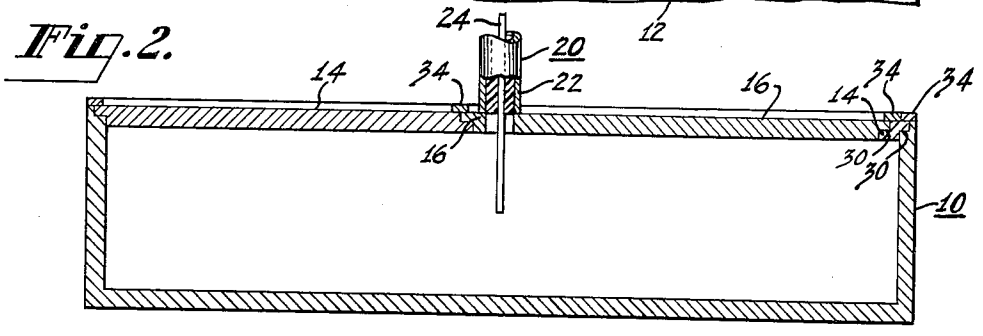


Fig. 2.



INVENTORS
LLOYD A. BROCKWELL
& JOSEPH J. MATTA
BY
Charles H. Brown
ATTORNEY

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2 Sheets-Sheet 2

Fig. 3.

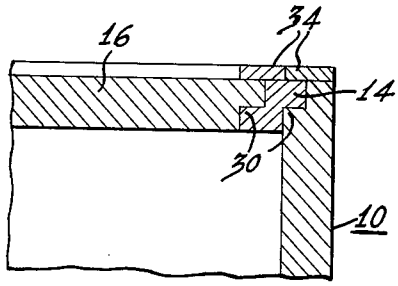
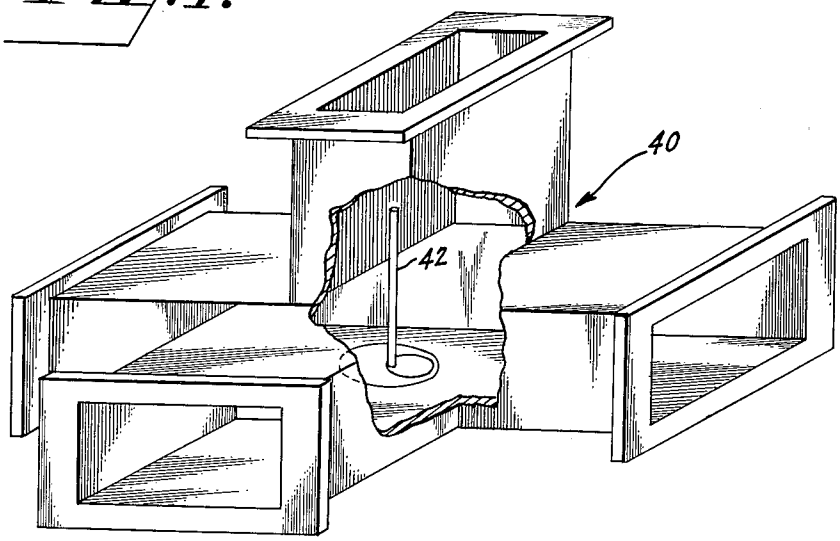


Fig. 4.



INVENTORS
LLOYD A. BROCKWELL
BY & JOSEPH J. MATTA
Charles H. Brown
ATTORNEY

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TUNING SECTION

Lloyd A. Brockwell, Moorestown, and Joseph J. Matta, Audubon, N.J., assignors to Radio Corporation of America, a corporation of Delaware

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4 Claims. (Cl. 333—11)

The invention relates to a tuning section for a waveguide or a cavity resonator, and has for an object to provide a tuning section that permits a probe-like element to be readily placed in any one of a very large number of positions in the resonator or the waveguide with a minimum of radio frequency leakage therefrom.

The invention is intended to be used with a cavity resonator or with a waveguide having at least one flat wall having a circular opening. A first circular plate that has a diameter substantially equal to the diameter of the circular opening is rotatably fitted in the circular opening. The first plate also has a circular opening, this circular opening encompassing an area which includes the center of the first plate and being eccentrically positioned in the first plate. A second circular plate that has a diameter substantially equal to the diameter of the circular opening in the first plate is rotatably fitted in the circular opening in the first plate. A probe-like coupling or tuning element is positioned at a point on the second plate that coincides with the center of the first plate for one position of rotation of the second plate. By a proper rotation of the two plates, it is possible to position the probe-like element at any point corresponding to any one of an infinite number of positions of the plates within the circumference of the first plate. The plates may be rotatably fastened in their respective openings so that substantially no discontinuity is presented in the waveguide wall. Thus leakage of radio frequency energy from the cavity resonator or the waveguide is reduced to a minimum.

The invention is explained in detail in connection with the accompanying drawing, in which:

Figure 1 shows a plan view of a rectangular cavity resonator or a waveguide having a tuning section in accordance with the invention;

Figure 2 is a transverse cross-sectional view taken along the lines 2—2 in Figure 1;

Figure 3 is an enlarged view of a portion of Figure 2 that shows the details of mounting the plates of the tuning section in their respective openings; and

Figure 4 shows a hybrid junction utilizing a tuning section in accordance with the invention.

The invention is intended to be used with a cavity resonator or with a waveguide having at least one flat metallic wall, such as the rectangular structure 10 shown in Figures 1 and 2. A circular opening is made in one metal wall 12 of the resonator or waveguide 10, it being preferred that this circular opening be symmetrically positioned in the transverse direction of the wall 12. A first circular electrically conductive metal plate 14, having a diameter substantially equal to the diameter of the opening in the wall 12, is positioned in the opening in the wall 12. The first plate 14 has a circular opening, the area of which includes the center of the first plate 14. This last circular opening is eccentrically positioned in the first plate 14. A second electrically conductive circular metal plate 16, having a diameter substantially equal to the diameter of the opening in the first plate 14,

is positioned in the opening in the first plate 14. A probe-like element, such as the inner conductor of a coaxial transmission line 20, is fastened to the second plate 16 at a point that coincides with the center of the first plate 14 for one position of rotation of the second plate 16. The transmission line 20 has an outer conductor 22 which is connected to the second plate 16, and an inner conductor 24 which passes through an opening in the second plate 16 at the point already mentioned so that the inner conductor 24 extends into the interior of the waveguide 10. While Figures 1 and 2 show a coaxial transmission line 20, it will be appreciated that any probe-like element, such as an inductive or capacitive probe (depending upon the length of the probe), can be fastened to the second plate 16 instead of the coaxial transmission line 20. The exact dimensions of the probe and its shape are determinable from electrical considerations.

The first and second plates 14, 16 are preferably made of the same electrically conductive material as the structure 10, and preferably have the same thickness as the wall 12 so as to introduce a minimum of discontinuity to radio frequency energy propagated in and through the waveguide 10. The first and second plates 14, 16 are designed to fit in their respective openings with just enough clearance so that the plates 14, 16 may be rotated and still present a substantially smooth and unbroken surface to the wall 12 of the waveguide 10. It will be seen that a proper combination of positions of either or both of the two plates 14, 16 makes it possible to position the coaxial transmission line 20 at any point within the circumference of an imaginary circle almost as large as the first plate 14. Thus, the coaxial transmission line 20 may be coupled to the interior of the waveguide 10 at any desired point within this imaginary circle without introducing a discontinuity in the waveguide 10, such as would be introduced by an elongated slot. If the plates 14, 16 are snugly fitted in their respective openings, a minimum of radio frequency energy will leak through the small clearance space between the plates 14, 16 and their openings.

Figure 3 is an enlarged view of a portion of Figure 2, and shows one way in which the plates 14, 16 may be mounted in their respective openings so as to provide a minimum of discontinuity and leakage in the waveguide 10. Each of the openings is provided with a small shoulder-like rim or flange 30 that extends around each of the circumferences of the openings. The plates 14, 16 are provided with a corresponding depression or groove so that each of the plates 14, 16 fits in its respective opening. When the plates 14, 16 are placed in their respective openings, they rest on the shoulders of their respective rims or flanges 30. Each of the plates 14, 16 may then be held in position by circular rings or seals 34 which cover the outer junction of the plates 14, 16 and their respective openings. Thus, an integral, electrically conductive junction may be provided for the plates 14, 16 and their openings.

Figure 4 shows a hybrid junction 40 utilizing a tuning section in accordance with the invention. Hybrid junctions are known in the art, and an explanation of them may be found beginning on page 339 of "Waveguide Transmission" by Southworth, 3rd printing, 1956, D. Van Nostrand Company, Incorporated. Generally, a hybrid junction may have a discontinuity due to mismatch of loads. These discontinuities are obviated by means of an appropriate compensating susceptance usually in the form of one or more appropriately positioned rods or probe-like elements positioned within the junction. These rods act either as a shunt inductance or as a shunt capacitance. While two rods or probe-like elements are generally needed, only one rod 42 is shown

in Figure 4 in the interests of clarity. As mentioned by Southworth in the above reference, the exact position of the rods is usually arrived at by empirical means, or by experimentation. If the two plates of the tuning section described in connection with Figures 1, 2, and 3 are placed in an appropriate wall of the hybrid section 40, and the rod 42 fastened to one plate, the location of the rod 42 may be varied. Thus, the tuning section of the invention provides a simple, yet effective means for positioning the rod within the hybrid section 40 in the best location after the hybrid section 40 is constructed and connected into operating apparatus.

While the tuning sections of the invention have been described in connection with probe-like elements which are fastened to a tuning section at only one end, it will be appreciated that two tuning sections, one being positioned in one wall of a waveguide and the other being positioned at a corresponding position in an opposite wall, can be used with a probe connected between the two tuning sections. Such an arrangement requires that the two tuning sections be rotated simultaneously and in the corresponding manner and directions.

The term probe, as used in the specification and claims, is deemed to include any rod-like element or wire, an electrically conductive loop, or any conductive structure which can be used to affect radio frequency energy in a waveguide or cavity structure or to couple energy to or from such a waveguide or cavity structure.

The invention claimed is:

1. A tuning section for a cavity resonator or a waveguide having at least one substantially flat wall, said wall having a circular opening therein, comprising a first circular plate having a diameter substantially equal to the diameter of said circular opening and being adapted to rotatably fit in said circular opening, said first plate having a circular opening eccentrically positioned therein, a second circular plate having a diameter substantially equal to the diameter of said circular opening in said first plate and being adapted to rotatably fit in said circular opening in said first plate, and means for attaching a probe-like element to said second plate so as to extend into the interior of said waveguide.

2. A tuning section for a cavity resonator or a waveguide having at least one substantially flat wall, said wall having a circular opening therein, comprising a first circular plate having a diameter substantially equal to the diameter of said circular opening and being adapted to rotatably fit in said circular opening, said first plate having a circular opening therein eccentrically positioned in said first plate and the area of which includes the center of said first plate, a second circular plate having a diameter substantially equal to the diameter of said circular opening in said first plate and being adapted to rotatably fit in said circular opening in said first plate, a tuning element fastened to said second plate so as to extend into the interior of said waveguide, said tuning element being positioned at a point on said second plate that coincides with the center of said first plate for one position of rotation of said second plate, and means for fastening said second plate in said opening in said first plate so that said second plate may rotate therein.

3. A tuning section, comprising a rectangular waveguide, one wall of said waveguide having a circular opening symmetrically positioned therein in the transverse direction, a first circular plate having a diameter substantially equal to the diameter of said circular opening and being adapted to rotatably fit in said circular opening, said first plate having a circular opening therein eccentrically positioned in said first plate and the area of which includes the center of said first plate, means for fastening said first plate in said opening in said wall so that said first plate may rotate therein, a second circular plate having a diameter substantially equal to the diameter of said circular opening in said first plate and being adapted to rotatably fit in said circular opening in said first plate, a probe fastened to said second plate and extending into the interior of said waveguide, said probe being positioned at a point on said second plate that coincides with the center of said first plate for one position of rotation of said second plate, and means for fastening said second plate in said opening in said first plate so that said second plate may rotate therein.

4. In combination with a hybrid junction, said hybrid junction comprising a plurality of waveguides which are intercoupled at a common point, and said junction having at least one substantially flat wall having a circular opening therein, a first circular plate having a diameter substantially equal to the diameter of said circular opening and being adapted to rotatably fit in said circular opening, said first plate having a circular opening eccentrically positioned therein, the area of which includes the center of said first plate, a second circular plate having a diameter substantially equal to the diameter of said circular opening in said first plate and being adapted to rotatably fit in said circular opening in said first plate, and a probe-like element attached to said second plate so as to extend into the interior of said hybrid junction, said probe-like element being positioned at a point on said second plate that coincides with the center of said first plate for one position of rotation of said second plate.

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