Feb. 28, 1956 P. R. BELL, JR 2,736,868

CAVITY TUNER

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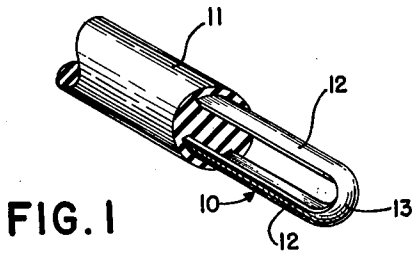

FIG. 1

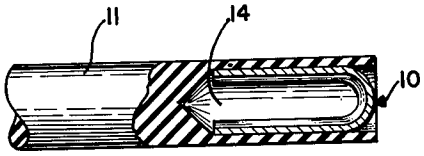

FIG. 2

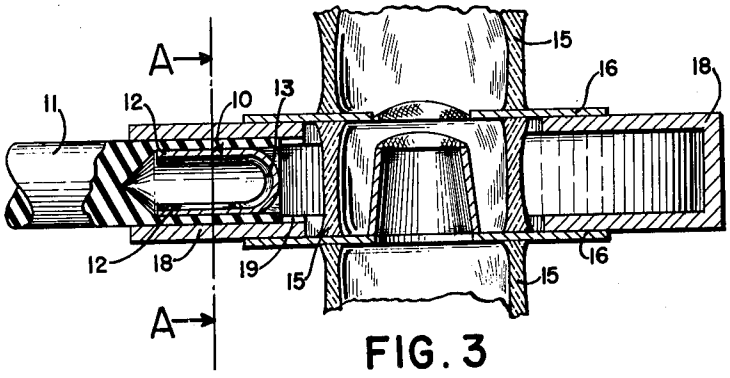

FIG. 3

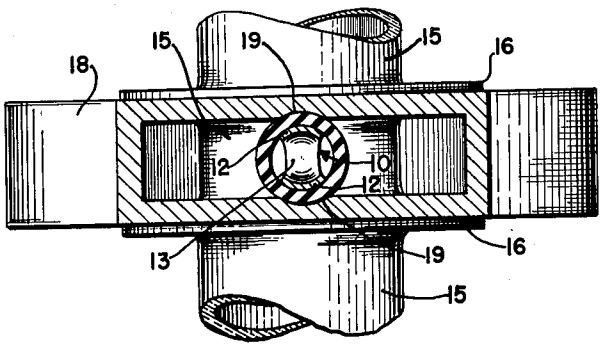

FIG. 3-A

INVENTOR
PERSA R. BELL, JR.

M. O. Hayes

BY

ATTORNEY

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CAVITY TUNER

Persa R. Bell, Jr., Cambridge, Mass., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

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13 Claims. (Cl. 333—83)

This invention relates to high frequency capacitive structures and more particularly to variable capacitive devices employed for the purpose of tuning cavity resonators.

Heretofore, capacitive structures when employed for cavity tuning have not offered a wide tuning range and at the same time been simple in construction and in operation.

A specific object of this invention is to provide a tuning element capable of controlling the frequency of a cavity resonator over a wide range of values.

Another object is to provide a tuning element which can tune a savity resonator over a wide frequency range and with a motion which is both simple and susceptible to calibration so as to allow the device to be employed for such band switching operations as are common in the electronic art.

A further object is to provide a tuning element which can easily be adapted to the wobbulation of the frequency of a cavity resonator.

A further object is to provide a tuning element which is simple both in construction and in operation.

With these objects in view, a cavity tuning element has been devised comprising a dielectric rod slideably inserted into a hole provided in a wall of a cavity to be tuned, a small metallic fitting, capacitive in nature, being mounted on that end of the rod disposed within the cavity. The resonant frequency of the cavity is adjusted by control of the depth of insertion and/or the angle of rotation of the capacitive fitting.

The structural details and features of the present invention are described in the following specification and shown in the accompanying drawing of which:

Fig. 1 is a perspective view of one form of the invention;

Fig. 2 is a cut away view of another form of the invention;

Fig. 3 is a cut away view of the structure of the invention inserted in the resonant cavity of a high frequency oscillator; and

Fig. 3A is another sectional view of the apparatus taken along line A—A of Fig. 3.

Referring to the drawing and more specifically to Fig. 1, metallic fitting **10** is shown disposed on an end of rod **11** which may be made of a dielectric material such as polystyrene. As shown, said fitting **10** is U-shaped, having two cylindrically curved walls **12** joined by a curved end piece **13**. The shape of the fitting **10** may vary somewhat over that shown in Fig. 1, but is designed to have a large tuning effect and to be non-resonant within the frequency range over which the structure is to be used.

In Fig. 1, the fitting **10** is merely pressed into or glued to the end of rod **11**. A more secure means of attaching fitting **10** to rod **11** is provided by the device of Fig. 2. Herein a recess **14** is made in an end of rod **11**, said recess **14** being cylindrically shaped to receive the fitting **10** as shown.

Fig. 3 is a cut away view showing the tuning structure of Fig. 2 inserted into the cylindrical resonant cavity **18** of a McNally oscillator. Fig. 3A is another sectional view of the same structure. As is well known, the cavity **18** of a McNally oscillator is external to the glass seals **15** and is electrically connected to the internal structure of the tube by metallic disks **16**.

A hole is drilled radially into the cylindrical cavity **18** and midway between the top and bottom of said cavity. This hole is made large enough to receive the rod **11**, and any of a number of well-known supporting and clamping structures may be employed to hold and allow positioning of the rod **11**.

As is clearly shown in Fig. 3A, the walls **12** of the fitting **10** form two cylindrical capacitors with the surfaces **19** of the cavity **18**. These two capacitors are connected effectively in series by the end piece **13** of the fitting **10** (Fig. 3), and their magnitude is controlled by the depth of insertion and the angle of rotation of the fitting **10**. The end piece **13** of the fitting contributes only a negligible inductive effect, and the capacitance between the walls **12** of the fitting **10** is small.

The rod **11** functions principally as the position controlling means of the tuning element, but with the structure of Fig. 2, also serves as the dielectric medium of the two variable capacitors formed.

In the apparatus of Figs. 3 and 3A, the resonant frequency of the cavity **18** is lowered by the introduction of the tuning element of this invention. Maximum tuning effect is had when said element is fully inserted and when angularly positioned as shown in Fig. 3A.

A form of the invention comprises a cavity resonator having a multiplicity of capacitive tuning devices of the type shown in Fig. 1. The tuning means of this invention is obviously not limited to application to McNally cavities alone.

It will be apparent to those skilled in the art that the resonant frequency of the cavity structure shown in Fig. 3 may be wobbulated in any number of ways such as by continuous or back and forth rotation of the rod **11** about its longitudinal axis, or by an in and out motion of the rod **11** relative to the cavity **18**. It can also be seen that the tuning structure of Fig. 3 can be calibrated in terms of frequency and that said device may be adapted to the discontinuous switching from one resonant frequency to another.

The invention described in the foregoing specification need not be limited to the details shown, which are considered to be illustrative of only one form the invention may take. What I desire to secure by Letters Patent and claim is:

1. In combination, a tuning element comprising a cylindrical dielectric rod having a U-shaped capacitive member fixedly secured to one end thereof, and a cylindrical cavity resonator having conducting wall surfaces, the distance between the top and bottom inside surfaces of said cavity being slightly less than the diameter of said dielectric rod, a hole having a diameter slightly greater than that of said dielectric rod being disposed radially in said cavity and midway between the top and bottom walls thereof, said dielectric rod being slideably engaged in said hole so as to support said U-shaped capacitive member inside said cavity.

2. A tuning element for a cavity resonator comprising, a conductive member substantially in the form of a hollow cylinder having one open end and one end closed by a substantially hemispherical surface, said conductive member being formed with two diametrically opposed slots extending from said open end of said cylinder to points adjacent said closed end of said cylinder, said slots extending in a direction substantially parallel to the axis

of said cylinder, a dielectric rod, the axis of said rod being coincident with the axis of said cylinder, said dielectric rod being mechanically secured to said conductive member, and means for supporting said dielectric rod so that at least a portion of said conductive member reciprocates within said cavity resonator.

3. A tuning element for a cavity resonator comprising, a conductive U-shaped member having two substantially parallel sidepieces and a curved endpiece joining said two sidepieces, said two sidepieces being in the form of curved, elongated strips lying on a common cylindrical surface, said sidepieces being disposed diametrically opposite each other, a cylindrical dielectric rod, said U-shaped member being secured to an end of said dielectric rod with the axis of said cylindrical surface coincident with the axis of said dielectric rod, and means associated with said cavity resonator for supporting said dielectric rod with said U-shaped member at least partially within said cavity resonator, said supporting means being adapted to permit predetermined adjustive movement of said U-shaped member relative to said resonator.

4. In combination, a cavity resonator having first and second spaced conductive end walls, a portion of each of said end walls being formed to conform to the surface of a circular cylinder, said cylinder having an axis extending between said walls and substantially parallel thereto and a tuning element, said tuning element comprising a conductive member substantially in the form of an elongated, hollow, circular cylinder having one open end and one curved, closed end, said conductive member being disposed in spaced relationship to said cylindrically formed portions of said end walls with the axis of said conductive member coincident with the axis of said cylindrically formed portions of said end walls, said conductive member being formed with two diametrically opposed slots extending parallel to the axis thereof from said open end to points adjacent said closed end, said tuning element further comprising a dielectric rod secured to said conductive member, said dielectric rod being slidably and rotatably supported by said cavity resonator.

5. In combination, a cavity resonator having first and second spaced conductive end walls, a portion of each of said end walls being formed to conform to the surface of a first circular cylinder, said cylinder having an axis extending between said walls and substantially parallel thereto, and a tuning element, said tuning element comprising a conductive U-shaped member having two substantially parallel sidepieces and a curved endpiece joining said two sidepieces, said two sidepieces being in the form of curved, elongated strips lying on a second cylindrical surface having an axis coincident with the axis of said first cylindrical surface, the diameter of said second cylindrical surface being smaller than said diameter of said first cylindrical surface, said sidepieces being disposed diametrically opposite each other, a cylindrical dielectric rod, said U-shaped member being secured to an end of said dielectric rod with the axis of said rod coincident with the axis of said second cylindrical surface, said dielectric rod being slidably and rotatably supported by said cylindrical portions of said end walls.

6. In combination, a cavity resonator having first and second spaced conductive end walls, a portion of each of said end walls being formed to conform to the surface of a first circular cylinder, said cylinder having an axis extending between said walls and substantially parallel thereto, and a tuning element, said tuning element comprising an elongated cylindrical dielectric member slidably received said cylindrically shaped portions of said end walls, said dielectric member being formed with a cylindrical axial opening therein at the end thereof extending between said end walls, and a conductive U-shaped member disposed within said cylindrical opening in said dielectric member, said conductive member being formed with two substantially parallel sidepieces and a curved endpiece joining said two sidepieces, said two sidepieces being in the form of curved, elongated strips conforming to the circumference of said cylindrical opening in said dielectric member, said sidepieces being disposed diametrically opposite each other, said closed end of said U-shaped member being disposed adjacent to the end of said dielectric member extending between said end walls.

7. A tunable cavity resonator comprising a resonating chamber formed by two, spaced, substantially parallel, conductive end plates and a conductive wall member joining said end plates to enclose the volume therebetween, the spacing between said plates being substantially less than at least one lateral dimension of said end plates, a portion of each of said end plates being formed to conform to the surface of a circular cylinder, said cylinder having an axis extending between said end plates and substantially parallel thereto, and a tuning element extending through said wall member and into said resonating chamber, said tuning element comprising an elongated, cylindrical dielectric member, slidably and rotatably received between said cylindrically shaped portions of said end plates, said dielectric member being formed with a cylindrical axial opening therein at the end thereof extending within said resonating chamber, and a conductive U-shaped member disposed within said cylindrical opening in said dielectric member, said conductive member being formed with two substantially parallel sidepieces and a curved endpiece joining said two sidepieces, said two sidepieces being in the form of curved, elongated strips conforming to the circumference of said cylindrical opening in said dielectric member, said sidepieces being disposed diametrically opposite each other, said closed end of said U-shaped member being disposed adjacent to the end of said dielectric member within said resonating chamber.

8. In combination, a cavity resonator having first and second spaced conductive end walls, a portion of said end walls being formed to conform to the surface of a circular cylinder, said cylinder having an axis extending between said walls and substantially parallel thereto, first and second conductive members disposed in spaced juxtaposition with said cylindrically formed portions of said first and second end walls, respectively, means supporting said members in said juxtaposed position, said supporting means being adapted to permit lateral movement of said members with respect to said cylindrically formed portions and rotational movement of said members about said axis, and means conductively coupling said two members.

9. A tuning element for a cavity resonator comprising, a conducting U-shaped member, the legs of said U-shaped member having curved surfaces lying along a common cylinder, the bight of said U-shaped member also having a curved surface, and a dielectric rod having a cylindrical axial recess in one end thereof, said U-shaped member being disposed within said recess with its bight adjacent the open end of said recess.

10. A tuning element for a cavity resonator comprising, a cylindrical dielectric rod, an axial recess in one end of said rod, and a U-shaped conductive member positioned within said recess, whereby the arms of said U-shaped member and the walls of said cavity resonator form two series connected capacitors, the material of said rod functioning as the dielectric medium in said capacitors.

11. In combination, a resonant cavity having a pair of spaced walls, tuning means for said resonant cavity comprising, a U-shaped member forming with said spaced walls two series capacitors, and means for rotatably and reciprocally mounting said U-shaped member, said means comprising polystyrene material enclosing said U-shaped member and serving as the dielectric in said capacitors.

12. A tuning element for a cavity resonator comprising a polystyrene rod, an axial recess in one end of said rod, and a conductive U-shaped member positioned within said recess, the legs of said U-shaped member conforming to the inner wall of said recess and the bight of said

U-shaped member lying adjacent the open end of said recess.

13. In combination, a resonant cavity, tuning means therefor comprising, a U-shaped member forming with the walls of said cavity two series connected capacitors, and means mounting said U-shaped member for rotational and translational movement to thereby vary the frequency of said cavity.

References Cited in the file of this patent

UNITED STATES PATENTS

2,226,479	Pupp	Dec. 24, 1940
2,262,020	Llewellyn	Nov. 11, 1941
2,280,824	Hansen	Apr. 28, 1942
2,401,489	Lindenblad	June 4, 1946
2,417,542	Carter	Mar. 18, 1947
2,442,671	Tompkins	June 1, 1948
2,513,205	Roberts	June 27, 1950