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TUNABLE CAVITY RESONATOR

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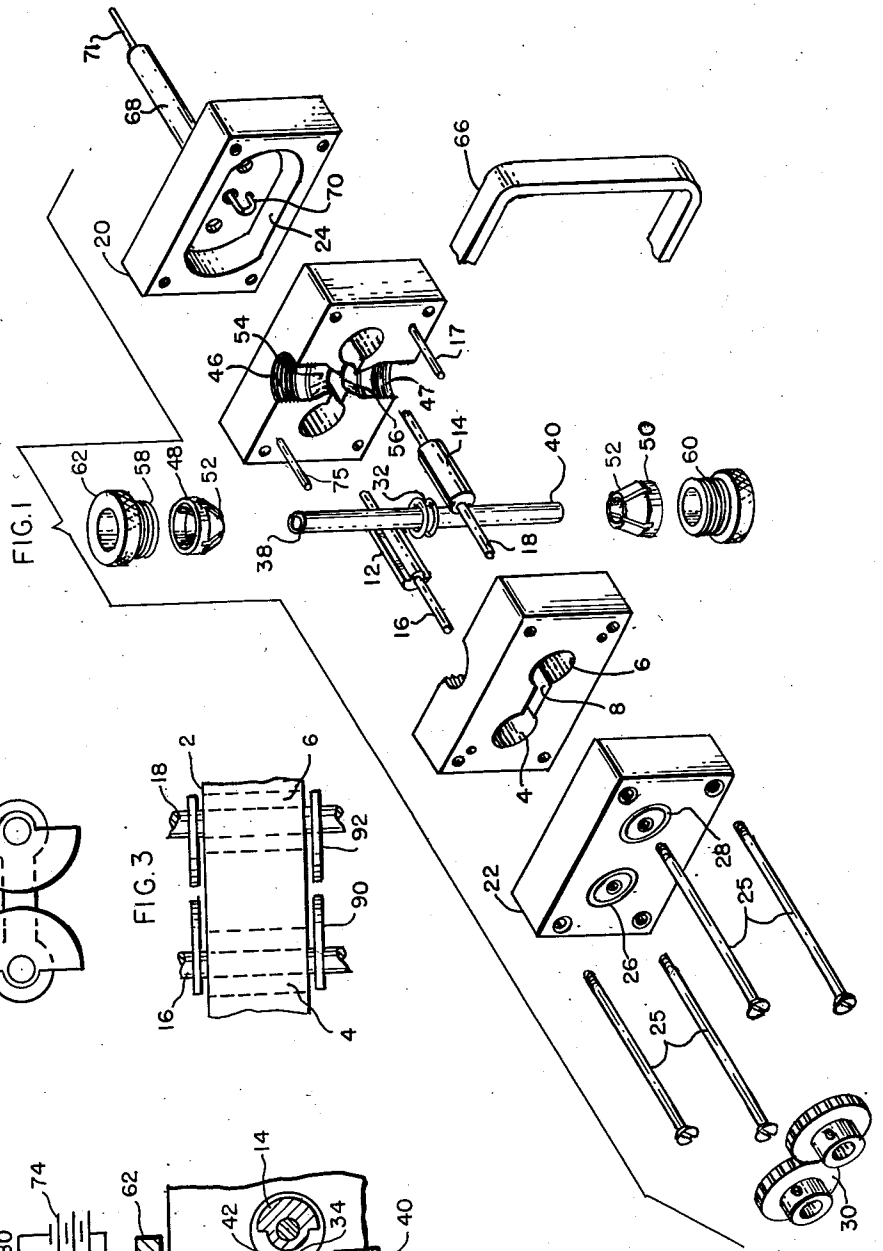


FIG. 1

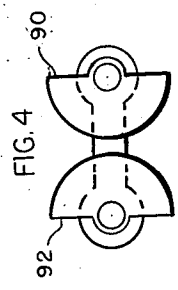


FIG. 4

FIG. 3

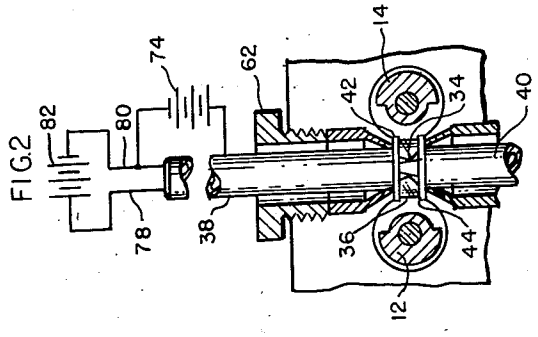


FIG. 2

INVENTOR.
BEVERLY D. KUMPFER

BY
Harry M. Saragovitz
ATTORNEY

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TUNABLE CAVITY RESONATOR

Beverly D. Kumpfer, Spring Lake Heights, N. J., assignor to the United States of America as represented by the Secretary of the Army

Original application September 5, 1950, Serial No. 183,222, now Patent No. 2,720,628, dated October 11, 1955. Divided and this application October 3, 1952, Serial No. 313,619

3 Claims. (Cl. 333—83)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment of any royalty thereon.

This application is a division of application Serial No. 183,222, filed September 5, 1950, now Patent No. 2,720,628.

This invention relates to arrangements for tuning an electromagnetic resonator of the cavity type and more particularly to resonators applicable to microwave apparatus.

One of the objects of the present invention is to provide a cavity resonator at ultra-high frequencies having improved tuning means for controlling the frequency of the resonator.

Another object of the present invention is to provide suitable means for tuning a resonant cavity through a wide range of frequency.

It is a further object of my invention to provide a resonant cavity having dynamically balanced tuning means.

It is a further object of my invention to provide broad range tuning means employing rotary elements to achieve a rapid rate of tuning.

For a better understanding of the invention together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings in which:

Fig. 1 is an oblique exploded view of a resonator embodying my invention;

Fig. 2 is a partial elevational view in section of the device shown in Fig. 1;

Fig. 3 shows another illustrative embodiment of my invention; and

Fig. 4 is an end view of the device shown in Fig. 3.

Although the invention is illustrated as it may be applied to a microwave oscillator of the magnetron type, it is to be understood that the invention is not limited thereto.

Referring now to Figs. 1 and 2, there is shown a cavity resonator **2** including cylindrical cavities **4** and **6** having mutually opposed slots linked by a slot linking channel **8** to form a hole-and-slot linking channel type resonating cavity. The surfaces of slot **8** are flat as illustrated in the drawing. Although cylindrical cavities **4** and **6** are shown as having circular end surfaces, it is to be understood that other shaped end surfaces may be used.

For tuning the resonator there are provided a pair of semi-cylindrical tuning rotors **12** and **14** made of brass or other suitable non-ferrous metal, rigidly mounted on rotatable axial shafts **16** and **18** respectively. Rotor **12** is coextensive with the cylindrical wall of cavity **4** and, similarly, rotor **14** is coextensive with the cylindrical wall of cavity **6**. The diameters of said rotors are slightly less than the diameter of the cylindrical cavities **4** and **6** in which they are contained. Shaft **16** is centrally positioned within cavity **4**, and extends therethrough. Similarly, shaft **18** is centrally positioned within cavity **6**.

It can readily be seen that, by this arrangement, the rotors are free of contact from the cavity walls. For sealing cavities **4** and **6**, there are provided end plates **20** and **22** having a hollowed chamber **24** to provide electromagnetic coupling between said cavities. As shown, end plates **20** and **22** are secured to resonator **2** by bolts **25**, or any other suitable means.

To support shafts **16** and **18** in position, each of said end plates are provided with a pair of appropriately spaced bearings **26** and **28** through which shafts **16** and **18** are extended. Any suitable means, such as gear mechanism **30** may be used for simultaneously rotating shafts **16** and **18** from outside the resonator. To offset the possibility of excessive vibration which might occur if the tuning elements were rotated simultaneously in the same direction, it is preferable, though not required, to rotate shafts **16** and **18** in opposite directions, so that when tuning element **12** is rotated clockwise, element **14** is simultaneously rotated counter-clockwise.

To more fully exlain how the invention is to be embodied in an oscillator, an interdigital type magnetron **32** is shown centrally positioned within the resonator. The interdigital type magnetron is well known in the art and does not form a part of my invention. Interdigital anode **34** and the associated cathode (not shown) are centrally positioned across slot linking channel **8** and are sealed in evacuated cylinder **36**. Anode **34** is supported between upper tubular structure **38** and lower tubular structure **40**, said tubular structures being integral with said anode. Each of said tubular structures include upper and lower flanges **42** and **44** sealed respectively to opposite ends of cylinder **36**. Supporting structure **38** extends axially through upper threaded aperture **46** and supporting structure **40** extends axially through lower threaded aperture **47**. It can readily be seen that the operating frequency of magnetron **32** is effected by the resonant characteristics of the external resonator formed by cavities **4** and **6** and slot linking channel **8**.

In order to prevent a substantial loss of radio frequency energy, it is desirable to maintain good radio frequency contact between magnetron **32** and the walls of cavities **4** and **6** at the base of upper and lower apertures **46** and **47** respectively. For this purpose contact sleeves **48** and **50** are respectively provided in said upper and lower apertures. One end of each of said sleeves converges and is longitudinally slotted to form contact fingers **52**. The converging portion of said sleeves are received in sloping flanges **54** and **56** which form the respective bases of upper and lower apertures **46** and **48**.

For firmly holding contact fingers **52** in position against magnetron flanges **42** and **44**, threaded bushings **58** and **60** are provided. Bushing **58** which is provided with a flanged knurled head **62**, is threaded into upper aperture **46** to forcibly engage with the rim of sleeve **48**, thereby providing the pressure to hold said contact fingers firmly in position. For holding contact fingers of sleeve **50** in position, bushing **60**, similar in structure to bushing **58**, is provided in lower aperture **48**.

As indicated in Fig. 1 the resonator may be formed in several parts which are symmetrical about a transverse axis in order to facilitate the assembly of the magnetron and the resonator. Guiding pins **75** and **77** are provided to properly align both halves of resonator **2**.

As is customary in the art, magnet **66** is arranged in cooperative relationship with the magnetron to provide an axial magnetic field substantially parallel to the cathode of magnetron **32**.

A suitable output connection for extracting high frequency energy from the resonator is provided by a concentric transmission line including an outer conductor **68** and an inner conductor **71** culminating in a looped portion **72** extending into the hollowed chamber **24** of

end plate 20. Coupling the output in this manner reduces the tendency to introduce distortion in the electric field generated in the resonating cavity by the magnetron.

In the operation of the device described, a steady magnetic field is applied by means of a magnet 66. A potential difference between the anode and cathode of magnetron 32 may be provided in any suitable manner and is represented here for simplicity as a battery 74, the positive terminal of which may be connected to the casing of the magnetron and grounded as at 76. Heating current may be supplied to the cathode through the conductors 78 and 80 from a suitable source such as battery 82, the cathode being heated directly or indirectly as desired.

Electrically, the resonating cavity is the equivalent of a parallel resonant circuit comprising two inductors and a capacitor. Cavities 4 and 6 correspond to the inductors, and slot linking channel 8 corresponds to the capacitor. Using this analogy, it can readily be seen that rotors 12 and 14 act as permeable tuners for cavities 4 and 6. With the rotors in the relative position illustrated in Fig. 2, the lowest amount of inductance is present, hence the resonator frequency is at a maximum. With the rotors 180° out of the position shown in Fig. 2, the inductance will be a maximum and the capacitance across slot 8 will also be a maximum. Hence, in this position the resonant frequency of the resonator is at a minimum. By rotating the elements at a predetermined rate, it can readily be seen that the resonator frequency can be smoothly varied from one extreme to the other.

Figs. 3 and 4 illustrate another embodiment of my invention. The same elements of Figs. 1 and 3 are represented by the same reference numerals. As shown in Fig. 3, semi-cylindrical rotor plates 90 and 92 are mounted on shafts 16 and 18 respectively at opposite ends of cavities 6 and 4 and are equally spaced therefrom. It is desirable that rotor plates 90 and 92 have a diameter substantially greater than the diameter of said cavities. It is also desirable that the rotor plates be free of contact with each other as they are rotated. For reasons hereinbefore stated, each pair of plates are simultaneously rotated in opposite directions by any suitable means to vary the resonant characteristics of the resonator 2.

While there has been described what is at present

considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A resonator adapted to operate at microwave frequency energy comprising a first and second cylindrical cavity, the cylindrical walls of each of said cavities having mutually opposed circumferentially spaced axial slots, a channel linking said slots, means terminating the ends of said cavities for coupling electromagnetic energy from one of said cavities to the other, a first axial rotatable shaft centrally positioned in said first cavity, a second axial rotatable shaft centrally positioned in said second cavity, a first pair of tuning plates mounted on said first axial shaft such that the first cavity is intermediate said first pair of plates, a second pair of tuning plates mounted on said second axial shaft such that the second cavity is intermediate said second pair of plates, and means for simultaneously rotating said first and second shafts in opposite directions whereby the relative positions of said plates with respect to said cavities and said channel vary the resonant characteristics of said resonator.

2. The resonator as defined in claim 1 wherein said plates are semi-cylindrical.

3. The resonator as defined in claim 1 wherein the diameters of both pairs of said tuning plates are substantially greater than the diameters of said cylindrical cavities and are equally spaced from the opposite ends of said cavities.

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