

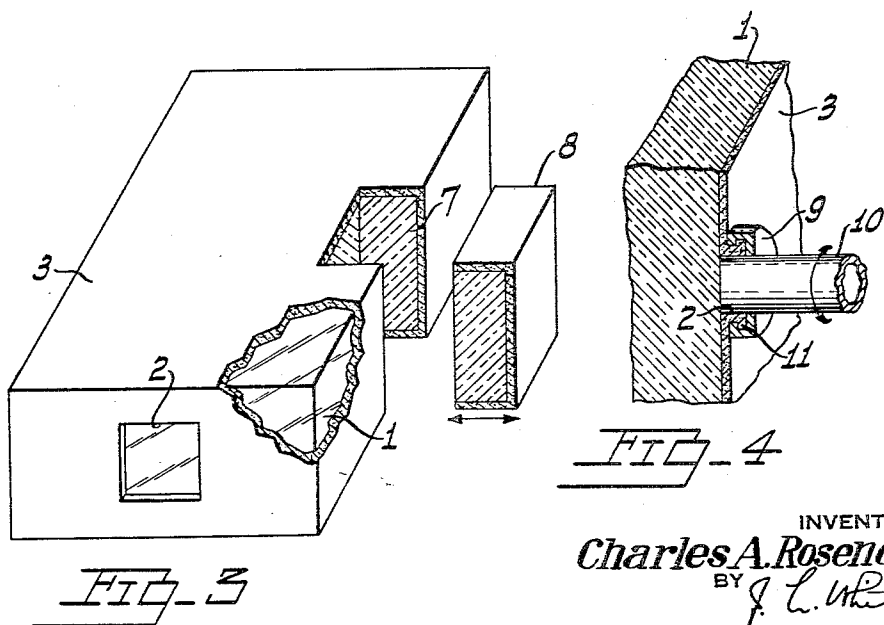
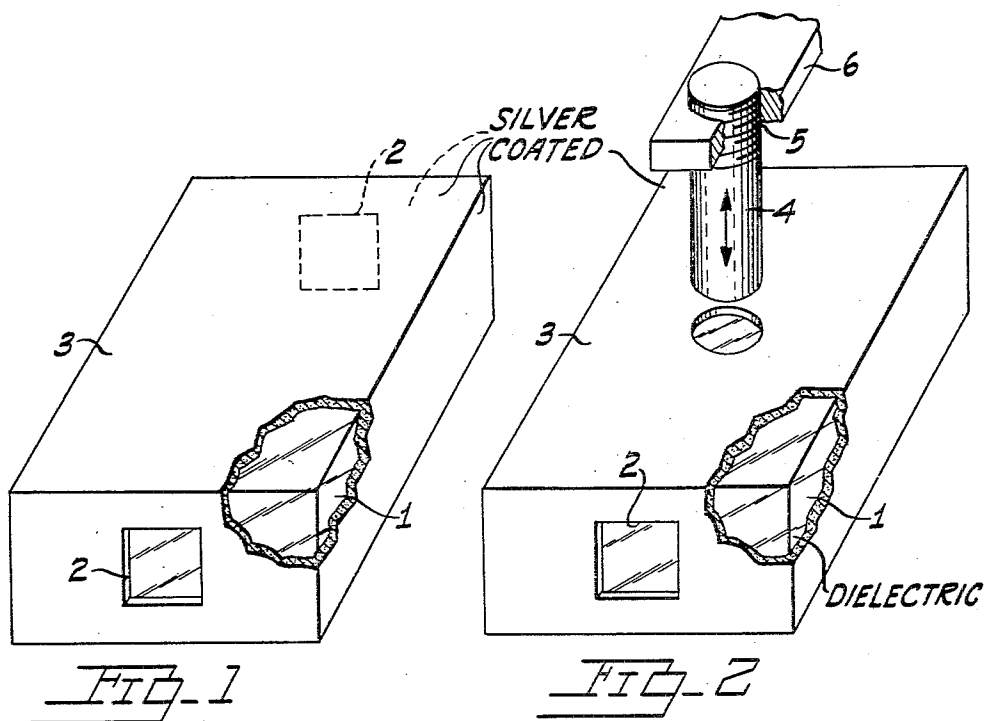
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TUNING MEANS FOR DIELECTRIC FILLED CAVITY RESONATORS

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TUNING MEANS FOR DIELECTRIC FILLED CAVITY RESONATORS

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This invention relates to cavity resonators and particularly to such cavity resonators used in the microwave region.

The conventional cavity resonator used in the microwave region, for example 7,000 mc., consists of a hollow cylinder or rectangular box. The walls of the cavity resonator are made of some metal, such as copper, brass or invar. As the oscillating currents are of high frequency, the inner surfaces are usually covered by a low resistance metal, such as silver. The conventional hollow cavity resonators, however, are expensive to make as they must be air- and moisture-tight, otherwise their stability is low when subjected to changes in temperature and humidity under operating and stand-by conditions and when exposed to wide ranges in temperature and humidity in localities in which microwave equipment is used.

The principal object of this invention is to provide a cavity resonator of improved stability.

Another object of the invention is to provide a cavity resonator in which the dielectric is a solid.

Another object of the invention is to provide a cavity resonator with a solid dielectric and capable of adjustment in its resonant frequency by orientation of the cavity with respect to the exciting field.

Another object of the invention is to provide a cavity resonator with a solid dielectric and capable of adjustment in its resonant frequency by adjustment of the area of the dielectric coupling the cavity and the exciting microwave field.

Another object of the invention is to provide a cavity resonator with a solid dielectric and capable of adjustment in its resonant frequency by varying the effective volume of the solid dielectric.

Another object of the invention is to provide a resonant cavity with a solid dielectric and capable of adjustment in its resonant frequency by bringing an exposed area of the dielectric into adjustable field-coupled relation with an external tuning element.

Other objects will be apparent from the description of the invention as hereinafter set forth in detail and from the drawing made a part hereof in which:

Figure 1 is a view in perspective of a solid dielectric cavity resonator according to the invention;

Figure 2 is a view in perspective of such a solid dielectric cavity resonator with a portion of the metal coating of the dielectric removed and an external solid tuning element in adjustable field-coupling relation to the dielectric of the cavity; and

Figure 3 is a view in perspective of a solid dielectric cavity resonator having a portion of the dielectric cut away for the insertion, removal or adjustment in position of a metallic or separate solid dielectric having a dielectric constant either the same as or different from the dielectric constant of the material forming the principal dielectric part of the cavity; and

Fig. 4 illustrates a different means for adjusting or varying the resonant frequency of such a cavity resonator by changing the orientation of the electric field vectors of energy coupled into the resonator.

Similar reference characters are applied to similar elements throughout the drawings.

Referring to Figure 1, a cavity resonator unit consisting of a rectangular block 1 of a solid low loss dielectric, such as fused quartz, is covered over, except at one or more windows 2, with a silver coating 3 which forms the conducting surface of the cavity resonator. As the circulating currents to be conducted are in the microwave region,

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and hence subject to "skin effect," the thickness of the coating 3 may be approximately 0.001 inch.

The windows 2 in the coating 3 preferably, but not necessarily, are in the center of two opposite sides of the cavity resonator, and serve to couple the cavity resonator to an electromagnetic field within a waveguide, not shown, in the circuit in which the cavity resonator is to be used.

It is apparent that the cavity resonator of this invention would be smaller in physical size than a hollow cavity resonator. The ratio of reduction in size would be $1:\sqrt{\epsilon}$, where ϵ is the dielectric constant of the material used.

As an example: for a rectangular cavity resonator resonant at 7051 mc., with fused quartz as the dielectric material, the dimensions would be approximately 0.6243 by 0.5001 by 0.2800 inch.

As the interior finish of the cavity resonator of this invention is essentially the same as the surface finish of the dielectric material, standard optical finishing methods for the dielectric prior to coating the metal thereon will effectively give the interior of the silver cavity resonator an excellent electrical finish. Low resistance with a relatively high effective Q will, therefore, be obtained in spite of the added losses incurred by the presence of the quartz dielectric.

Among the advantages in the use of the cavity resonator of this invention, is its adaptability to making small changes in its resonant frequency to obtain exact desired resonant frequencies. The frequency of a cavity resonator unit depends upon the dielectric constant of the solid material used and the physical dimensions of the unit. The physical dimensions of a unit cannot be changed, but the resonant frequency of the unit may be changed by bringing a dielectric material of a different dielectric constant, or metal, in field-coupling relation to the solid dielectric 1 of the unit. Two examples of such arrangements are disclosed in Figures 2 and 3, respectively.

Referring to Figure 2, a portion of the coated surface 3 may be removed, or an area of the surface of the dielectric 1 may be blanked off, during the coating, providing exposure of the dielectric 1 therein to a tuning element, such as rod 4, of metal or of dielectric having a dielectric constant preferably, but not necessarily, different from that of the dielectric 1 within the unit. The metal Invar, or any low-loss dielectric, are suitable materials for this purpose. Rod 4 may be threaded as at 5 to engage threads in a frame 6 rigidly supporting the resonator. By adjusting the position of rod 4 with respect to the cavity resonator, the reactance of the unit will be changed and there will be a corresponding change in the resonant frequency of the unit.

Referring to Figure 3, the cavity resonator disclosed therein is the same as in Figure 1, except that a slot 7 is cut out from a side of the resonator. The three faces of the slot 7 are not coated with silver. A block 8 of metal, or dielectric of an appropriate different dielectric constant, is inserted in slot 7 to adjust the resonance frequency of the cavity resonator. Block 8 may be fully inserted in slot 7 for maximum adjustment or may be partially inserted in slot 7 and held in position by any conventional actuating or securing means, not shown.

Another structure adapted to vary the resonant frequency of the cavity unit is shown in Figure 4. A male circular collar 9 is fitted to a feed waveguide 10 to be connected to the cavity resonator. On the window 2 of the cavity resonator is mounted a circular collar 11 that fits into the collar 9. When the cavity resonator is oriented with respect to the exciting field in the waveguide 10, the resonance frequency of the cavity resonator is varied. It has been found that a variation of 2 or 3 mc. in the resonant frequency in a cavity resonator normally resonant at 7000 mc. can be produced by this structure and method of adjustment.

The structure disclosed herein also provides a method of adjusting the resonant frequency of the cavity resonator by changes in the size of the coupling windows 2. Small changes in the resonant frequency of cavity resonator have been made without an appreciable reduction in the coupling between the waveguide and the cavity resonator.

What I claim is:

1. A cavity resonator comprising a solid non-magnetic

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dielectric having an optically finished surface covered with a low resistance metal coating, said resonator being resonant to radio waves and having its resonant cavity defined by said coating, said dielectric being enclosed in said cavity, the said coating having a pair of windows therein, one of said windows being on a first side of said dielectric, a transmission circuit coupled to said resonator through said one window, the other of said windows being on a second side of said dielectric and a tuning element coupled to said resonator through the other said window.

2. A cavity resonator comprising a solid low loss dielectric having an optically finished surface covered with a low resistance metal coating, said resonator being resonant to radio waves and having its resonant cavity defined by said coating, said dielectric being enclosed in said cavity, the said coating having a pair of windows therein, one of said windows being on a first side of said dielectric, and a waveguide coupled to said resonator through said one window, the other of said windows being on a second side of said dielectric, a tuning element coupled to said resonator through the other of said windows, the said tuning element being adjustable in positional relation to said dielectric.

3. A cavity resonator comprising a solid low loss dielectric having an optically finished surface covered with a low resistance metal coating, said resonator being resonant to radio waves and having its resonant cavity defined by said coating, said dielectric being enclosed in said cavity, the said coating having a window therein on a first side of said dielectric, and means coupling radio wave apparatus to said resonator including the said window, the said dielectric having a removable portion thereof for tuning in another side of said dielectric.

4. A cavity resonator comprising a solid low loss dielectric having an optically finished surface covered with a low resistance metal coating, said resonator being resonant to radio waves and having its resonant cavity defined by said coating, said dielectric being enclosed in said cavity, the said coating having a window therein on a first side of said dielectric, and means coupling radio wave apparatus to said resonator including the said window, the said dielectric having a removable portion thereof for tuning in a side adjacent the said first side.

5. A cavity resonator comprising, in combination, a solid low loss dielectric having an optically finished surface covered with a low resistance metal coating, said resonator being resonant to radio waves and having its resonant cavity defined by said coating, said dielectric being enclosed in said cavity, the said coating having a pair of windows therein, one of said windows being on a first side of said dielectric, a waveguide coupled to said resonator through said one window, the other of said windows being on a second side of said dielectric and being formed by the removal of a portion of said coating and said dielectric, and a tuning element adjustably to replace said removed portion.

6. In a cavity resonator including a solid low loss dielectric having an optically finished surface covered by a low resistance metal coating and a window therethrough, said resonator being resonant to radio waves and having its resonant cavity defined by said coating, said dielectric being enclosed in said cavity, the method of tuning said resonator comprising: removing a portion of said dielectric and coating and substituting therefor a dielectric of a different dielectric constant.

7. In a cavity resonator including a solid low loss di-

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electric having an optically finished surface covered by a low resistance metal coating and a window therethrough, said resonator being resonant to radio waves and having its resonant cavity defined by said coating, said dielectric being enclosed in said cavity, the method of tuning said resonator comprising: removing a portion of said dielectric and coating and placing in adjusted positional relation to the space occupied by said portion a tuning element.

8. A cavity resonator comprising a solid, non-magnetic dielectric having an optically finished surface covered with a low resistance conductive coating, said resonator being resonant to radio waves and having its resonant cavity defined by said coating, said dielectric being enclosed in said cavity, said coating being formed with at least a pair of windows therein, means including one of said windows for coupling radio wave apparatus to said resonator, and tuning means disposed entirely externally of said resonator and in operative relation with the other of said windows for tuning said resonator.

9. A cavity resonator as set forth in claim 8, wherein said tuning means comprises a waveguide and means for orienting said waveguide with respect to said resonator comprising adjustable means for mechanically coupling said waveguide to said resonator.

10. A cavity resonator as set forth in claim 9, wherein said means for mechanically coupling said waveguide to said resonator comprises interlocking rings secured respectively to said resonator coating and said waveguide for permitting rotation of said waveguide with respect to said resonator.

11. A cavity resonator comprising a solid, low-loss dielectric having an optically finished surface, and a low resistance conductive coating on said surface, said resonator being resonant to radio waves and having its resonant cavity defined by said coating, said dielectric being enclosed in said cavity, said coating being formed with at least a pair of windows therein, and tuning means disposed entirely externally of said resonator and in the vicinity of one of said windows and coupled to said resonator through said one window, whereby displacement of said tuning means tunes said resonator.

12. A cavity resonator as set forth in claim 8 wherein said tuning means comprises means for coupling said resonator through said other window to an external circuit, and means operatively associated with said other window for varying the opening area thereof.

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