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TEMPERATURE COMPENSATED WAVEGUIDE CAVITY

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FIG. 1

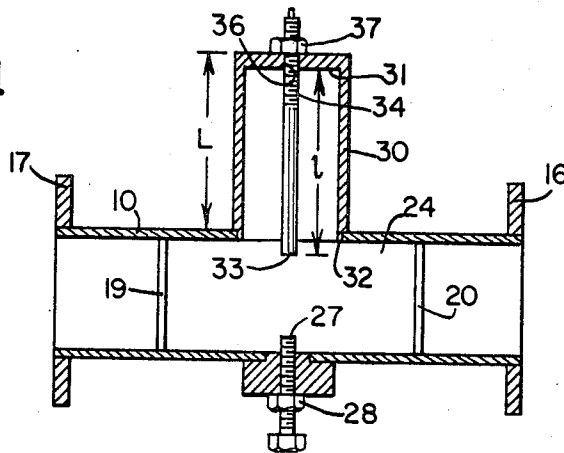


FIG. 2

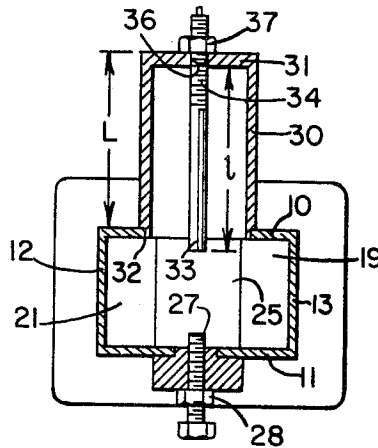
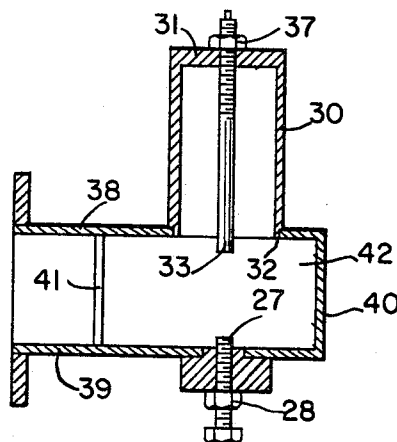


FIG. 3



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TEMPERATURE COMPENSATED WAVEGUIDE CAVITY

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8 Claims

ABSTRACT OF THE DISCLOSURE

A waveguide cavity includes a screw extending within the cavity and adjustable for tuning the cavity. The cavity also includes a separate temperature compensating element including a rod extending within the cavity with the temperature compensating element responsive to temperature changes to vary the position of the rod within the cavity. The use of a separate temperature compensating element provides temperature compensation which is independent of the resonant frequency of the cavity.

BACKGROUND OF THE INVENTION

Waveguide cavities are employed in microwave systems for providing a device having a fixed resonant frequency. These cavities may be tuned by means of a tuning screw which extends within the cavity. Varying the position of the screw within the cavity varies the resonant frequency of the cavity over a desired range. The resonant frequency of the cavity is a function of the dimensions of the cavity and thus changes in these dimensions with temperature cause the resonant frequency of the cavity to vary. Conventional cavities may include temperature compensation means combined with the screw tuning means to offset the change in cavity dimensions by repositioning the screw tuning element as the temperature changes.

In commercial microwave equipment it is desirable to manufacture relatively large quantities of cavities at one time and to store them until needed for particular systems. With prior art cavities each cavity was separately temperature compensated at the frequency at which it was to be used. This must be done at the time the equipment is being assembled for shipment to a customer as it is necessary to know the frequency at which the cavity will operate. Each time the cavity was retuned to a new frequency the cavity was again compensated for temperature.

SUMMARY

It is, therefore, an object of this invention to provide a waveguide cavity having an improved temperature compensation structure.

Another object of this invention is to provide a waveguide cavity in which the temperature compensation of the cavity is independent of the resonant frequency of the cavity.

In practicing this invention a microwave waveguide cavity is provided having a screw-type tuning element for tuning the cavity over a frequency range. The tuning is accomplished by changing the position of the screw within the cavity. A separate temperature compensating element is provided consisting of a spacer made of a material having a relatively high coefficient of thermal expansion combined with a rod having a relatively low coefficient of thermal expansion. In operation the rod is positioned within the cavity. As the temperature changes the length of the spacer changes according to its coefficient of thermal expansion. However, since the rod has

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a low coefficient of thermal expansion its length remains relatively constant and therefore the position of the rod within the cavity changes to offset the change in dimensions of the cavity due to temperature changes.

After manufacture of this cavity the cavity may be temperature compensated at a single frequency, the temperature compensating element locked in place and the cavity stored until needed. When the cavity is to be used, it is tuned to the desired frequency by means of the tuning screw and no further temperature compensation is needed. If the resonant frequency of the cavity is to be changed the only adjustment required is to reposition the tuning screw. No further temperature compensation is needed after each frequency change.

The invention is illustrated in the drawings of which: FIG. 1 is a cross-sectional side view of a waveguide structure and cavity incorporating the features of the invention;

FIG. 2 is an end view of the rectangular waveguide cavity structure of FIG. 1; and

FIG. 3 is a cross-section side view of a waveguide cavity having a single apertured wall.

DESCRIPTION OF THE INVENTION

Referring to FIGS. 1 and 2 there is shown a waveguide structure incorporating the features of this invention. The waveguide consists of conductive walls 10, 11, 12 and 13 which provide a rectangular waveguide structure. Flanges 16 and 17 are fastened at each end of the waveguide for coupling the cavity to other waveguide portions. Wall portions 19, 20 and 21 within the waveguide structure extend across the interior of the waveguide and combine with conductive walls 10 to 13 to form the resonant cavity 24. An aperture 25 in wall structure 19, 21 provides a means for coupling energy between the cavity and the remaining portions of the waveguide. A similar aperture is also present in wall 20.

The resonant frequency of cavity 24 can be varied, by means of a tuning screw 27 positioned within the cavity 24. By turning tuning screw 27 its position within cavity 24, is changed to change the resonant frequency of the cavity. Nut 28 is used to lock screw 27 in place.

The resonant frequency of the cavity is determined by its dimensions, thus cavity structure 24 will have a fixed resonant frequency if its dimensions do not change. However, temperature variations will cause the dimensions of the cavity to change thereby changing the resonant frequency of the cavity. If the cavity is made of metals having a relatively low coefficient of thermal expansion the frequency of the cavity will remain substantially constant over a temperature range. However, the cost of such cavities, using low coefficient of thermal expansion metals is excessive, particularly for use in commercial microwave systems. Accordingly the cavity is made of metals having a relatively high coefficient of thermal expansion and a temperature compensating element is provided. The temperature compensating element consists of a tubular spacer 30 having a closed end 31 and an open end positioned around an opening 32 in side wall 10. A rod 33 having a threaded end portion 34 is inserted in a threaded hole 36 in the closed end 31. Rod 33 extends within the cavity structure 24 and thus affects the resonant frequency of the cavity. The position of rod 33 within cavity 24 is adjustable by means of the threaded portion of the rod and threaded hole. A nut 37 is used to lock rod 33 in place after it has been adjusted.

The tubular spacer 30 is often manufactured of the same material as the waveguide which may be a material which has a relatively high coefficient of thermal expansion such as brass, having a coefficient of thermal expansion of the order of $20.2 \cdot 10^{-6}$. Rod 33 may be formed

of a material having a relatively low coefficient of thermal expansion such as the nickel-steel alloy sold under the trademark Invar, which has a coefficient of thermal expansion of the order of $0.6 \cdot 10^{-6}$. Thus with changes of temperature the length L of spacer 30 varies while the length l of rod 33 remains relatively constant. By this means spacer 30 moves rod 33 in cavity 24 as the dimensions of the cavity change with temperature to compensate the cavity structure.

By using a temperature compensation structure, in a rectangular waveguide cavity, separate from the cavity tuning element, it is possible to temperature compensate a cavity at one frequency and then tune the cavity to a different frequency without further temperature compensation.

In FIG. 3 there is shown the side view of a cavity structure having only one aperture which serves to both couple energy into and out of the cavity. Walls 38 and 39 form the top and bottom walls of a rectangular waveguide structure. The waveguide is closed off by an end wall 40. An internal wall 41 with an aperture therein, similar to the aperture shown as aperture 25 in the wall 19, 21 of FIG. 2, is the other wall of the cavity. The temperature compensating structure and tuning structure includes tuning screw 27, temperature compensating rod 33 and spacer 30 which are identical to the structural portion of FIGS. 1 and 2 having the same reference number.

An example of the results obtained with the temperature compensating structure of this invention is as follows. A cavity was temperature compensated at 7850 mHz. over a temperature range of -30° C. to $+55^{\circ}$ C. With the cavity retuned to 7750 mHz. the maximum change in the resonant frequency of the cavity varied from approximately $+75$ kHz. to -125 kHz., a range of 200 kHz. or a total change in frequency of .0025%. With the resonant frequency of the same cavity changed to 7000 mHz., the resonant frequency again changed over a 200 kHz. range, from $+100$ kHz. to -100 kHz. or a total change of .0029%. No additional temperature compensation was required after tuning the cavity to the resonant frequencies to achieve the above results. In prior art cavities operating under the same conditions, i.e., temperature compensation at one frequency and returning to another frequency without recompensation for temperature, errors across a similar temperature range were of the order of 0.1%.

I claim:

1. A temperature compensation structure for a waveguide cavity, including in combination, a hollow structure having a first pair of substantially parallel conductive walls spaced apart by a second pair of substantially parallel conductive walls, said first and second pairs of conductive walls together defining a rectangular waveguide of fixed dimensions, a pair of cavity walls extending across said waveguide and being spaced apart to form a cavity within said waveguide, at least one of said pair of cavity walls having an aperture therein for coupling energy between said cavity and the remaining portion of said waveguide, a tuning element mounted on one wall of one of said pairs of conductive walls, said tuning element including a tuning rod extending within said cavity and being adjustable for changing the resonant frequency of said cavity, temperature compensating means separate from said tuning element and mounted on the wall opposite to said one wall of said one pair of conductive walls, said temperature compensating means including a temperature compensating rod extending within said cavity, said temperature compensating means further including means for moving said temperature compensating rod into and out of said cavity in response to changes in the temperature of said cavity to maintain the resonant frequency of said cavity substantially constant over the operating temperature range of said cavity, said temperature compen-

sating means being effective to maintain the resonant frequency of said cavity substantially constant for resonant frequencies within the frequency range produced by said tuning element.

2. The temperature compensation structure of claim 1 wherein, said tuning rod is a tuning screw threadably mounted on said one wall of said one pair of conductive walls, said tuning screw extending within said cavity and being adjustable for changing the resonant frequency of said cavity.

3. The temperature compensation structure of claim 2 wherein, only one of said cavity walls has an opening therein for coupling energy into and out of said cavity.

4. The temperature compensation structure of claim 3 wherein, said conductive wall which mounts said temperature compensating means includes an opening extending therethrough, said means for moving said temperature compensating rod includes a spaced tube positioned on said conductive wall which mounts said temperature compensating element and outside of said cavity, said spaced tube being made of material having a relatively high coefficient of thermal expansion and having an open end surrounding said opening and a closed end, said closed end having a threaded hole therein, said temperature compensating rod having a threaded first end mounted in said threaded hole and a second end extending through said opening into said cavity, said temperature compensating rod being formed of a material having a relatively low coefficient of thermal expansion, whereby changes in the length of said spacer tube with changes in temperature causes the position of said temperature compensating rod within said cavity to change to compensate for changes in the dimensions of said cavity with changes in temperature.

5. A temperature compensation structure for a waveguide cavity, including in combination, a hollow structure having a first pair of substantially parallel conductive walls spaced apart by a second pair of substantially parallel conductive walls, said first and second pairs of conductive walls together defining a rectangular waveguide of fixed dimensions, a pair of cavity walls extending across the interior of said waveguide and being spaced apart to form a cavity within said waveguide, each of said pair of cavity walls having at least one aperture therein for coupling energy between said cavity and the remaining portions of said waveguide, said hollow structure being formed of a material having a temperature coefficient of expansion such that the dimensions thereof change with temperature, a tuning screw threadably mounted on one of said conductive walls, said tuning screw extending within said cavity and being adjustable for changing the resonant frequency of said cavity, a temperature compensating element separate from said tuning screw and mounted on another one of said conductive walls, said temperature compensating element including a rod extending within said cavity, said temperature compensating element further including supporting means for said rod, said rod having a temperature coefficient of expansion different from that of the material forming said hollow structure and cooperating with said supporting means so that said rod moves into and out of said cavity in response to changes in the temperature of said cavity to compensate for the changes in dimensions of said hollow structure and maintain the resonant frequency of said cavity substantially constant over the operating temperature range of said cavity.

6. The temperature compensation structure of claim 5 wherein, said conductive wall which mounts said temperature compensating element includes an opening extending therethrough, said means for moving said rod includes a spacer tube positioned on said conductive wall which mounts said temperature compensating element and outside of said cavity, said spacer tube being made of material having a relatively high coefficient of thermal

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expansion and having an open end surrounding said opening and a closed end, said closed end having a threaded hole therein, said rod having a threaded first end mounted in said threaded hole and a second end extending through said opening into said cavity, said rod being formed of a material having a relatively low coefficient of thermal expansion, whereby changes in the length of said spacer tube with changes in temperature causes the position of said rod within said cavity to change to compensate for changes in the dimensions of said cavity with changes in temperature.

7. The temperature compensation structure of claim 6 wherein, said spacer tube is made of brass and said rod is made of Invar.

8. The temperature compensation structure of claim 6 wherein, said temperature compensating element is

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mounted on one wall of said first pair of conductive walls and said tuning screw is mounted on the other wall of said first pair of conductive walls.

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