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2,528,387

CLAMPED CAVITY RESONATOR

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Fig. 1.

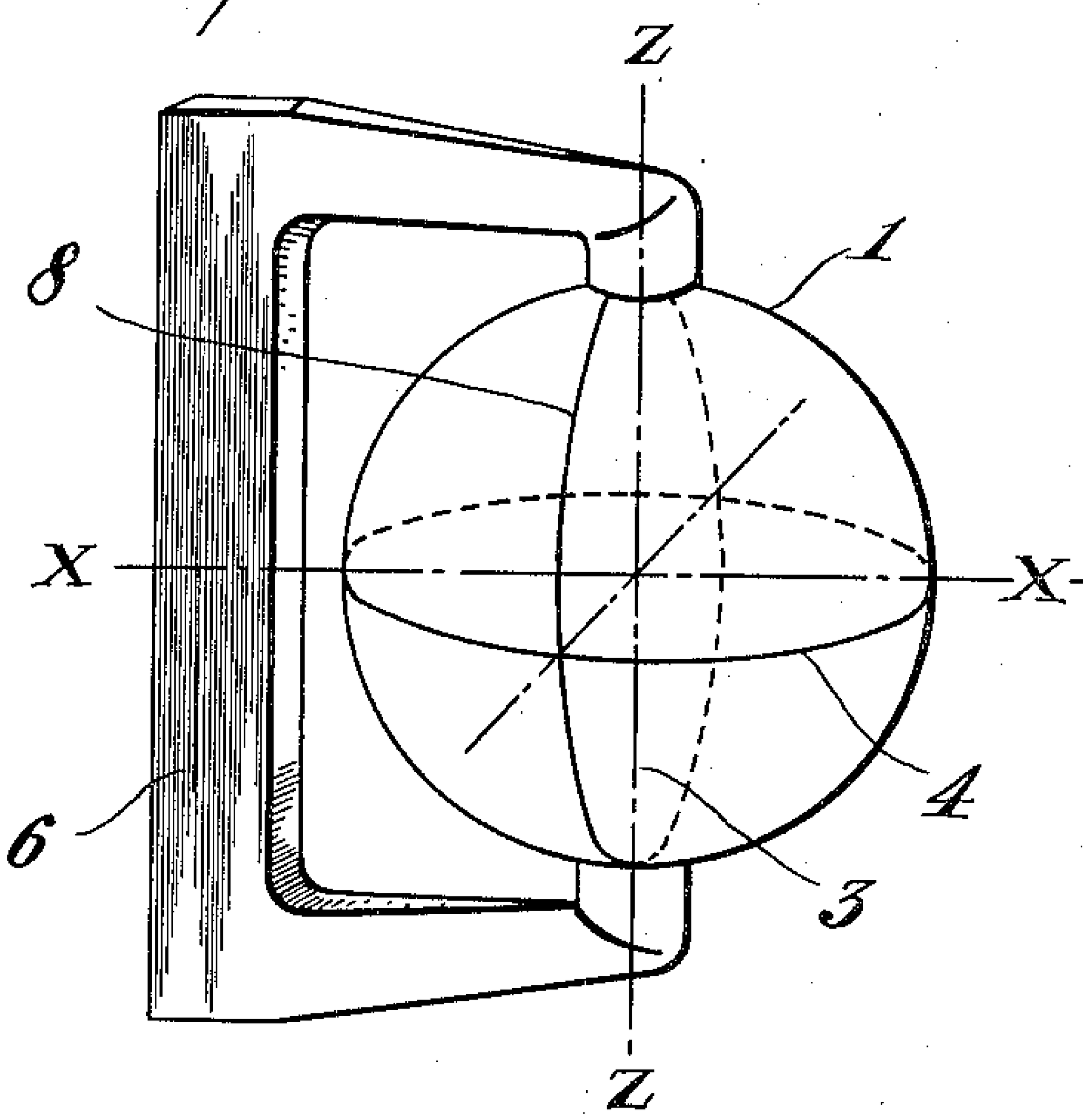


Fig. 2.

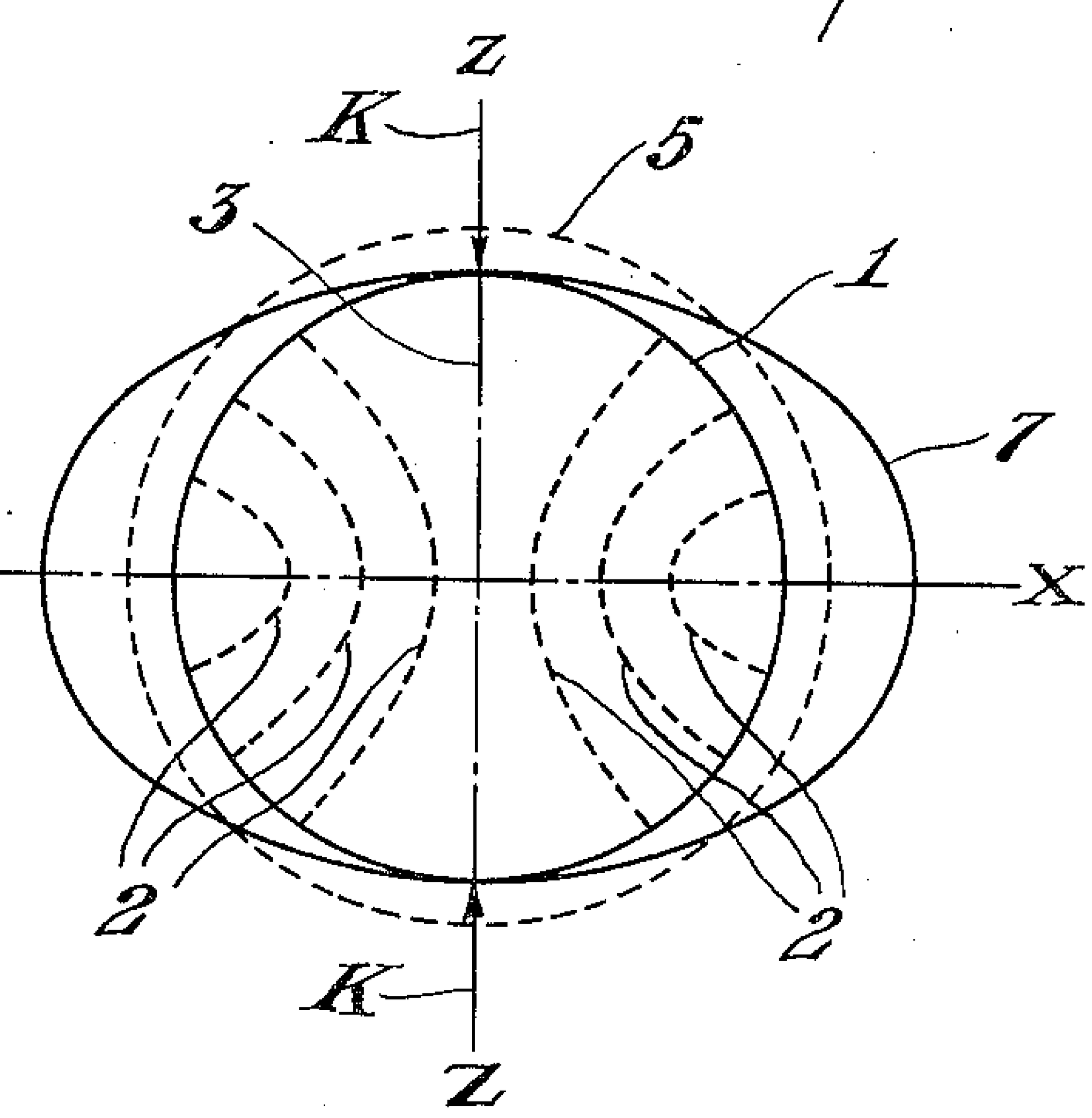


Fig. 3.

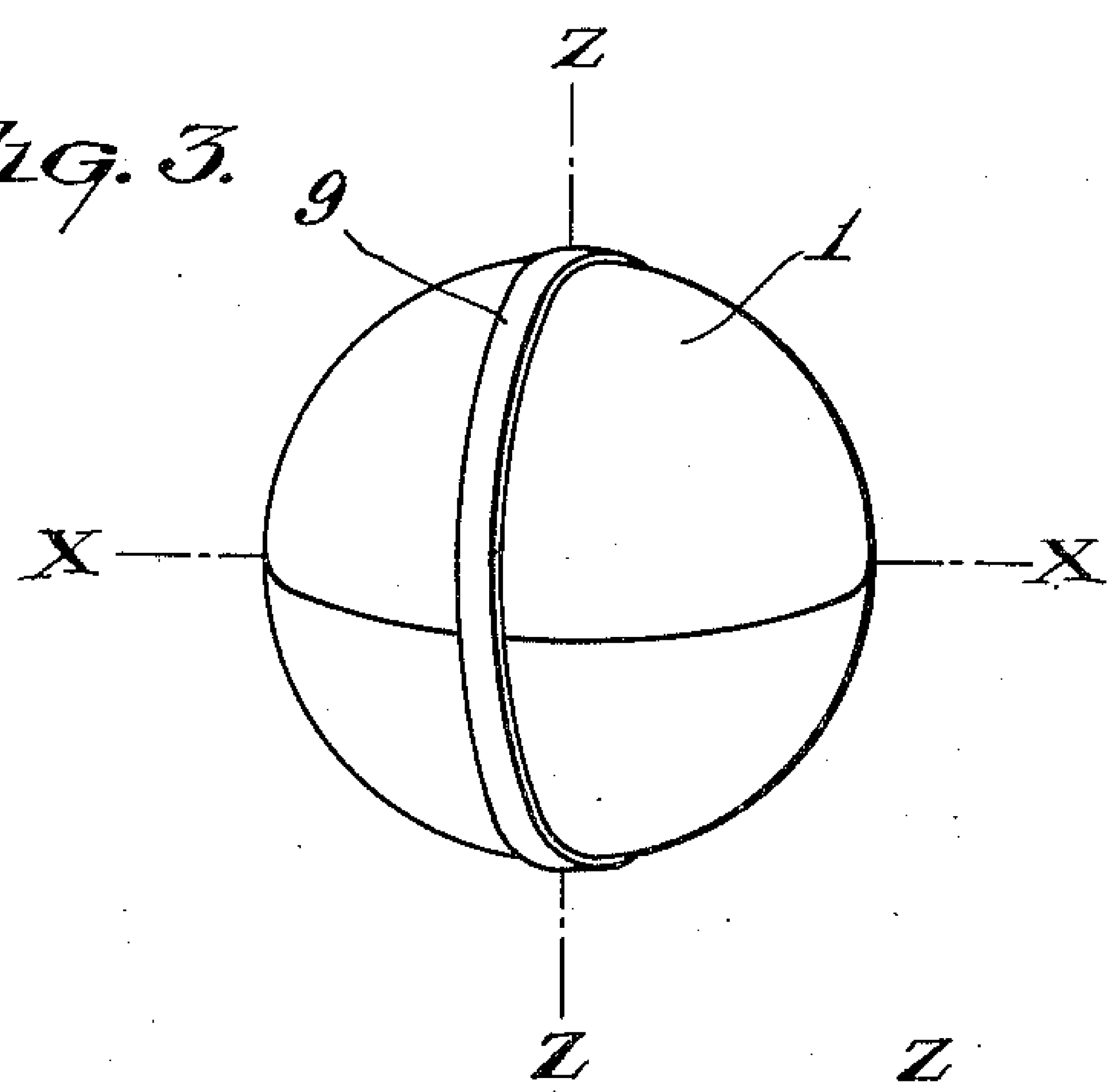


Fig. 4.

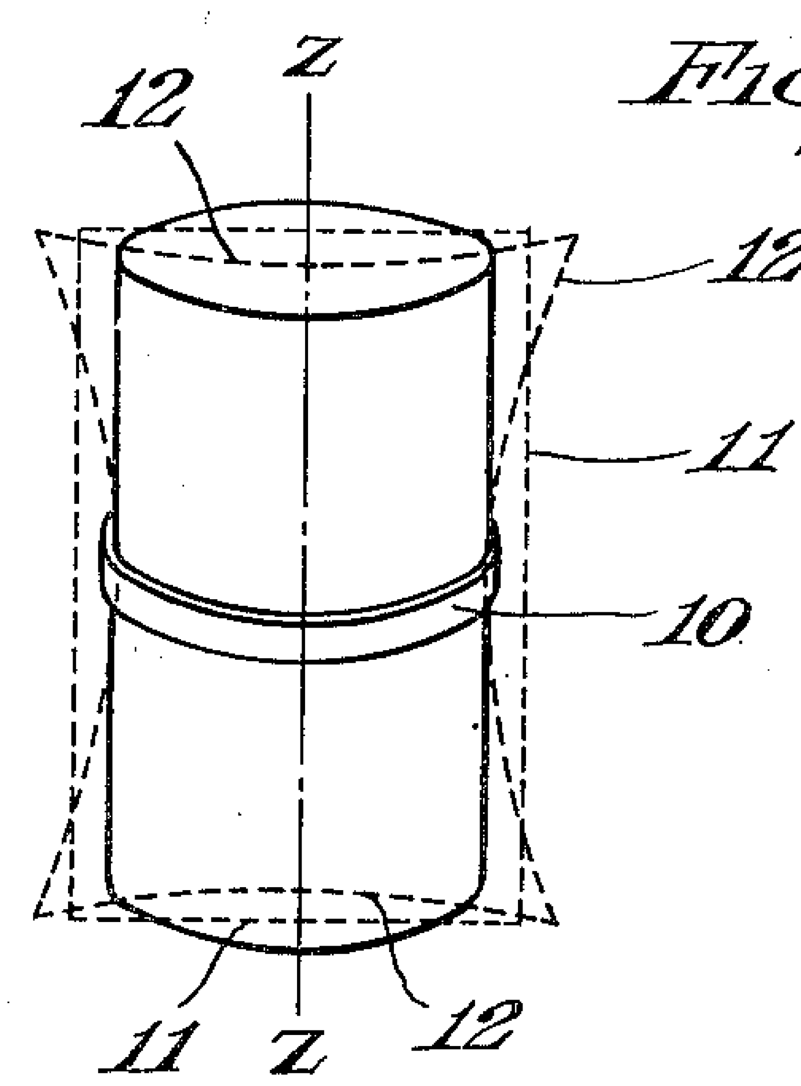
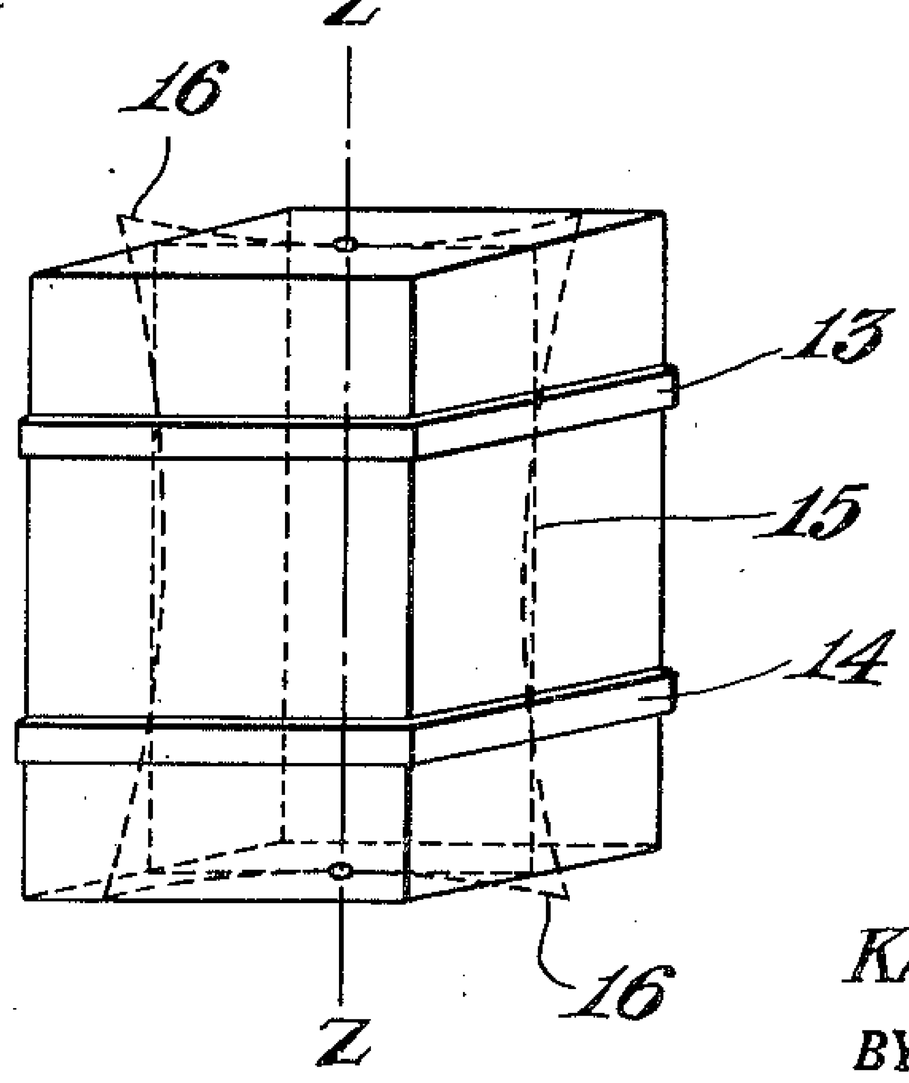


Fig. 5.



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CLAMPED CAVITY RESONATOR

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4 Claims. (Cl. 178—44)

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This invention relates to an electric resonant cavity, the dimensions of which are dependent on temperature, and to a device for ultra-short waves, for example a radio-transmitting device comprising such a resonant cavity.

The term "resonant cavity" is to be understood in this description to mean an oscillatory circuit for ultra-short waves having the form of a hollow-space resonator in which a concentrated inductance and capacity are lacking and of which the dimensions are thus of the order of magnitude of the wavelength of the fundamental frequency (smallest natural frequency). As has been exposed more fully in the Philips' Technisch Tijdschrift, July 1941, pages 222 to 223, these oscillations belong to the non-quasi stationary systems.

The walls of such a resonant cavity constitute a body substantially closed on all sides, which usually exhibits the shape of a cylinder, a parallelopiped or a ball and is made of a metal having a very high electrical conductivity such, for example, as copper.

In the case of variations in temperature of the resonant cavity body, which may occur either due to variations in the ambiant temperature or due to losses occurring in the resonant cavity, the dimensions of the resonant cavity body are submitted to variations, resulting in a variation of the natural frequencies of the resonant cavity.

The present invention has for its purpose to provide means for limiting or avoiding the frequency deviation of such a resonant cavity which occurs with variations in temperature.

According to the invention, for this purpose the resonant cavity body is constructed so as to be liable to deformation, means being provided whereby a variation in the dimensions of the resonant cavity body which occurs with a variation in temperature is locally limited or avoided, which as a matter of fact involves at another place an increase of the variation in dimensions which occurs with the same variation in temperature. However, by means of a suitable choice of the place where the latter variation in dimensions occurs, that is to say at the place where a corresponding variation in dimensions brings about a frequency deviation smaller or even inverse to that brought about by a corresponding variation in dimensions at the first-mentioned place, the frequency deviation with a variation in temperature is compensated at least in part or even an overcompensation may be effected.

The invention is thus based on the recognition of the fact that with the resonant cavities

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constituted in the usual manner the influences of corresponding variations in dimensions on the frequency variation are so strongly dependent on the place where they occur that an at least partly transfer or "displacement" of the variation in dimensions from the place where it occurs to another place, which may be obtained in a simple manner by utilising a resonant cavity body liable to deformation, can limit the frequency variation.

In order that the invention may be more clearly understood and readily carried into effect, it will now be described more fully by reference to the accompanying drawing.

Figures 1 and 3 represent two forms of construction of a spherical resonant cavity according to the invention.

Figure 2 shows a section of the resonant cavity shown in Figure 1, while

Figs. 4 and 5 represent a cylindrical and a parallelopiped-shaped resonant cavity according to the invention.

In Figure 1, reference **1** indicates a spherical resonant cavity which is constituted, for example, by two copper scales each exhibiting the shape of a hemisphere. This resonant cavity is excited in such manner, for example with the aid of a loop-shaped conductor (not shown) which is led through a recess of the wall into the interior of the resonant cavity, that the field of electrical lines of force produced in the resonant cavity, as viewed in a section according to the plan of the drawing, exhibits the picture indicated by **2** in dotted lines in Fig. 2. The field of electrical lines of force exhibits an axis of symmetry or an electrical axis **3** which co-incides with the geometrical axis Z of the spherical body **1**. The geometrical equator **4** associated with this geometrical axis coincides with the electrical equator of the resonant cavity which occurs with the described excitation.

With an increase in temperature the spherical body—if its arrangement is imagined to be entirely free—will expand in accordance with the linear coefficient or expansion of the material constituting the wall and the diameter of the ball will increase as indicated by **5** in dotted line in Figure 2. In this connection it is remarked that the enlargement of the resonant cavity which occurs is represented on an excessive scale for clearness' sake in this and in other figures.

As a result of the increase in temperature a certain variation in the natural frequencies of the resonant cavity occurs, which in the case of a spherical resonant cavity is principally due to the variation in dimensions of the spherical body in the direction of the electrical axis **3** which coincides with the Z-axis. The corresponding variation in dimensions of the spherical body in the direction of the X-axis or the increase in length of the electrical equator in itself results in a frequency deviation which, taken according to its absolute value, is considerably smaller (about $\frac{1}{10}$ to $\frac{1}{5}$) and in the present instance has in addition an opposite sign to that of the first-mentioned frequency deviation.

The present invention makes use thereof for limiting the frequency deviation with variations in temperature.

In the form of construction shown in Figure 1, a variation in the electrical length of the axis **3** of the resonant cavity is limited by a clamping device **6** which is arranged outside the resonant cavity and at the places of the extremities of the electrical axis exerts on the spherical body a pressure increasing with temperature. The latter result may be obtained, for example, by manufacturing the clamping device from a material having a linear coefficient of expansion which is smaller than that of the spherical body constituted by copper or some other good conductor, i. e. for example by invar, ceramic material, or wood.

The pressure exerted on the spherical body by the clamping device and indicated by K in Figure 2 approximately brings about such a deformation of the ball, which is a body liable to deformation, as to form an ellipsoid flattened in a rotation symmetrical manner relatively to the Z-axis, as is indicated by **7** in the sectional view. The variation in dimension which would occur in the direction of the Z-axis in the absence of the clamping device (conf. **5**) is now avoided but involves an increase of the variation in dimension which occurs in the absence of the clamping device in the direction of the X-axis, the latter, however, as stated already before, bringing about a comparatively much smaller frequency deviation than the variation in dimensions now avoided in the direction of the Z-axis.

In the foregoing it has been taken for granted that the spherical body was throughout equally rigid. However, it is of course also possible to apply the invention to other spherical bodies and to attenuate this spherical body, for example, at those places at which the largest variation in dimensions must occur; for example, with the resonant cavity shown in Fig. 1 the spherical body may be readily liable to deformation along the geometrical equator **4**.

For limiting or avoiding the frequency deviation use may also be made of a clamping device which engages the spherical body not only at the points of the extremities of the electrical axis but exhibits a larger contact surface with the spherical body. The contact surface may extend, for example, on each side of the extremities of the electrical axis **3** along the circle **8**, which is located in a plane comprising the electrical axis.

As is shown in Fig. 3, it is also possible to utilise a band **9**, constituted for example by invar, which tightly surrounds the whole spherical body, the band being located in a plane comprising the electrical axis. With an increase in temperature the spherical body will now substantially take the form of an ellipsoid elongated in a rotation symmetrical manner relatively to the X-axis.

In order to prevent the clamping device **6** or the band **9** from not exerting pressure on the spherical body with a low ambient temperature, the spherical body is preferably arranged in the clamping device **6** or the band **9** after being cooled down to a temperature which is lower that the lowest operating temperature to be expected.

One constructional example of the invention with a cylindrical or a parallelopiped-shaped resonant cavity is shown in Figs. 4 and 5. If such a resonant cavity is excited in such manner that, as before, the electrical axis coincides with the Z-axis, a variation in dimension in the direction of the electrical axis will substantially not result in a frequency deviation. On the contrary, variations in dimension in directions normal to the electrical axis, will result in a frequency deviation, these deviations being, however, smaller according as the variations occur farther from the middle of the electrical axis.

It is thus possible to limit the frequency variation of such a resonant cavity by means of a band **10** of invar or similar material which, as is shown in Fig. 4, tightly surrounds the middle of the body. With an increase in temperature the section of the cylinder will now not take the form indicated by **11**, but take the form indicated by **12**. The variation in dimension thus displaced to the extremities of the cylinder affects but slightly the frequency of the resonant cavity.

A greater limitation of the frequency variation or even an overcompensation thereof may be obtained in the manner illustrated in Fig. 5 by utilising two bands **13**, **14** arranged preferably symmetrically on each side of the middle of the electrical axis (Z-axis). As it appears from the section indicated in dotted lines by **15**, **16**, with an increase in temperature there occurs between the bands a decrease in dimensions and at the extremities of the body an increase in dimensions.

Like in the form of construction shown in Fig. 5, an overcompensation may in general be obtained by utilising means known per se whereby a local variation in dimensions of the resonant cavity, in contradistinction to the foregoing, is not only limited or avoided but a variation is effected which is inverse to the variation which normally occurs.

In the constructional examples shown, for limiting the frequency deviation use has always been made of means which are located outside the resonant cavity. Of course, use may also be made of means arranged inside the resonant cavity, for example in the case of a spherical resonant cavity of a rod of ceramic material which is arranged in accordance with the electrical axis, but this involves an increase in the electric losses of the resonant cavity. Consequently, the forms of construction shown are in general preferable, the more so as in these cases the means provided form part of the fastening device of the resonant cavity.

I claim:

1. In combination; a substantially enclosed high-frequency cavity resonator structure constituted by a deformable substance, the dimensions of said structure normally varying in accordance with changes in ambient temperature, and means to clamp said structure at a position maintaining one dimension thereof substantially independent of variation with temperature, whereby said structure becomes deformed in another dimension in response to a temperature change, said structure being characterized by the fact that a variation in the value of said other

dimension effects a smaller frequency deviation than a corresponding change in the value of said one dimension, said clamping means being constituted by a substance having a coefficient of expansion which is small relative to that of said structure.

2. In combination; a substantially enclosed high-frequency cavity resonator structure of parallelepiped shape constituted by a deformable substance, the dimensions of said structure normally varying in accordance with changes in ambient temperature, and at least one rectangular band surrounding said structure about the geometrical axis coincident with the electrical axis thereof, said band being constituted by a substance having a coefficient of expansion which is small relative to that of the structure.

3. An arrangement, as set forth in claim 2, including two bands in spaced relation located on either side of the center point of said geometrical axis and approximately midway between said point and the extremities of said axis.

4. The combination as set forth in claim 1, further characterized in that said resonator structure is of spherical shape and said clamping means is constituted by an annular band encircling said spherical structure about a circumferential line lying in a plane passing through the geometrical axis of said structure coinciding with the electrical axis thereof.

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