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TEMPERATURE COMPENSATED RESONANT CAVITY STRUCTURE

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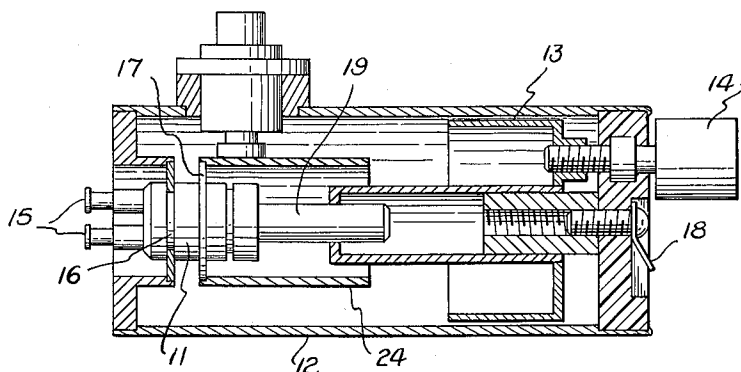


Fig. 1

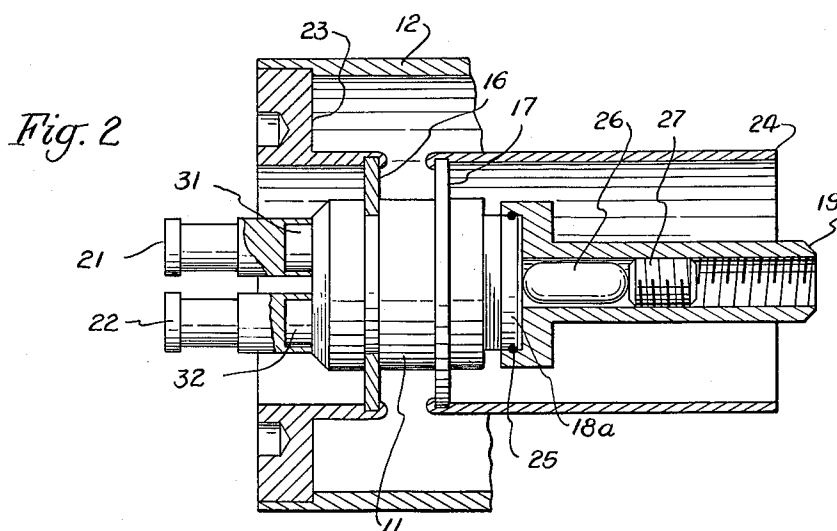


Fig. 2

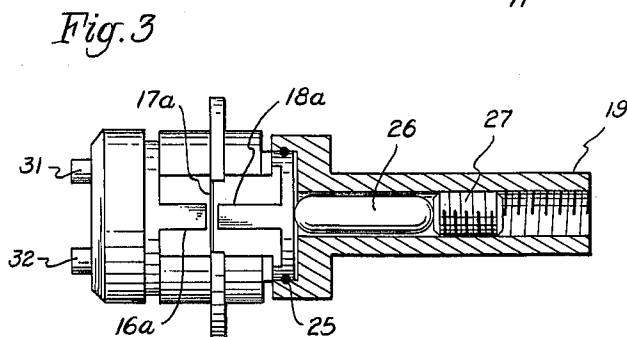


Fig. 3

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This invention relates in general to microwave devices and in particular to means for temperature compensation in such devices.

It is well recognized that high frequency oscillators and amplifiers of the cavity variety are frequently plagued by temperature sensitivity problems. In the case of oscillators, the electrical resonance of the device is inclined to deviate with temperature changes, and this, of course, results in a change in output frequency. Since it is generally essential that a constant frequency output be maintained, it is standard practice to incorporate temperature compensation means of some kind in such devices. Usually the methods of the prior art for temperature compensation have employed either temperature sensitive capacitive means made of a bimetallic strip or strips located in a field of high electrical intensity, or, alternately, the devices have been designed to utilize the differential expansion of the cavity due to different types of metal, for example invar and brass, in alteration of the inductance of the associated resonance circuit.

It is well known that prior art temperature compensation means leave something to be desired in numerous areas of application and that a means for temperature compensation which avoids or alleviates the defects of the prior art is needed and would be welcomed as a substantial advancement of the art. More particularly, it is recognized that most means for temperature compensation have a slow speed of response and poor electrical efficiency. In addition, most temperature compensation means are characterized by excessive rigidity which precludes use in high mechanical vibration applications, are difficult to adjust, and are prohibitively expensive.

Accordingly,

It is an object of this invention to provide a microwave device which incorporates a new and novel means for temperature compensation which is relatively quick acting.

It is also an object of this invention to provide a microwave device which incorporates a new and novel means for temperature compensation which affords a reasonable electrical efficiency.

It is another object of this invention to provide a microwave device which incorporates a new and novel means for temperature compensation which does not substantially alter the rigidity characteristic of the device.

It is still another object of this invention to provide a microwave device which incorporates a new and novel means for temperature compensation which is readily adjustable.

It is a further object of this invention to provide a microwave device which incorporates a new and novel means for temperature compensation which does not substantially increase the cost factor of the microwave device.

Other objects of the invention will become apparent upon a more comprehensive understanding of the invention for which reference is had to the following specification and drawings wherein:

FIGURE 1 is a cross-sectional showing of a microwave triode oscillator in accordance with one embodiment of the present invention.

FIGURE 2 is a more detailed showing of the temperature compensation means in the embodiment of FIGURE 1.

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FIGURE 3 is a cross-sectional showing of the planar tube in the embodiment of FIGURE 1.

Briefly, this invention provides a means for temperature compensation in various microwave devices employing planar tubes. The compensation is provided by incorporating a bar having a relatively low coefficient of expansion in a sleeve section having a predetermined coefficient of expansion such that the bar acts on an end member of a planar tube to counteract interelement spacing variation within the tube.

Referring now to the drawings,

In FIGURE 1, a microwave oscillator of the cavity variety is shown embodying a planar tube, indicated at 11, and a variable resonant chamber consisting of a metallic sleeve, 12, and a movable end wall section, 13, insulated therefrom, which is adjustable by means of tuning screw, 14. Filament, cathode, grid and anode terminals of the planar tube, which may be a GE Type 7486, for example, are shown at 15, 16, 17 and 18, respectively.

In the embodiment of FIGURE 1, the anode extension, indicated at 19, is adapted internally to provide a compensating force in the presence of thermal variations which is applied to the anode support member of planar tube 11. As discussed in more detail in connection with FIGURE 2, the anode extension 19 is hollowed and the hollow contains an Invar bar, shown in FIGURE 2, which is disposed in positive contact with the anode of the planar tube 11 by means of a set screw, also shown in FIGURE 2.

In the cross-sectional showing of FIGURE 2, the planar tube 11 and its associated terminal structure is depicted substantially as in the embodiment of FIGURE 1 but enlarged for purposes of a more detailed showing. In FIGURE 2, the filament terminals 15, shown in FIGURE 1, constitute filament pins 21 and 22 attached to the filament terminal buttons on the cathode end of the tube, the cathode ring terminal 16 of the tube is secured to metal collar member 23 which, in turn, is secured to the metallic sleeve 12 such that the outer sleeve 12 is at cathode potential. Likewise, a grid sleeve 24 is secured to the grid ring terminal 17 of the tube and is disposed in coaxial relation with the anode extension 19.

The anode extension 19 is rigidly attached to the edge of the disc shaped anode 18a by means of a lock wire 25 disposed in complementary grooves located in the external surface of anode 18a and the internal surface of anode extension 19, such that the disc surface is free.

As shown in the drawing, the anode extension 19 is hollowed to form a sleeve section and a bar 26 of a material having a relatively low coefficient of expansion, such as Invar, is contained therein. The bar 26 is disposed with one end in contact with the disc surface of the anode 18a by means of a set screw, indicated at 27, which forces the bar 26 against the anode 18a to exert axial pressure thereon. It will be appreciated that the set screw, 27, effectively loads the disc surface, that is, establishes a slight deflection such that further deflection is solely dependent upon the relation between the coefficients of expansion of the bar 26 and of the anode extension 19 takes with the set screw 27. In the ultimate consideration, the bar 26 is dimensionally stable and is substantially unaffected by changes in temperature, and it has been found that Invar material is suitable in this respect.

Assuming the bar 26 is dimensionally stable such that it does not change with temperature, the fixed length of this bar is critical to this invention. It will be seen that the length of the bar establishes the length of the vital portion of the anode extension 19, that is, the length of the portion which expands and contracts to affect the axial pressure on the anode 18. Thus, the maximum axial pressure is a function of the length of the bar 26 provided, of course, the axial pressure does not exceed the

fundamental elastic limit of the material to which it is applied.

Operation of the invention can best be understood by reference to FIGURE 3 wherein the internal electrode structure of a typical planar tube useful in the device of this invention is illustrated in cross section together with the temperature compensation means shown in the embodiment of FIGURE 1.

It will be appreciated that when the temperature of the tube changes in the absence of the temperature compensation means, either as a result of changes in ambient temperature or changes in the operating conditions of the tube, the anode 18a expands or contracts and in so doing causes a change in the capacity between grid 17a and anode 18a. However, with the temperature compensation means of this invention, a change in temperature of the tube likewise affects its anode extension 19 which may be of brass or of any other material, metal or otherwise, with a relatively high coefficient of thermal expansion. It will be seen that the physical connection between the anode 18a and the anode extension 19 acts as a point of reference and that the expansion and contraction of each with changes in temperature is in the same direction with respect to this reference point but in opposite direction with respect to each other. Thus the effect of the interconnecting bar 26, which is relatively unaffected dimensionally by changes in temperature, is to nullify changes in grid to anode interelectrode spacing with changes in temperature. It is recognized that speed of response is largely dependent upon the rate of heat transfer between the anode 18a and the anode extension 19.

In operational analysis, as the temperature of the anode 18a increases, the temperature of the anode extension 19 also increases, causing the anode 18a to approach the grid 17a and the anode extension 19 to lengthen. Since the bar 26 does not change dimensionally, to any significant extent, the axial pressure exerted on the disc surface of the anode 18a is reduced causing slightly less deflection of the disc surface of the anode. Thus the increased length of the anode 18a is offset by withdrawal of the anode structure and the anode-grid interelectrode spacing remains substantially constant.

As mentioned previously, the length of the bar 26 is a critical factor in determining the sufficiency of correction. If the bar 26 is too long, it obviously overcompensates the anode movement and if it is too short, it will undercompensate the deviation. In actual practice, it has been found desirable to make the cavity of brass and to slightly overcompensate for changes in grid to plate capacity in order to counteract the effect produced by the expansion and contraction of the rest of the cavity. It will be appreciated, however, that if the cavity is of Invar or a like metal, there will be relatively little effect produced by the minute expansion and contraction of the cavity and that in such instance there would be no necessity to overcompensate.

While the device of this invention has been depicted in the drawings in a preferred embodiment, it is understood that various modifications of the depicted embodiment not specifically illustrated would be apparent to those skilled in the art and that such modifications are within the purview of this disclosure. For example, it is within the purview of this disclosure to construct the anode structure of the tube and the anode extension as a one-piece unit integral with the tube, if desired.

Moreover, this invention is not restricted to planar tubes of the type exemplarily shown in the drawings and other tubes having an interelectrode spacing deviation with changes in temperature which involve a flexible semiresilient electrode support may be adapted in accordance with the teaching of this invention for temperature compensation thereof. As an example, this invention is not restricted to three electrode tube structures, and it is not critical to this invention that the temperature compensation means act upon the anode. Like-

wise, it is not essential that the compensator bar act upon a circular disc member as shown in the drawings and other configurations of the flexible semiresilient member also would be suitable provided, of course, such other configurations are sufficiently flexible and resilient to follow the movement of the bar 26.

It has been found that the compensation means of this invention is substantially superior to prior art means for this purpose in terms of speed of response and mechanical rigidity. In particular, it has been found that conditions of severe shock and vibration produce far less frequency or phase modulation in oscillators utilizing the temperature compensation means of this invention as compared with oscillators utilizing the most popular compensation means, strips of thermostat metal, to change electrical characteristics of the cavity.

In addition, it has been found that the compensation means of this invention which serves to maintain a constant grid-anode spacing rather than to correct for the change in capacity which accompanies a change in electrode spacing affords a much higher electrical efficiency. More particularly, by maintaining a constant spacing between grid and anode, transit time therebetween remains the same and thus the relationship between cathode-grid and grid-anode transit time remains substantially the same with a resultant minimum efficiency deviation as temperature conditions change.

Finally, it is understood that this invention is not restricted to microwave cavity devices operative in the axial mode and the invention is only to be limited by the scope of the claims appended hereto.

What is claimed is:

1. A microwave device comprising

an electron tube means of the planar variety having a plurality of electrodes substantially centered in axial alignment with significant spacing therebetween,

at least one of said electrodes including a flexible resilient planar support member, the flexure condition of which determines an interelectrode spacing;

means for energizing said electron tube means to produce an output;

means for utilizing the output of said electron tube means when energized;

temperature compensation means adapted to change the flexure condition of said planar support member in response to temperature deviations of said microwave device,

said temperature compensation means including a hollow sleeve member having a selected axis and attached to the edge of said planar support member in axial alignment with said plurality of electrodes,

said hollow sleeve being of a material having a relatively high thermal coefficient of expansion;

a dimensionally stable elongated bar member disposed within said hollow sleeve with one end in contact with said planar support member;

said bar member being adapted for free movement relative to said hollow sleeve;

and bar member holding means connected to said hollow sleeve and in physical contact with the other end of said bar member,

said holding means being adapted to hold said bar member under compression force against said planar support member such that said planar support member has a predetermined reference flexure condition.

2. A microwave device as defined in claim 1 wherein said temperature compensation means is connected to the edge of said planar support member in temperature conductive relation.

3. A microwave device comprising

an electron tube means of the planar variety having

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a plurality of electrodes substantially centered in axial alignment with significant spacing therebetween,

at least one of said electrodes including a flexible resilient planar support member, the flexure condition of which determines an interelectrode spacing;

means for energizing said electron tube means to produce an output;

means for utilizing the output of said electron tube means when energized;

temperature compensation means adapted to change the flexure condition of said planar support member in response to temperature deviations of said microwave device,

said electron tube means, said means for energizing and said means for utilizing the output including resonant cavity means in shunt with selected electrodes of said electron tube means such that said microwave device is operative as a microwave oscillator,

said temperature compensation means including a hollow sleeve member having a selected axis and attached to the edge of said planar support member in axial alignment with said plurality of electrodes,

said hollow sleeve being of a material having a relatively high thermal coefficient of expansion;

a dimensionally stable elongated bar member disposed within said hollow sleeve with one end in contact with said planar support member,

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said bar member adapted for free movement relative to said hollow sleeve;
and bar member holding means connected to said hollow and in physical contact with the other end of said bar member,

said holding means adapted to hold said bar member under compression force against said planar support member such that said planar support member has a predetermined reference flexure condition.

4. A microwave device as defined in claim 3 wherein said hollow sleeve member is disposed within said resonant cavity means.

5. A microwave device as defined in claim 4 wherein said hollow sleeve member is of a material having a thermal coefficient of expansion substantially that of brass.

6. A microwave device as defined in claim 5 wherein said temperature compensation means is connected to the edge of said planar support member in temperature conductive relation.

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