May 22, 1951 R. L. CARNINE ET AL 2,553,811

CONSTANT FREQUENCY CAVITY DEVICE

Filed Nov. 23, 1949

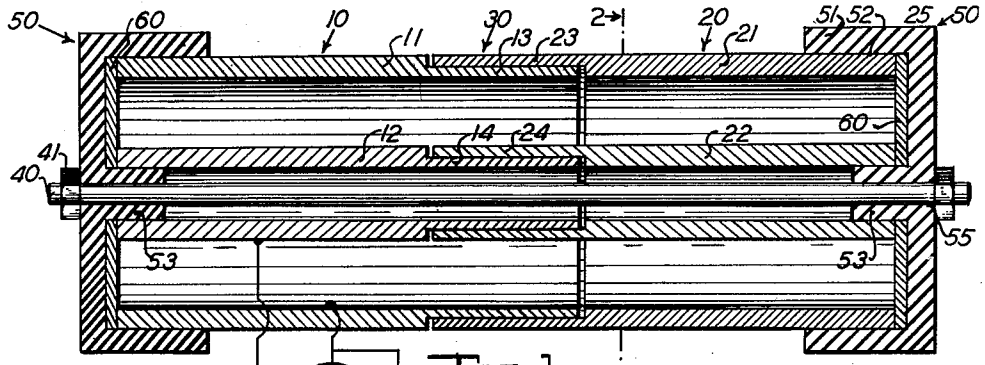
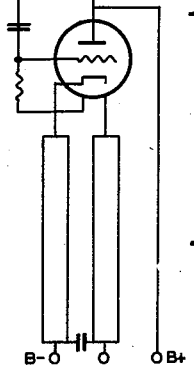


Fig. 1



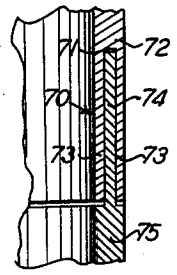


Fig. 3

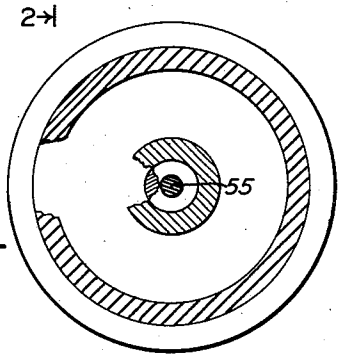


Fig. 2

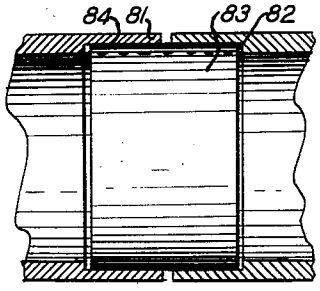


Fig. 4

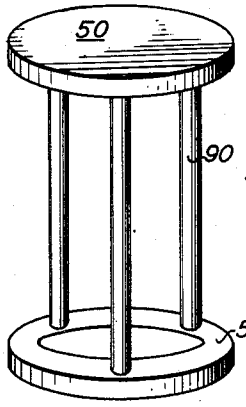


Fig. 6

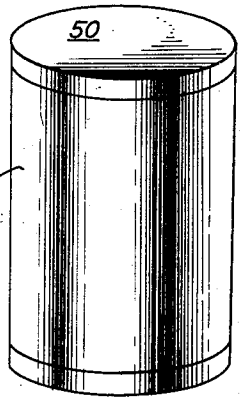


Fig. 7

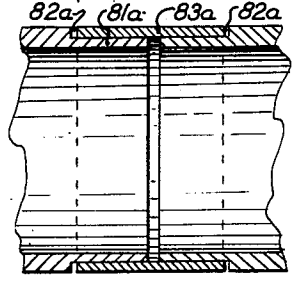


Fig. 5

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CONSTANT FREQUENCY CAVITY DEVICE

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8 Claims. (Cl. 178—44)

1

This invention relates generally to electrical resonators and has particular relation to a constant frequency cavity device of the concentric resonant line type.

It is well known that devices of this type generally consist of an inner conductor and an outer conductor having such dimensions and being so connected as to form a tuned circuit for predetermined frequencies. The constructions and characteristics of devices of this type are set forth in United States Patents 2,077,800; 2,103,515; 2,108,895; 2,435,442; and 2,286,408, the latter patent including a further list of United States patents and literature references directed to devices of this general type. In view of these and other prior art disclosures, it is unnecessary to set forth a detailed explanation concerning the well known characteristics and operation of devices of this general type.

An object of the present invention is to provide an improved constant frequency cavity device which will control and will hold constant the frequency of electronic units such as radio transmitters and receivers in spite of changes in temperature.

Another object of the invention is to provide such a device which will be capable of operating in an improved manner as compared to the prior art devices and which will overcome the disadvantages of the prior art devices.

Another object is to provide such a device which is operable at high frequencies and ultra high frequencies and can be effectively utilized to operate with the same results achieved by a crystal maintained in an oven holding the crystal temperature constant, the crystal being coupled with several stages of frequency multiplication.

Another object of the invention is to provide a constant frequency cavity device which is extremely simple and inexpensive of construction and which has a further advantage of extreme portability so as to enable the construction of ultra portable transmitters and receivers, when utilizing the present invention.

These and other objects of the invention will be fully understood by reference to the following description and accompanying drawing.

The present invention generally comprises a constant frequency cavity device, comprising two pairs of concentric conductor tubes, each pair including an outer tube and an inner tube, said device including overlapping connections for the respective inner ends of said outer and inner tubes for permitting relative longitudinal

2

movement of the respective connected tubes due to changes in temperature, means electrically connecting the outer ends of each pair of tubes, and mounting means connecting the outer ends of said assembly of tubes, said mounting means including an element having a low expansion coefficient, for maintaining the overall length of the device substantially constant with changes of temperature.

Additionally, the overlapping connection of the present structure includes a construction wherein the walls of the inner end portions of at least one of the connecting tubes are each of relatively thinner cross-section than the remainder of the tube. In a preferred form the connection includes such a construction wherein the opposing connecting conductor tubes are of substantially equal thickness throughout their length and throughout the overlapping connection. In one modification, the overlapping connection includes a ring cooperating with thinned portions of the inner ends of at least one of the opposing conductor tube walls, and in a further modification the overlapping connection comprises a mating tongue and groove on the inner end portions of at least one of the connecting tubes.

In the drawings,

Fig. 1 is a cross-sectional view of a constant frequency cavity device embodying the present invention;

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a partial sectional view showing a modified form of the overlapping connection;

Fig. 4 is a partial sectional view of a further modified form of the overlapping connection;

Fig. 5 is a partial sectional view showing a further modified form of the overlapping connection;

Fig. 6 is a perspective view showing a modified form of the mounting means and closure plates for connecting the outer ends of the assembly of conductor tubes; and

Fig. 7 is a perspective view of a further modified form of the mounting means and closure plates for connecting the outer ends of the assembly of conductor tubes.

The constant frequency cavity device of the present invention generally comprises two opposing pairs of concentrically positioned conductor tubes indicated as 10 and 20 respectively. Each pair comprises an outer tube 11 and 21 and an inner tube 12 and 22. The opposing conductor tubes are preferably designed to have

equal wall thickness, are cylindrical in configuration and have a common longitudinal axis.

The opposing pairs of conductor tubes are maintained in sliding contact at their inner ends by an overlapping connection indicated generally at 30. As shown in a preferred form, the overlapping connection comprises a pair of inner and outer mating flanges 13—23 and 14—24 forming the ends of the inner end portions of the opposing conductor tubes 11—21 and 12—22, respectively. As shown, the wall thickness of the overlapping connection 30 and the wall thickness of the remainder of the opposing conductor tubes are substantially equal. Thus, the sum of the thickness of the flanges 13 and 23 is substantially equal to the thickness of the tube walls 11 and 21 respectively. Sliding contact between the opposing sets of conductor tubes is maintained by the adjacent walls of the mating flanges.

The mounting means for joining the outer ends of the opposing pairs of concentric conductor tubes 10 and 20 comprises an axially mounted rod 40 having a low expansion coefficient; such as of Invar metal or hard wood, such as sugar maple or beech wood, and preferably lignum vitae. In the construction shown, the opposing pairs of conductor tubes 10 and 20 are held in fixed concentric relationship and joined to the mounting rod at their outer ends by dielectric closure plates 50. The closure plates 50 as shown, each comprise a generally cup-shaped element having an outer annular flange 51, the inner wall of which slidingly contacts the adjacent outer wall of the outer and conductor tube, as at 52, to hold the outer tube in alignment. The closure plates 50 are each provided with an axially positioned cylinder portion 53, the outer wall of which slidingly contacts the inner wall of the inner conductor tube 22 to maintain the inner and outer conductor tubes in concentric alignment. The closure plates 50 are each provided with an axial bore hole 55 which is adapted to receive the low expansion coefficient rod 40. The relative longitudinal position of the closure plates 50 along the rod 40 may be set by adjusting means such as the nuts 41, screw threadably connected to the outer ends of the rod 40, as shown. Conducting disks 60 are provided between the outer ends of the conductor tubes in order to provide electrical connecting means between the inner and outer tubes. Preferably, the conducting disks 60 are secured to the closure plates 50 on one side and secured to the outer ends of the conductor tubes on the other side under conditions of extreme temperature variation in order to maintain a constant overall distance between the outer sides of the conducting disks 60.

A suitable circuit arrangement given by way of example only, is shown connected to both the inner tube and the outer tube. The circuit arrangement, as shown, is directed to one-half wave length lines, although it will be understood that the length is immaterial to the practice of the invention and the invention is not to be so limited.

In the operation of the present device, it will be apparent that the low expansion coefficient rod 40 will maintain the overall length of the two pairs of conducting tubes substantially constant throughout changes of temperature. It will also be apparent that the conductor tubes will expand longitudinally toward their inner ends with flanges 13—23 and 14—24 in sliding contact. By means of this overlapping connection, the wall thickness throughout the overlapping connections and the outer tube section will remain substantially constant, this result being achieved by the inner end portions of the opposing connecting tubes being of relatively thinner cross-section than the remainder of the tubes and overlapped to provide an overlapping connection. This feature of constant wall thickness is of particular importance in all cases excepting where tubes of relatively large diameter are used as determined by a ratio of wall thickness to tube diameter, or in such case where relatively thin wall tubes, for example, of the order of 15 to 20 thousandths inch thickness are used. In the case of these exceptions, opposing tubes having a conventional overlapping inner end portion have been found satisfactory, although considerably improved results are obtained by having the entire length of the opposing tubes of constant wall thickness.

In practice, it has been found preferable to silverplate the inner wall surface of the outer conductor tubes and the outer wall surface of the inner conductor tubes. Likewise it has been found advantageous to silverplate the sliding contacting surfaces of the overlapping connecting flanges. Additionally, it has been found advantageous to silverplate the inner wall surface of the conducting disks 60 contacting the outer ends of the conductor tubes. In practice, satisfactory results have been obtained by using brass conductor tubes and brass metal disks 60, silverplated as aforesaid. Also, satisfactory results have been obtained by using hard wood and rubber closure plates. Likewise, satisfactory results have been obtained with both Invar metal and hard wood connecting rods.

In one specific adaptation of the invention embodied in a working model constructed essentially as shown in Fig. 1, brass conductor tubes having an overall length of 2.75 inches were mounted in closure plates of lignum vitae, a hard wood having an extremely low coefficient of linear expansion in its direction of grain. The axial mounting rod was likewise constructed of the same wood. The outside diameter of the inner tube was 0.50 inch with a $\frac{1}{16}$ inch wall thickness. The outer tube had an inside diameter of $1\frac{5}{8}$ inches and a $\frac{1}{16}$ inch wall thickness. Brass conducting disks, having a thickness of $\frac{1}{8}$ inch, were secured by soldering to the outer ends of the tubes and secured by bolts to the closure plates.

A conventional oscillator circuit arrangement, as shown, including a $6K_4$ vacuum tube was connected to the line resonator. At room temperature (68° F.), it oscillated at 500 megacycles and at 250° F., it oscillated within .007% of the same frequency.

Preferred modified forms of the overlapping connection structure are shown in Figs. 3, 4 and 5. In the embodiment shown in Fig. 3, the overlapping connection indicated at 70 comprises a centrally disposed annular groove 71 on the inner end portion 72 of one of the connecting tubes forming an opposing pair of flanges 73. A centrally disposed mating tongue 74 is provided on the inner end 75 of the opposing tube to form a tongue and groove sliding contact. Thus, in this modified form of overlapping connection, a constant wall thickness may be maintained throughout the length of the opposing tube sections.

In a further modified form of the overlapping connection as shown in Fig. 4, the inner ends of an opposing set of conductor tubes are provided with an outer flange 81 defining an inner cut-

away portion 82 adapted to receive a conducting ring 83, the outer wall of which is adapted to slidingly contact the inner wall portions 84 of both opposing flanges 81. Preferably, the thickness of the ring 83 is made, as shown, so that a constant wall thickness may be maintained throughout the length of the opposing set of tubes. It will be apparent that this modified form of construction may be utilized for either or both the outer set or inner set of conductor tubes.

In the modified form of overlapping connection shown in Fig. 5, the inner ends of an opposing set of conductor tubes are each provided with an inner flange 81*a* defining an outer annular groove 82*a* which is adapted to receive a conducting ring 83*a*, the adjacent surfaces of the flange and the ring being maintained in a sliding contact. It will be apparent that in this form of the overlapping connection, the overall wall thickness of a set of opposing tubes may be maintained substantially constant. It will also be apparent that this modified form of overlapping connection may be utilized for either or both the inner or the outer conductor tubes.

Referring now to Fig. 6, there is shown a modified form of the mounting means comprising a plurality of low expansion coefficient rods 90 joined at their outer ends to the closure plates 50. In the form shown, the rods are mounted outside the outer conductor tube set (not shown).

In the modified form of mounting means shown in Fig. 7, the element having a low expansion coefficient is shown in the form of a cylinder 91 connecting the closure plates 50, thereby forming a relatively closed and sealed unit. It will be apparent that suitable adjusting means, such as the screw-threaded bolt arrangement 41 for the Fig. 6 device, may be utilized to provide suitable adjusting means for determining and adjusting the overall length of the constant frequency cavity device.

It will be apparent that various modifications may be made by those skilled in the art without departing from the present invention as set forth in the appended claims, and it is intended that all such modifications as come within the spirit and scope of the claims shall be thereby covered.

We claim:

1. A constant high frequency cavity device adapted for use as an electromagnetic resonator, comprising two pairs of concentric conductor tubes, each pair including an outer tube and an inner tube, said device including overlapping connections for the respective inner ends of said outer and inner tubes for permitting relative longitudinal movement of the respective connected tubes due to changes in temperature, means electrically connecting the outer ends of each pair of tubes, and mounting means connecting the outer ends of said assembly of tubes, said mounting means including an element having a low expansion coefficient relative to that of said tubes, said element extending parallel to the longitudinal axis of said device for maintaining the overall length of the device substantially constant with changes of temperature.

2. The combination as set forth in claim 1, wherein the walls of the inner end portions of one of said connecting tubes are each of relatively thinner cross-section than the remainder of the said tubes, said thinned portions being overlapped to provide said overlapping connection.

3. The combination as set forth in claim 1, wherein the walls of the inner end portions of one of said connecting tubes are each of relatively thinner cross-section than the remainder of the said tubes, and including a ring cooperating with said thinned portions of said tube walls to provide said overlapping connection.

4. The combination set forth in claim 1 wherein the end face of the inner end portion of one of said connecting tubes is provided with an annular groove and the end face of the inner end portion of the opposing tube is provided with a mating tongue to provide said overlapping connection.

5. The combination set forth in claim 1 wherein the wall thickness of the overlapping connection of one of said connecting tubes and the wall thickness of the remainder of said connecting tubes are substantially equal.

6. The combination set forth in claim 1 wherein the mounting means includes an axially positioned rod having a low-expansion coefficient.

7. The combination set forth in claim 1 wherein the mounting means includes a plurality of rods having a low-expansion coefficient positioned parallel to the common axis of said tubes.

8. The combination set forth in claim 1 wherein the mounting means includes a cylinder of low expansion coefficient positioned coaxially with the common axis of said conductor tubes.

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The following references are of record in the file of this patent:

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