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TUNING ARRANGEMENT FOR CONCENTRIC TRANSMISSION LINE RESONATORS

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Fig. 1.

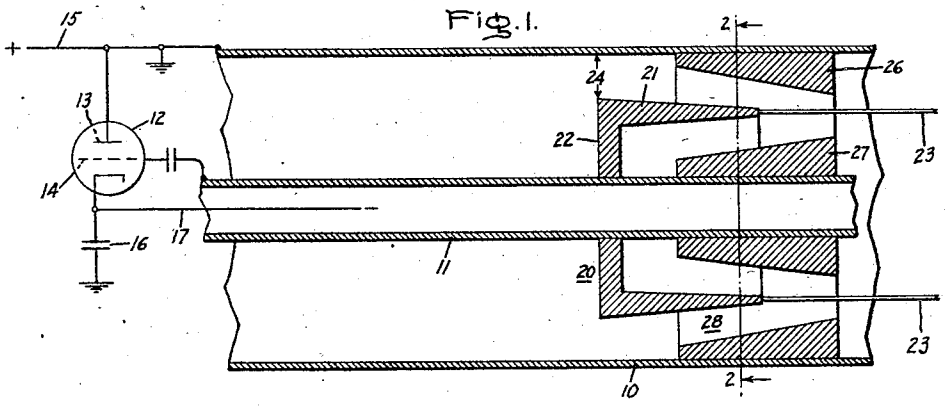


Fig. 2.

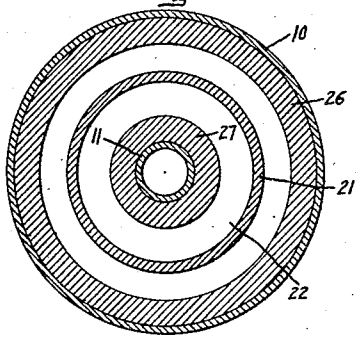
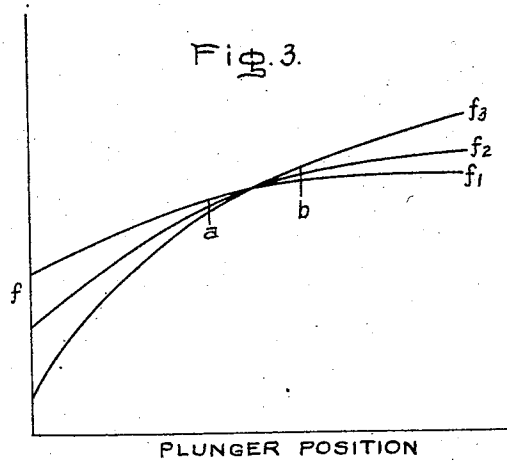


Fig. 3.



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2,435,442

TUNING ARRANGEMENT FOR CONCENTRIC TRANSMISSION LINE RESONATORS

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4 Claims. (Cl. 178—44)

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This invention relates to space resonant cavities of the concentric transmission line type, and in particular to arrangements for tuning such space resonant cavities.

It is an object of my invention to provide a new and improved capacitive tuning arrangement for a concentric transmission line cavity resonator.

It is known that a space resonant cavity of the type comprising a tubular outer conductor and a centrally disposed inner conductor may be excited by means of suitable exciting means, such as an electron discharge device, to establish transverse electromagnetic waves between the inner and outer conductors. The frequency of the space resonant system thus defined may be adjusted by adjustment of the electrical length of the concentric transmission line. In the past, tuning plungers for adjusting the length of such lines and of the capacitive type have been employed, the tuning plunger usually consisting of a cylindrical sleeve interposed between the inner and outer conductors and adjustably supported on one of these conductors. This sleeve forms a short section of transmission line with each of the conductors, the two sections of transmission line being connected in series for electromagnetic waves within the resonant cavity. It is apparent that in such a system the sections of transmission line formed by the plunger are of fixed length and, hence, optimum performance is obtained at only one frequency.

It is an object of my invention to provide a new and improved capacity tuning arrangement for a concentric transmission line resonator in which optimum operation of the resonator is obtained over a wide band of frequencies.

The features of the invention desired to be protected herein are pointed out in the appended claims. The invention itself, together with further objects and advantages, may best be understood by reference to the following description taken in connection with the drawing in which Fig. 1 is a longitudinal sectional view of a concentric transmission line cavity resonator embodying one of my improved capacitive tuners; Fig. 2 is a cross-section of the capacitive tuner of Fig. 1 along the line 2—2; and Fig. 3 is a graph illustrating the tracking characteristic of the ultra high frequency arrangement of Fig. 1.

Referring to Figs. 1 and 2 jointly, there is shown an ultra high frequency space resonant system of the concentric transmission line type and comprising a tubular outer conductor 10 and a centrally disposed inner conductor 11. Electromagnetic waves of the TEM, or transverse electromagnetic, type are established in the region between the conductors 10 and 11 by any suitable exciting means, such as the electron discharge device 12 having its anode 13 connected to outer conductor 10 and its control electrode 14 connected for alternating currents to inner conductor 11. The outer conductor 10, preferably, is operated at ground potential and anode potential is supplied to anode 13 over a conductor 15. The cathode of the device may be connected to ground for alternating currents through bypass capacitor 16 and to a source of negative potential for unidirectional currents by means of a lead 17. The exact form of the electron discharge device employed for establishing electromagnetic waves between the conductors 10 and 11 forms no part of the present invention and any suitable electron discharge device may be employed for this purpose. In the usual type of such systems, the electrodes themselves of the device 12 form a part of the boundary of the space resonant system.

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The space resonant region between the conductors 10 and 11 may be adjusted to resonate at a desired frequency by means of a cup-like metallic plunger 20 slidably supported on inner conductor 11 and comprising a cylindrical sleeve portion 21 concentrically disposed between the inner and outer conductors and extending longitudinally between these conductors, and an end wall 22 connecting the sleeve 21 to the conductor 11. The longitudinal position of the plunger 20 along the concentric transmission line defined by the conductors 10 and 11 may be adjusted by any suitable adjusting means, one form of which is illustrated in the drawing as a pair of rods 23.

In the operation of capacitive tuning plunger 20 the sleeve 21 concentrically disposed between the conductors 10 and 11 forms therewith a pair of short sections of concentric transmission line, one of which is defined by the outer surface of sleeve 21 and the inner surface of outer conductor 10 and the other of which is defined by the inner surface of sleeve 21 and the outer surface of conductor 11. These sections of transmission line are serially connected between the space resonant cavity to the left of the end wall 22 and the right-hand side of the end wall 22. The end wall 22 forms a short-circuit across the end of these serially connected sections of transmission line. From well-known considerations, it is apparent that optimum operation of a system employing a capacitive tuning plunger of this type is obtained at only one frequency, namely, the frequency at which the previously mentioned

two serially connected sections of transmission line are equal to a half wave length or an odd multiple thereof of the electromagnetic wave established between the conductors 10 and 11. At this particular frequency, the short-circuit constituted by the right-hand surface of wall 22 is reproduced at the other end of the serially connected transmission line sections to appear as a short-circuit across the gap 24 between the plunger 20 and outer conductor 10. As the frequency of the electromagnetic waves traveling along the conductors 10 and 11 is varied from this optimum operating frequency, the impedance across gap 24 is increased and the electromagnetic waves are no longer completely confined within the space resonant cavity.

In order to provide means whereby the capacitive plunger 20 may be utilized to operate a concentric transmission line resonator efficiently over a wide range of frequency in the system of Fig. 1, a pair of reflecting members in the form of annular sleeves 26, 27 are secured, respectively, to the inner surface of outer conductor 10 and the outer surface of inner conductor 11 and are located substantially in the same longitudinal position along the concentric transmission line 10, 11. The inner surface of annular member 26 and the outer surface of annular member 27 are conically shaped, having opposed surfaces which define an annular region 28, wedge-shaped in cross section. The sleeve portion 21 of plunger 20 extends into the wedge-shaped region 28 a distance which is adjustable by means of rods 23. The members 26 and 27, respectively, form capacitances with the cooperating surface of sleeve 21, which capacitances are connected across the short sections of concentric transmission line defined by members 21 and 10 and members 21 and 11. The addition of such capacitances across these transmission line sections is effective to increase the electrical length of the sections. By properly dimensioning the annular sleeves 26 and 27 and the sleeve 21 of the plunger 20, the capacitances connected across the transmission line sections may be caused to vary as the position of plunger 20 is varied to maintain the electrical length of each of these sections at a quarter wave length of the electromagnetic waves within the space resonant cavity as the frequency of the electromagnetic waves in the cavity is adjusted over a considerable range of frequencies. To this end, the members 26 and 27 may be formed of either metal or a suitable dielectric, such as polystyrene, to obtain a desired tracking characteristic.

The operation of the capacitance tuning plunger illustrated in Fig. 1 to provide more efficient operation of the space resonant system over a wide range of frequency may be illustrated by reference to Fig. 3 in which f_1 designates the frequency of the electromagnetic waves existing in the cavity resonator defined by conductors 10 and 11; f_2 denotes the resonant frequency of the concentric transmission line section defined by the outer surface of the sleeve 21 and the inner surface of conductor 10; and f_3 denotes the resonant characteristic of the concentric transmission section defined by the inner surface of sleeve 21 and the outer surface of conductor 11. As may be seen from the curve shown in Fig. 3, by the addition of the annular sleeves 26, 27, the frequency characteristics of the three concentric line sections may be made to coincide substantially over a considerable range of frequencies denoted in Fig. 3 as the range extending between the points *a* and *b*. It is apparent that as the plunger 20 is moved to the left, the frequency f_1 of electromagnetic waves of the space resonant system is gradually increased. At the same time, the capacitance between members 26 and 21 is decreased, so that, in effect, the electrical length of the section of concentric transmission line defined by the outer surface of sleeve 21 and the inner surface of conductor 10 is decreased with a consequent increase in the resonant frequency of this section. At the same time, movement of the plunger 20 to the left increases the resonant frequency of the section of transmission line defined between the inner surface of sleeve 21 and conductor 11.

While the invention has been described by referring to a particular embodiment, it will be understood that numerous modifications may be made by those skilled in the art without departing from the invention. I, therefore, aim in the appended claims to cover all such equivalent variations as come within the true spirit and scope of the foregoing disclosure.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination a space resonant system of the concentric transmission line type comprising a tubular outer conductor and a centrally disposed inner conductor, exciting means for establishing electromagnetic waves within said system, and means for adjusting the resonant frequency of said system, said means comprising a pair of reflecting members attached respectively to the outer surface of said inner conductor and the inner surface of said outer conductor, said members being substantially co-extensive along said conductors and having opposed tapered surfaces defining a wedge-shaped region therebetween, and a metallic cup-like member connected to said inner conductor and extending into said region an adjustable distance.

2. In combination a space resonant system of the concentric transmission line type comprising a tubular outer conductor and a centrally disposed inner conductor, exciting means for establishing electromagnetic waves within said system, and means for adjusting the resonant frequency of said system, said means comprising a pair of reflecting members attached respectively to the outer surface of said inner conductor and the inner surface of said outer conductor, said members being substantially co-extensive along said conductors and having opposed tapered surfaces defining a wedge-shaped region therebetween, and a metallic cup-like member connected to said inner conductor and extending into said region an adjustable distance, said metallic member forming with said conductors two serially connected sections of concentric transmission line and said sections and said resonator being tuned over a wide band of frequencies as the position of said metallic member is adjusted.

3. In combination, a space resonant system of the concentric transmission line type comprising a tubular outer conductor and a centrally disposed inner conductor, exciting means for establishing electromagnetic waves within said system, a metallic plunger slidably supported on said inner conductor, said plunger having a cylindrical sleeve concentrically disposed between said inner and outer conductors and defining therewith a pair of serially connected sections of concentric transmission line, and means for causing said system and said sections to resonate at substantially the same frequency over a substantial range of frequencies as the position of said plunger on

said inner conductor is varied, said means comprising a pair of annular sleeves secured respectively to the inner surface of said outer conductor and the outer surface of said inner conductor, said annular sleeves being substantially co-extensive along said conductors and having opposed surfaces defining an annular region therebetween into which said cylindrical sleeve is adapted to extend.

4. In combination, a space resonant system of the concentric transmission line type comprising a tubular outer conductor and a centrally disposed inner conductor, and means for adjusting the resonance frequency of said system and for preventing the leakage of electromagnetic waves therefrom, said means comprising a pair of wave reflecting members attached respectively to the outer surface of said inner conductor and the inner surface of said outer conductor, said members being substantially coextensive along said conductors, and an annular sleeve conductively

connected to one of said conductors and extending into the region between said members an adjustable distance, said members and said sleeve forming a choke for high frequency currents flowing along said conductors, said members and said sleeve having surfaces of such configuration that as the position of said sleeve between said members is adjusted the resonance frequencies of said system and said choke are matched over a substantial range of frequencies.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,955,093	Roosenstein	Apr. 17, 1934
2,171,219	Malter	Aug. 29, 1939