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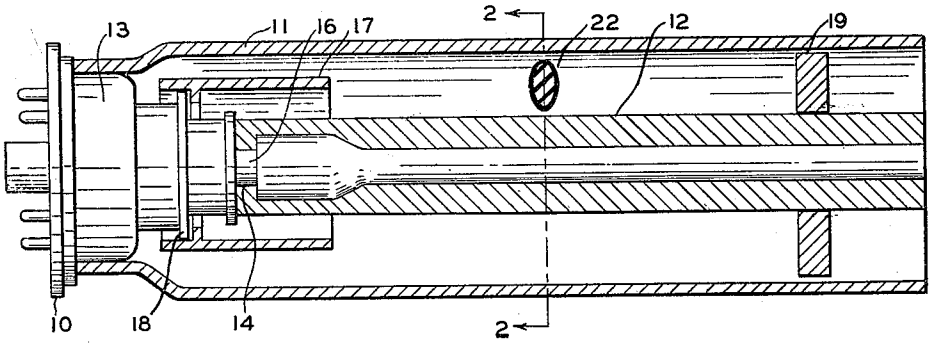
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OSCILLATOR TUBE WITH TUNABLE COAXIAL RESONATOR

Filed Aug. 1, 1945

FIG. 1



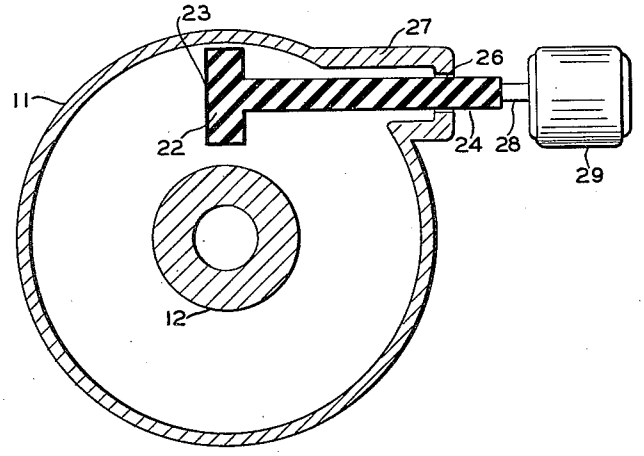


FIG. 2

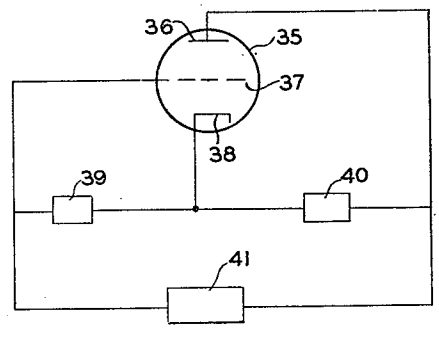


FIG. 3

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OSCILLATOR TUBE WITH TUNABLE COAXIAL RESONATOR

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1 Claim. (Cl. 315—39)

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This invention relates to ultra high frequency generators and more particularly to cavity oscillators.

Systems have been developed in the prior art for producing oscillatory electrical energy by means of suitable apparatus associated with cavity resonators. Means have been provided for adjusting the frequency of oscillation of said energy by suitable tuning arrangements associated with the cavity resonator.

As is well understood in the art, however, it would be desirable to provide simple and effective means that will cause the frequency of the oscillations to change over a limited range in a predetermined periodic fashion.

It is an object of this invention, therefore, to provide a system for causing the frequency of the electrical energy derived from a cavity type oscillator to change in a predetermined periodic manner over a predetermined range of frequencies.

In accordance with the present invention there is provided a cavity type oscillator with means associated with said cavity for changing the electrical characteristics of said cavity in a predetermined periodic manner.

For a better understanding of the invention reference is had to the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view of an oscillator employing the present invention;

Fig. 2 is a cross sectional view of the oscillator of Fig. 1 taken along the line 2—2' in Fig. 1; and

Fig. 3 is a block diagram of a basic oscillator circuit.

Referring now more particularly to Fig. 1, there is shown a type of cavity oscillator employing the present invention. In this embodiment of the invention a type of three-element vacuum tube 10 known to the art as a lighthouse triode is used. A coaxial line having an outer conductor 11 and an inner conductor 12 is used to form a resonant cavity. Cathode ring 13 of tube 10 makes contact with the conductor 11. The lighthouse triode tube is constructed so that there is no direct-current connection between cathode ring 13 and the actual cathode (not shown) of the tube. The cathode is connected to cathode ring 13 through an alternating-current path for oscillatory energy. Since only the oscillatory energy circuit is discussed, the terms "cathode" and "cathode ring" will be used synonymously, and in any connection made to cathode ring 13 it will be assumed that a connection is made to the cathode of the tube. An opening 14 is formed in conductor 12 so as to receive the anode cap 16 of tube 10. Conductor 12 makes electrical contact with anode cap 16. A cylindrical sleeve 17 is so placed in the space between conductors 11 and 12 that it makes contact with grid ring 18 of tube 10. Sleeve 17 is coaxially located with respect to conductors 11 and 12. An adjustable plunger 19 is disposed in the space between conductors 11 and 12. Plunger 19 is so constructed that conductor 11 is effectively short circuited to conductor 12 for oscillatory energy by a capacitative path without providing a path for direct current.

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A rotatable element 22 is placed in the space between conductors 11 and 12 at some point between plunger 19 and the base of tube 10. The location of element 22 is more clearly shown in Fig. 2. Conductors 11 and 12 and element 22 in Fig. 2 are numbered to correspond with Fig. 1. In the present embodiment of the invention, element 22 is an elliptical cylinder that is so constructed that the outer wall of the cylinder is substantially an equipotential surface. One method of obtaining the desired equipotential surface would be to form cylinder 22 of metal or dielectric material that has been silver-plated on the surfaces indicated by the heavy line 23. Element 22 is supported on a dielectric rod 24 which passes through an opening 26 in radio frequency choke 27. Choke 27 may be designed so that the impedance at the point where choke 27 joins conductor 11 is very low. Rod 24 is coupled to shaft 28 of motor 29.

Referring now to Fig. 3, there is shown a block diagram of a basic oscillator circuit employing a triode vacuum tube 35 having an anode 36, a grid 37, and a cathode 38. An impedance 39 is connected between grid 37 and cathode 38; an impedance 40 is connected between cathode 38 and anode 36, and an impedance 41 is connected between anode 36 and grid 37.

In the operation of the type of oscillator shown in Figs. 1 and 2 a cavity resonator formed by sleeve 17 and conductor 12 is connected between grid 18 and anode 16. A cavity resonator formed by conductors 11 and 12 and plunger 19 is connected between anode 16 and cathode 13. The operation of this type of oscillator is well known to the art and, therefore, no explanation of the function of the various elements will be given herein.

In the basic oscillator circuit shown in Fig. 3 it is known that if the circuit is to generate electrical energy of an oscillatory nature, impedances 39 and 40 must be of the same type, that is both inductive or both capacitive, and impedance 41

must be inductive when impedances 39 and 40 are capacitive and capacitive when they are inductive. It is also known that if any one of impedances 39, 40 and 41 is changed, the frequency of oscillation of the energy generated by the circuit will be changed.

It can be seen from a study of Fig. 1 that the cavity formed by conductors 11 and 12 and plunger 19 forms at least a part of an impedance corresponding to the impedance 40 of Fig. 3. Varying the effective impedance of this cavity of necessity changes the total impedance between anode 16 and cathode 13. It is well known to the art that the impedance or tuning of this cavity may be varied by moving plunger 19 in an axial direction with respect to conductor 12. It can be seen, however, it is not feasible to use plunger 19 for a continuous periodic variation of the tuning of the cavity since plunger 19 must make a sliding fit on one or both of conductors 11 and 12. Also, relatively small changes in position of plunger 19 causes large changes in the tuning of the cavity. It would require elaborate mechanical arrangements to cause plunger 19 to move in such a manner as to produce relatively small periodic changes in frequency of the electrical energy produced by the system. Plunger 19 is, therefore, used to select a base frequency about which the frequency of oscillation will be varied by other elements of this invention. As is known to the art, the tuning of the cavity may be varied by connecting a conventional type of capacitor between conductor 11 and conductor 12. This capacitor would have to be variable in order to change the frequencies in the manner desired. It would be difficult to provide means for suitably connecting a conventional capacitor between conductors 11 and 12 for changing the capacitance of the variable capacitor in the desired manner. This invention, however, provides a type of variable capacitance between conductor 11 and conductor 12.

It can be seen that when the longer axis of the ellipse 22 is perpendicular to the axis of conductor 12, the space between the cylinder and conductors 11 and 12 is very small. The effective capacitance between conductors 11 and 12, therefore, is large at this point. When the cylinder 22 is rotated so that the shorter axis of the ellipse is perpendicular to the axis of conductor 12, the space between the cylinder and conductors 11 and 12 is considerably greater. The effective capacitance is, therefore, reduced. As has already been stated, changing the capacitance between conductors 11 and 12 will change the tuning of the cavity and the frequency of oscillation of the electrical energy produced by this system. In this embodiment of the invention elliptical cylinder 22 is supported on a polystyrene rod 24 which is, in turn, adapted to be mounted on shaft 28 of motor 29. Shaft 28 passes through an opening 26 in choke 27. It is not necessary to provide a bearing at the opening 26 in choke 27 for the polystyrene rod 24 since the bearings of motor 29 provide sufficient support for rod 24 and element 22. It is obvious that the speed of rotation of element 22 may be controlled by suitable controls associated with the source of energy for motor 29.

The operation of this invention may be summarized as follows. Lighthouse triode 10 and its associated cavities are so designed that they will produce oscillatory electrical energy. The anode-cathode cavity is provided with two adjustments. Plunger 19 selects the base frequency at which the system oscillates, and element 22 provides a means for periodically varying the frequency over a predetermined range.

It should be understood that while element 22 has been described as an elliptical cylinder, any other shape suitable for the purpose may be used if desired. Moreover, the invention is not limited to the particular type of cavity oscillator shown but may be used with any type of cavity oscillator whose frequency may be varied by a rotating element similar to element 22. Thus, while there has been disclosed what is at present considered the preferred embodiment of the invention, it will be recognized by those skilled in the art that various changes and modifications may be made therein without departing from the invention.

I claim:

An oscillator comprising an electron tube having grid, anode and cathode terminals, first, second and third cylindrical conductors coaxially arranged and connected to said terminals, said first and second conductors forming a resonator between said anode and said grid terminals, said second and third conductors forming a resonator between said grid and cathode terminals, said first and third conductors defining a resonator between said anode and cathode terminals, an adjustable plunger interposed between said first and third conductors, said plunger providing a capacitative short circuit for radio frequency currents, an elliptical cylinder interposed between said first and third conductors, a conductive coating on said cylinder, the axis of said cylinder being transverse to the common axis of said conductors, a dielectric shaft axially supporting said cylinder, said shaft projecting through an opening in said third conductor, a motor for driving said shaft whereby said cylinder is rotated to periodically vary the effective capacitance between said first and third conductors.

JOHN J. GUARRERA.

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