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2,071,564

CYCLIC VARIABLE FREQUENCY OSCILLATOR

Original Filed Dec. 30, 1930 2 Sheets-Sheet 1

FIG. 1

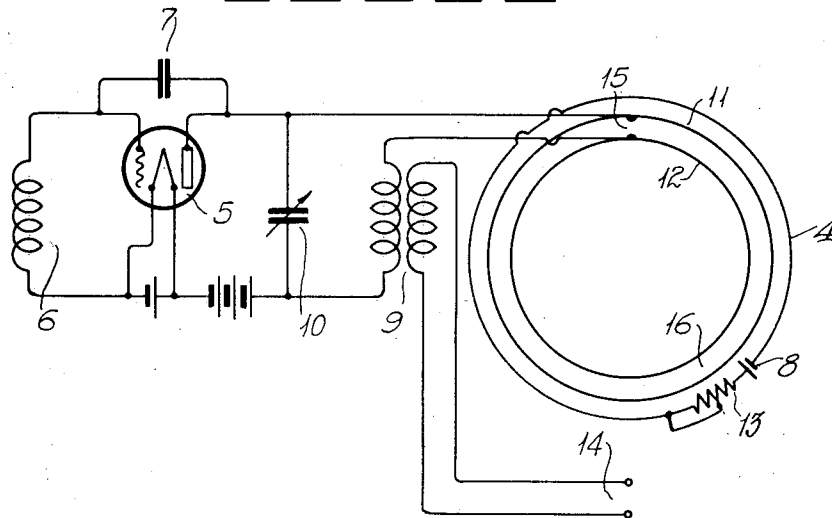


FIG. 2

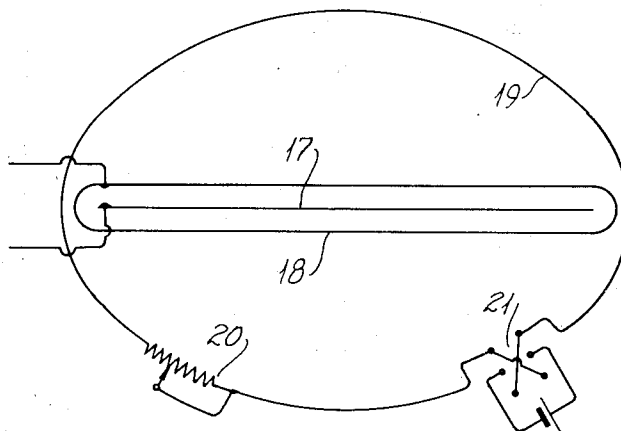


FIG. 3



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FIG. 4

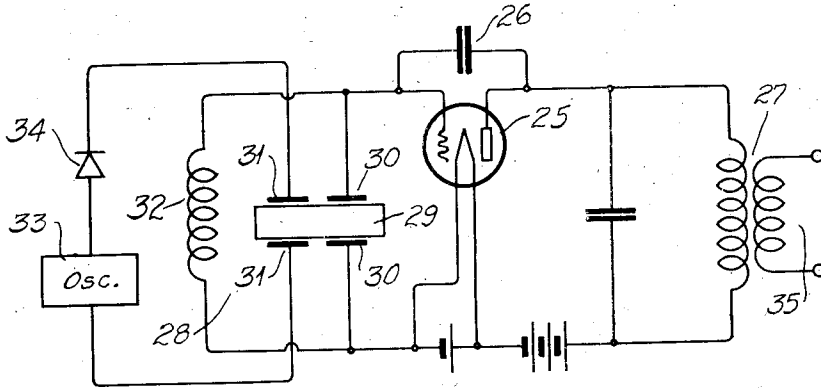


FIG. 5

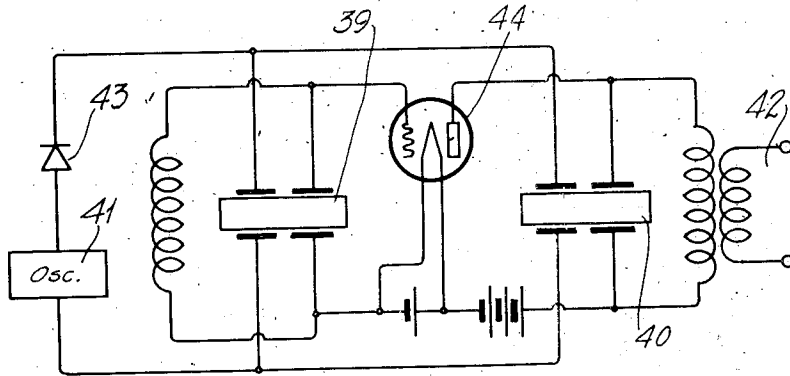
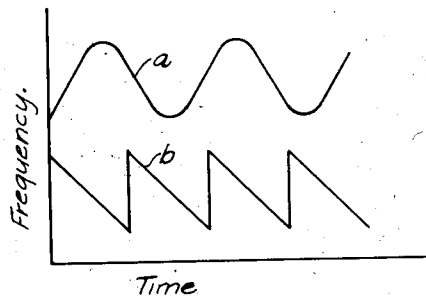


FIG. 6



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CYCLIC VARIABLE FREQUENCY
OSCILLATOR

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11 Claims. (Cl. 250—36)

This invention relates to electrical current oscillators, and particularly to such oscillators which produce a cyclic varying frequency.

5 An object of the invention is to obtain electrical current oscillations.

Another object of the invention is to obtain electrical current oscillations having a cyclic varying frequency.

10 A further object of the invention is to rapidly vary the inductance of an oscillating generator at a uniform rate.

A still further object of the invention is to rapidly vary the capacitance of an oscillating generator circuit at a uniform rate.

15 The method of and means for producing electrical current or voltage oscillations with a thermionic vacuum tube is well known in the art, and such oscillators are employed as common practice wherever high frequency oscillations are desired. They are also used to generate low frequency oscillations by the heterodyning method of beating two high frequencies together to obtain the low frequency oscillation.

20 The present invention contemplates the use of a high frequency oscillator of the thermionic vacuum tube type in which the inductance of the tuned circuit or the capacity thereof is varied uniformly at a high rate of change. The capacity and inductance of a tuned circuit has heretofore been varied by mechanical means, this method being limited by mechanical rotating speeds. The present invention varies these constants in an oscillator circuit in an electrical manner without the use of any mechanically moving parts whatever, permitting the attainment of extremely high speed variations.

25 The changes in inductance is obtained by the progress of an electrical discharge or arc over an electrode rail system wherein the arc is forced to travel by the field produced by the arc currents in the electrode rails. As the arc progresses along the rails, the inductive current path of the tuned circuit is varied by the variation of self-inductance in the electrode rails themselves. 30 The arc may also be made to travel over the rails in any direction desired by an auxiliary field, the variation in self-inductance being the same as with the self-propelled arc. The arc path may be continuous in the form of a circular path, or may follow a linear path, reversing at each end thereof. Furthermore, this arc path may be in a straight line and discontinuous, blowing out at one end and being immediately initiated at the other. In fact, the arc path may have

any configuration, depending upon the frequency characteristic desired.

The means for changing the capacity of the tuned circuit of the oscillator is a Rochelle salt crystal. It has been found that by varying the potential on a Rochelle salt crystal, the dielectric constant thereof may be varied within the limits of 70 to 14,000 and above. This effect is also present in quartz crystals, but not to such a marked degree. Accompanying this variation in dielectric constant is a change in capacity of the circuit in which the crystal is placed. Employing this principle in the tuned portion of an oscillator circuit, I vary a direct current potential on the crystal in a cyclic manner, obtaining a similar variation in capacity and consequently a variation in the frequency of the current generated by the oscillator.

The details of the invention will be better understood from the following description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a thermionic oscillator circuit in which the inductance is uniformly varied by the use of a traveling arc.

25 Figs. 2 and 3 show modifications of the arc system of Fig. 1.

Figs. 4 and 5 show thermionic oscillator circuits embodying a crystal of varying capacity; and

30 Fig. 6 is a graph of the output obtained from the oscillators disclosed in this invention.

Referring particularly to Figure 1, a vacuum tube 5 having a grid circuit 6 and a coupling condenser 7 is shown employed in the usual type of thermionic oscillator circuit. In the anode circuit of this oscillator is the primary of an output transformer 9 shunted by a condenser 10 for purposes of tuning the circuit to generate the band of oscillations desired. In series with the primary of the transformer 9 and forming part of the tuned circuit are the arc rails 11 and 12, between which current passes in the form of an electrical discharge or arc which is propagated along the rails by the magnetic flux from a winding 4, supplied from a source 8 under control of the rheostat 13. The arc rails may be contained within a gaseous or evacuated envelope, or may be in open air. The self-inductance of the electrodes 11 and 12 add to the inductance of the primary winding of the transmitter 9, the amount of the addition being determined by the position of the arc along the rails. As this oscillator is for the purpose of obtaining a current having a frequency in the neighborhood of a mega cycle

and above, only slight changes in the tuning inductance is required to considerably vary the frequency obtained at the output circuit 14. The highest frequency will be obtained when the arc is in the position 15, at which time the smallest amount of inductance is added to the tuning circuit, while the lowest frequency is generated when the arc is at the point 16, and the largest amount of self-inductance is added.

In the rail system in Fig. 2 which may be connected into the oscillator circuit in Fig. 1, the same type of frequency variation will be obtained. The arc is created along the rails 17 and 18 at any point, and with the use of a field, direct current or alternating, the arc may be controlled as to its speed and direction along the arc rails 17 and 18. Such a field either cylindrical or spherical is represented by the single turn 19. A rheostat 20 varies the field strength to change the speed of propagation of the arc, while a reversing switch 21 changes the direction thereof.

Referring to Fig. 6 for a moment, the curve "a" having frequency and time coordinates is illustrative of the variation in the frequency of the generated current obtained from the circuit shown in Fig. 1 with the rail system shown therein or the rail system shown in Fig. 2. The curve "b" in Fig. 6 is illustrative of the variations obtained in the output circuit 14 of Fig. 1, when the discontinuous rail system of Fig. 3 is employed. With the rail system of Fig. 3 the arc is created at initiating gap 23, and is propagated along to the blow-out terminal 24 solely by the field produced by the current in the rails and the arc. When the arc disappears at 24 it is immediately created at 23 and retraces its path, producing in the output of the oscillator a frequency which uniformly varies from a high value when the arc is at 23 to a minimum value when the self-inductance of the rails is added to the tuned oscillator circuit. It is to be understood, that should other frequency variations be desired, the arc rails may be designed accordingly, that is, the inductance may be added non-uniformly per unit time by different rail configurations, to obtain a non-uniform change in frequency.

Referring now to Figure 4, a vacuum tube 25 having a coupling capacity 26 and an output transformer 27 is shown having a tuned grid circuit 28 with a crystal 29 used as the capacity element. This crystal is provided with two sets of electrodes 30 and 31, electrodes 30 being connected in shunt to a grid inductance 32, and electrodes 31 being connected to a variable voltage oscillator 33 through a rectifier 34. As the oscillator 33 varies the output voltage, which is rectified so as to be uni-directional, the dielectric constant of the crystal 29 is varied, causing the capacity of the tuned grid circuit to vary likewise. This variation produces a cyclic varying frequency in the output circuit 35, which is shown by the curve "a" in Fig. 6. This curve will vary in form with the variations in the oscillator output potential.

In Fig. 5 a modification of the circuit in Fig. 4 is disclosed, in which a crystal 39 is employed in the grid circuit similarly to the crystal 29 in Fig. 4. In addition to this crystal, however, a second crystal 40 is used in the plate circuit, the dielectric constant of which is varied in unison with that of crystal 39 from the oscillator 41. In the system of Fig. 5, therefore, the plate circuit is tuned along with the grid circuit, providing a more efficient and stable oscillating system. The

output from this oscillator system obtained in the output circuit 42 will also be in accordance with the curve "a" in Fig. 6. Similarly to the system of Fig. 4, however, the frequency variations from the double crystal system are subject to the potential variations from the oscillator 41, the form of the potential variations being dependent upon the design of the oscillator 41. A rectifier 43 is used in this circuit in the same manner as the rectifier 34 in Fig. 4, that is, a uni-potential voltage is placed upon the crystals 39 and 40 to obtain dielectric variations, and consequently capacity changes in the grid and anode circuits of the vacuum tube 44.

The principle of inductance variation by a traveling arc along electrode rails, and the principle of capacity variation of the circuit by the variation in the dielectric constant of a Rochelle salt crystal may be employed in other electrical transmission circuits beside those disclosed above, and the invention is to be limited only by the scope of the appended claims.

What is claimed is:

1. In an electrical system, a thermionic vacuum tube having input and output circuits for generating electrical oscillations, a portion of one of said circuits being resonant to the generated frequency, means for coupling said circuits, and means for varying the resonance of said circuit portion, said resonance varying means comprising arc electrode rails as a portion of said resonance circuit.

2. In an electrical system, a vacuum tube, input and output circuits therefor for producing electrical oscillations, means for coupling said circuits, electrode rails in one of said circuits for varying the inductance of said circuit, and means for energizing said electrode rails and said vacuum tube.

3. In an electrical system, a vacuum tube having input and output circuits for producing electrical oscillations, means for coupling said circuits, inductance and capacity elements in said circuits to form a resonant circuit for tuning said system, and means for varying the tuning of said resonant circuit continuously and in cyclic order, said means including a moving electrical ionized path.

4. In an electrical oscillator system, a thermionic device, a tuned circuit for said device for defining the frequency of oscillations of said system, said tuned circuit having inductance and capacity elements, an input for said device coupled to said tuned circuit for partial regeneration, a direct current source connected to said tuned circuit, and an ionized path forming a part of the inductance of said tuned circuit for varying said inductance, said path being confined between electrodes.

5. In an electrical oscillator system, a thermionic device, a tuned circuit for said device including capacity and inductance, means for returning a portion of said energy in said tuned circuit to the input of said device, a fixed inductance in said tuned circuit, and a variable inductance in said tuned circuit, said variable inductance including a discharge path varying in position from time to time.

6. An electrical oscillator system in accordance with claim 5, in which the position of said electrical discharge varies in a definite pattern from time to time.

7. In an electrical oscillating system, a generator for producing oscillations of cyclic varying frequency, input and output circuits for said gen-

erator, one of said circuits being tunable to a predetermined frequency, means for coupling said circuits, and means for producing an ionized current path variable in position as part of said tunable circuit to produce said cyclic varying frequency.

8. In an electrical oscillating system, a vacuum tube, input and output circuits for said tube, one of said circuits having a resonant circuit therein, means for coupling said circuits, and a variable inductance in said resonant circuit including an ionized current path variable in length to vary said resonant circuit.

9. In an electrical oscillating system, a vacuum tube, input and output circuits therefor, means for returning a portion of the energy in said output circuit to said input circuit and a resonant circuit having capacity, fixed and variable inductances formed in one of said circuits, said variable inductance including an ionized current

path variable in position to vary said resonant circuit.

10. In an electrical oscillator system, a thermionic device, a tuned circuit for said device including capacity and inductance, means for returning a portion of the energy in said tuned circuit to the input of said device, a fixed inductance in said tuned circuit, and a variable inductance in said tuned circuit, said variable inductance including a discharge path.

11. In an electrical generating system, a thermionic vacuum tube having input and output circuits, a portion of one of said circuits being resonant to a frequency to be generated, means for coupling said circuits for generating said frequency, and means for utilizing the current flowing in said resonant circuit for cyclically varying the tuning of said circuit.

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