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FREQUENCY STABILIZING CIRCUIT

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Fig. 1.

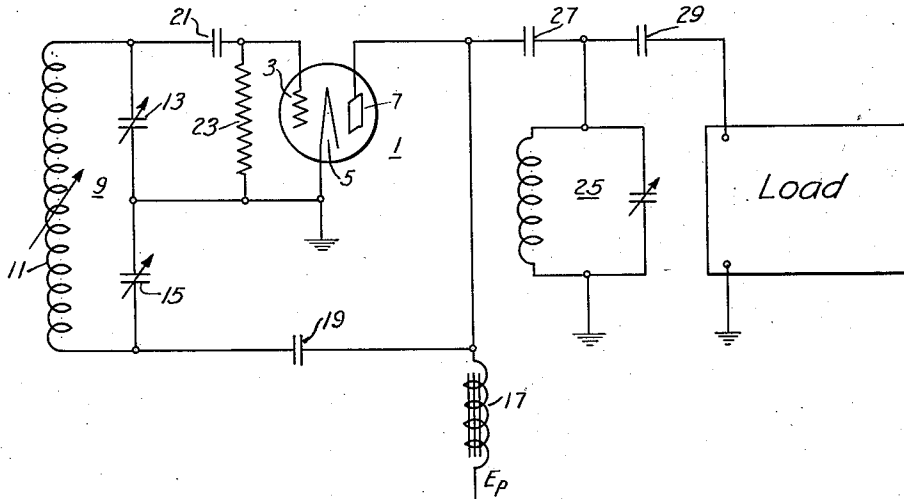
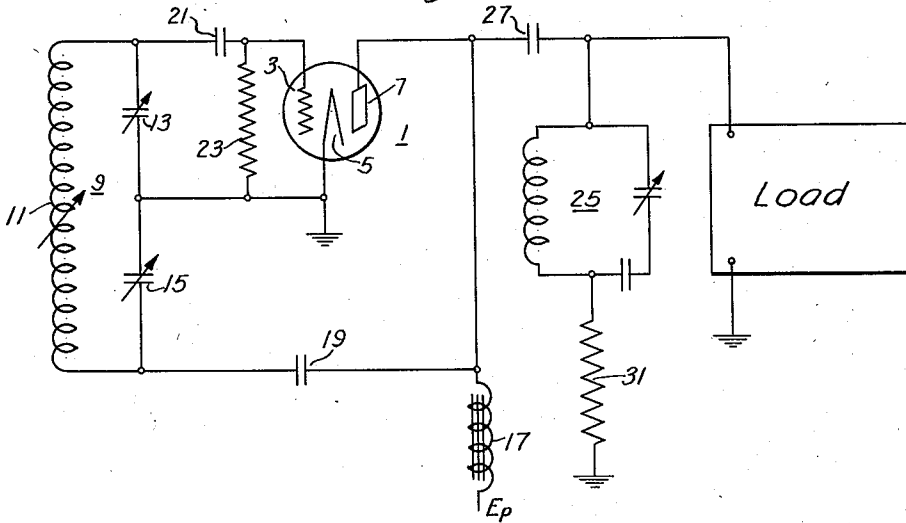


Fig. 2.



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FREQUENCY STABILIZING CIRCUIT

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4 Claims. (Cl. 250—36)

My invention relates to radio circuits, more particularly to an oscillation generator employing an electron discharge device. In the design of variable frequency transmitters, the general practice is to employ a master oscillator for the generation of frequency. A master oscillator usually comprises an oscillation generator of any of the well known types, such as the Hartley or Colpitts oscillators, the frequency determining circuit of which is made adjustable so that the carrier frequency may be altered at will. Crystals cannot be employed conveniently in transmitters of the variable frequency type by reason of the fact that once a crystal is inserted in the generator, the frequency of the generator becomes fixed and the adjustability of the generator to vary the frequency is lost as long as the crystal is maintained in the circuit. Consequently, by reason of the fact that advantage cannot be taken of the stability characteristics which a crystal will impart to a generator, a master oscillator is, therefore, subject to the frequency shifting influences normally caused by a change in the plate supply source or a change in the loading. Such frequency changes, according to theory, are traced to changes in the internal characteristics of the electron discharge device produced by a change in the plate voltage or the loading, the internal characteristics of the tube determining to a slight extent the frequency at which the oscillator will oscillate. Thus, if the plate voltage is doubled in value, the frequency may be caused to shift on the order of about one-half of one percent. By removing the load from the generator, a change in frequency of approximately one-third of one percent may be obtained. Due to the high degree of frequency stability required in current practice, such large variations in the frequency of the oscillator cannot be tolerated.

It is accordingly an object of my invention to provide an oscillation generator having a high degree of stability and one which does not require the use of a crystal to obtain such stability.

Another object of my invention is to provide a variable oscillation generator having a frequency stability approaching that of a crystal controlled oscillator.

A further object of my invention is to provide an oscillation generator which is simple in design and not subject to appreciable reactive effects due to changes in the plate supply voltage or changes in the load.

Additional objects of my invention will be disclosed in the following description of the same.

In the drawing, I have disclosed two embodi-

ments of my invention, Figure 1 and Figure 2 each disclosing one form of the invention.

Referring now to the figures, I have disclosed my invention as designed around an oscillator of the Colpitts type although, after the same has been described, it will be obvious how my invention may be applied to oscillators of any general character. In the circuit of Fig. 1, the oscillation generator comprises an electron discharge device 1 having a grid, cathode and plate electrodes 3, 5 and 7 respectively, the grid circuit and plate circuits being coupled through a frequency determining circuit 9 comprising an inductor 11 and a pair of condensers 13 and 15 shunting the inductor. The cathode is connected to a point on the frequency determining circuit intermediate the two condensers. A source of potential for the plate electrode is applied to the same through a high frequency choke coil 17 which functions to permit the passage of low frequency or direct current but which prevents the flow of the high frequency energy developed in the generator. Blocking condensers 19 and 21 are inserted in the grid and plate leads to the frequency determining circuit, these condensers functioning to provide a low resistance path for the high frequency energy at the same time serving to keep the high voltage of the plate supply source from being impressed upon the frequency determining circuit or the grid of the tube. Condenser 21 may also serve as a grid condenser, and the customary grid leak 23 may be provided between the grid and cathode or in any other suitable location.

The output circuit for the generator comprises a tunable circuit 25 coupled to the plate or anode circuit through a capacitor 27. This tunable circuit will normally, in the practice of my invention, be tuned to a harmonic of the frequency determining circuit 9. The load to be fed by the generator may be coupled to the output circuit as shown through a condenser 29 connected intermediate the coupling condenser 27 and the harmonically tuned circuit 25.

With the fundamental frequency determining portion of the generator designed to produce a wave rich in harmonics, the harmonically tuned circuit 25 will be vigorously excited and a substantial output to the load at the harmonic frequency will be obtained.

The oscillation generator disclosed in Fig. 2 is similar to that of Fig. 1, but differs only in the fact that the tuned output circuit 25 is directly connected instead of capacitively coupled to the load which might comprise the grid of an ampli-

fier. Where this design is resorted to, the harmonically tuned circuit 25 will comprise both the output circuit of the generator and the input circuit to the subsequent amplifier and a grid resistor 31 will be connected in series with the harmonically tuned circuit.

I have found in the operation of the above generators that a high degree of frequency stability can be obtained. This stability approaches that of a crystal controlled oscillator and the generator is free of the disadvantage accompanying the use of the crystal in that the frequency of the generator may be varied by adjusting the tuning of the tuned circuits, either individually or simultaneously. If the frequency of the determining circuit is changed, the harmonically tuned circuit may thus, for best results, also be changed to maintain the desired harmonic relationship.

While I have disclosed the output circuit as including a resonant circuit tuned to a harmonic of the frequency determining circuit, I have found that a choke having a low impedance to the frequency of the frequency determining circuit will also give me a generator which will have the same high degree of frequency stability. However, the output of the generator does not equal that obtained when a harmonically tuned output circuit is employed due, no doubt, to the fact that a harmonically tuned circuit may be vigorously excited by harmonics in the fundamental, whereas this will not occur to an appreciable extent when employing a low impedance choke.

As an example of the high degree of stability obtained in the improved generator of my invention, I have found that in doubling the voltage, the frequency shift has been reduced from about .5 of one percent to approximately .001 of one percent and that by removing the load on the generator, the frequency shift has been reduced from about .33 of one percent in the old type generator to approximately .0015 of one percent in the generator designed according to my invention.

While I am not prepared to tie the operation of my invention down to a fixed theory, it is fairly certain that a successful operation of the same requires that the output circuit of the generator comprises a load which is inductive at the fundamental frequency, that is, the frequency of the frequency determining circuit.

In the book entitled "Thermionic Vacuum Tube" by Van der Bijl on page 208 is an equation representing the effective capacity due to the internal characteristics of an electron discharge device. This formula appears as follows:

$$C = C_{gf} + C_{vp} \left(1 + \frac{MR_i}{R_p + R_i} \right)$$

wherein

C_{gf} = Capacity from grid to filament
 C_{gp} = Capacity from grid to plate
 C_{pf} = Capacity from plate to filament
 R_g = Grid to filament resistance
 R_p = Plate resistance
 R_i = Load resistance
 M = Amplification factor of the tube.

From this relationship, it can be seen that a decrease in the plate resistance of the electron discharge device caused by increasing the voltage on the tube produces an increase in the effective capacity of the discharge device. This increase in effective capacity when taken in consideration with the frequency determining circuit constants will result in a slight lowering of the fundamental

frequency. Now, if the load resistance R_i can be decreased at the same time, the effect of decreasing the tube resistance R_p can be in a large measure offset. This offsetting reaction can be obtained by making R_i inductive at the frequency of the frequency determining circuit or in other words, the fundamental frequency. Thus, any change in either the plate voltage or the load will tend to produce a shift in frequency which, in turn, will react to produce a counter effect, thus producing an effective balance of undesired conditions and in this way hold the frequency of the circuit constant.

Various changes in the above circuits may become obvious to those skilled in the art now that the fundamental principle of the same has been disclosed. Therefore, while I have gone into great detail to describe two embodiments of my invention, it should be apparent that various changes might be made without departing from the scope of my invention and I, therefore, do not desire to be limited to the details described except as is necessitated by the prior art and the appended claims.

I claim as my invention:

1. An oscillation generator comprising a tube having at least an anode, cathode and control grid, a circuit connected between said grid and cathode, a circuit between said anode and cathode, means for coupling said circuits for feeding energy from the second-mentioned circuit to the first-mentioned circuit, means including at least one of said circuits for tuning said oscillator to a desired frequency and a circuit antiresonant to a harmonic of said desired frequency connected in a path shunting the second-mentioned circuit between said anode and said cathode.

2. An oscillation generator comprising a tube having at least an anode, cathode and control grid, tuned circuit means comprising said anode, grid and cathode for the feed back of energy from said anode to said grid whereby oscillations of a desired frequency are produced and a circuit antiresonant to a harmonic of said desired frequency connected in a path between said anode and cathode, said path being separate and distinct from that portion of said oscillation generator which produces the fundamental frequency.

3. An oscillation generator comprising a tube having at least an anode, cathode and control grid, a circuit connected between said grid and cathode, a circuit between said anode and cathode, means for coupling said circuit for feeding energy from the second-mentioned circuit to the first-mentioned circuit, means in the first-mentioned circuit for tuning said oscillator to a desired frequency and a circuit tuned to a harmonic of said desired frequency connected in a path shunting the second-mentioned circuit between said anode and said cathode.

4. An oscillation generator comprising a tube having at least an anode, cathode and control grid, a circuit interconnecting said anode and cathode, a second circuit interconnecting said control grid and cathode, said circuits being coupled and including tuning means whereby oscillations of a desired frequency are produced, a separate and distinct circuit interconnecting said anode and said cathode, said last mentioned circuit including a resonant circuit tuned to an harmonic of the aforementioned frequency, and a load circuit coupled to said last mentioned circuit.