

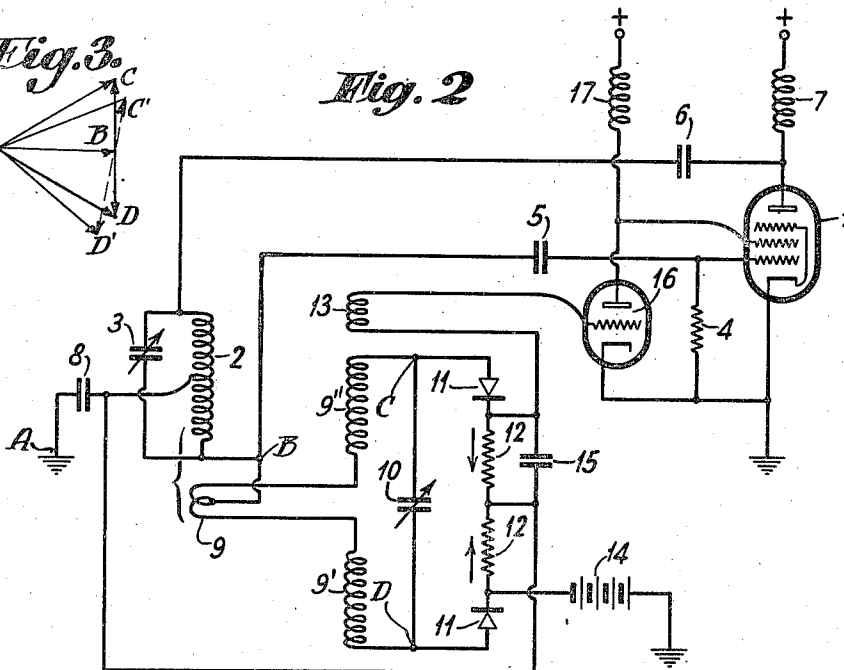
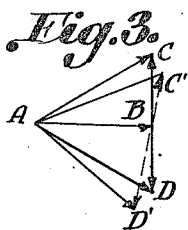
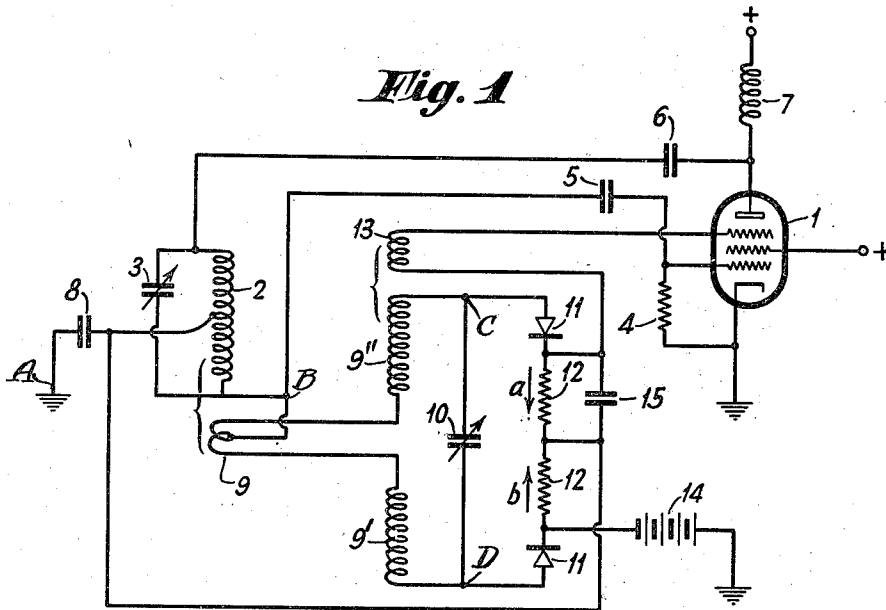
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STABILIZED-FREQUENCY OSCILLATOR ARRANGEMENT

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STABILIZED-FREQUENCY OSCILLATOR
ARRANGEMENT

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The outstanding feature of this arrangement is that the said circuit is not in need of being essentially of the low-loss or low-damped kind and that, therefore, the same may be of reduced dimensions and may preferably be confined inside a thermostat.

The invention is based upon an appreciation of the fact that, if in addition to the normal excitation on the control grid (which excitation is in phase opposition to the output potential), there is impressed on the same grid or upon another grid a supplementary excitation which is in quadrature to the normal excitation, variations of the ensuing frequency will be occasioned. If, then, the value of the excitation in quadrature or its effect is made to be a function of the instantaneous frequency itself, it is possible to secure a control action whose influence will increase with larger variations in this excitation in quadrature, or will have a different effect for a given departure of the frequency. If the tuned circuit supplying this quadrature excitation is not particularly satisfactory, the excitation may vary only a small amount, but its effect nevertheless can be made very variable if a slight variation of instantaneous frequency results in an appreciable change in the biasing of the grid upon which the same is impressed, and this is possible to do by means of a differential system.

In brief, the invention as applied to a self-generating or self-oscillatory circuit organization consists in creating supplementary excitation which is essentially in quadrature relation to the normal or main excitation, and in applying the same to a control grid whose bias varies very markedly with the frequency.

Figs. 1 and 2 illustrate by way of example two embodiments of the present invention. Fig. 3 is a vector diagram given to aid in an understanding of the invention.

Referring to this Fig. 1; there is shown an oscillator circuit including a pentode vacuum tube 1, having in circuit therewith an oscillatory circuit comprising an inductance coil 2 and a shunt tuning condenser 3, this oscillatory circuit being adapted to maintain oscillations. Associated with the control first grid of tube 1 there is a leak resistance 4. The first grid and the plate of the vacuum tube are respectively coupled to the oscillatory circuit 2, 3 by means of condensers 5 and 6. The condenser 5, in effect, is a blocking condenser. A plate blocking inductance coil 7 is provided between the plate of the vacuum tube 1 and the positive terminal of a source of polarizing potential as shown.

It will be noted that all of these elements occur in the so-called Hartley oscillator arrangement which has here been chosen for the sake of argument and example. However, instead of connecting directly with the cathode (ground) a suitable point of the inductance coil 2, the said point is connected through a capacity of large value 8; and this will bring about no change in the properties of the circuit organization.

Now, incorporated in the latter are the following elements, and this constitutes the characteristic feature of the invention: First, an oscillatory circuit consisting of an inductance comprising three constituent parts, namely 9, 9' and 9'', the part labeled 9 being in coupling relationship with the inductance 2 as indicated in the drawing, and of the (variable) tuning capacity 10. Second, two detectors 11 working upon resistances 12 which are of a high and equal value. Third, a coupler coil 13 coupled to part 9'' and designed to insure excitation in quadrature and which in the present instance is applied to the "rejector" (suppressor grid) of the pentode.

It will be noted that the circuit of the said grid comprises in addition to the coupling coil 13, the two resistances 12 from *a* to *b*, and the biasing battery 14.

It will also be noticed that the resistance 12 connected at *b* is, as a matter of fact, shunted by the capacity 8; and the second resistance 12 will be shunted the same way by the capacity 15. These capacities are intended to insure filtering of the detected radio frequency. Examining the properties of this part of the circuit organization which basically is known in the art, it will be understood that the direct current voltage tapped between *a* and *b* is zero when the circuit 9, 9', 9'', 10 is strictly tuned to the frequency, and this by virtue of the fact that the radio frequency potentials applied to the detectors are equal as resultants of a common voltage furnished by the inductance 2 and a voltage which is in quadrature and set up across the terminals of the condenser 10 as a result of mutual inductance existing between coils 2 and 9. The potentials in phase quadrature are: On the one hand, the potential of inductance 2 (or of the small inductance 9 coupled to 2), and on the other hand, the potential between the center point B of the small inductance 9 and the point of junction of one of the large inductances 9' or 9'' and the condenser 10, labeled C or D (or the potential in inductance 13 coupled to the large inductance 9''). Under these conditions, the battery 14 alone will govern the biasing of the suppressor grid, and the ex-

citation in quadrature set up at 13 has a definite effect. However, it will at once be seen that if the frequency varies, then the potential across the terminals of 10 is no longer in quadrature relationship to that across the terminals of 2, and a direct current potential will arise between or across *a* and *b*; this potential being added to or deducted from that of the battery 14 will alter the bias or polarization of the suppressor grid and as a consequence the effect of the excitation set up across the terminals of 15, even if the amplitude of the latter may be taken to have remained unchanged. Hence, all that is necessary is to choose a convenient sense for the mutual inductance in order to insure the desired action. It will be noted that—and this is an essential feature of the invention—the action and thus the stability of the frequency may be raised, without affecting the quality of the circuit 9, 9', 9'' by relaxing or loosening the coupling between 9'' and 13 and increasing the amplitudes set up across the terminals of the detectors. Indeed, under these conditions there will be the same alternating amplitude at 13, but the variable bias between *a* and *b* will vary at a much faster rate with departure of the frequency.

The appearance of unequal currents in resistances *a* and *b* is due to the dephasing which is produced at tuning of circuits 9, 10 and 2, 3; the unrectified potentials, applied between the common point of resistances *a* and *b* and the respective terminals of condenser 10, are indeed normally expressed by equal vectors AC and AD shown in Fig. 3, potential AB being furnished by inductance 2, potentials in quadrature BC or BD being derived between the center point of the small inductance 9, and each respective terminal common to condenser 10 and to a large inductance 9' or 9''.

When detuned, vectors BC and BD become BC' and BD', they continue to be equal and opposed, and their amplitude changes very little in regard to vectors BC and BD. However, the resultants AC' and AD' become clearly different, and the rectified potentials applied to the terminals of resistances *a* and *b* are proportional to the amplitudes of said vectors which explains a resulting term which modifies the continuous bias on the suppressor grid.

In what precedes, the implicit assumption has been made that the slope of the characteristic of the plate current as a function of the potential of the suppressor grid is not linear; hence, it will be desirable to make the latter of a variable pitch. It would also be feasible to increase the control action by incorporating in the circuit organization a small supplementary variable slope (μ) tube designed to amplify the quadrature excitation. What thus results is a circuit scheme of the kind shown in Fig. 2. Also, in this case the oscillator tube is of the pentode type.

In Fig. 2 the same reference letters are used for identical elements as in Fig. 1. The voltage across the terminals of 13 is amplified by the variable- μ tube 16 instead of being applied directly to a control electrode of tube 1. In this particularly simple embodiment, the amplified potential serves to control the pentode by connecting the plate of tube 16 with the screen of tube 1 and a suitable positive potential through a blocking inductance coil 17.

What I claim is:

1. An oscillation generator comprising an electron tube having a cathode, an anode, first and second grid electrodes, a tuned circuit coupled to

said cathode, anode and first grid electrode, and means for producing an oscillatory voltage in said tuned circuit, said means comprising means for applying an excitation voltage derived from said tuned circuit to said first grid electrode of the tube for sustaining oscillations, means for applying a second excitation voltage derived from said tuned circuit to said second grid electrode of the tube, means for dephasing said second excitation voltage substantially in quadrature with respect to said first excitation voltage, means for combining voltages proportional to said two excitation voltages to produce two direct current voltages, one responsive to the vector sum and one responsive to the vector difference of said proportional voltages, and means for applying the resultant of said two direct current voltages to said second grid, whereby the frequency of said tuned circuit is stabilized.

2. An oscillation generator comprising an electron tube having a cathode, an anode, first and second grid electrodes, a main tuned circuit coupled to said cathode and one of the said grid electrodes, an auxiliary tuned circuit having two sides and coupled with said main tuned circuit so as to be driven thereby, means for combining voltage from the main tuned circuit and voltage on one side of the auxiliary tuned circuit, and means for rectifying said combined voltage, means for combining voltage from the main tuned circuit and voltage on the other side of the auxiliary circuit, and means for rectifying said last combined voltage, means for combining said rectified voltages in opposing relation to produce a resultant voltage, and means for applying to said other grid said resultant voltage and a biasing voltage and also a voltage in phase with the voltage across said auxiliary circuit, whereby departures of the generated frequency from the normal operating frequency controls the magnitude and polarity of said resultant voltage in such sense as to oppose said departures of frequency.

3. An oscillation generator comprising an electron discharge device having a cathode, an anode and a grid, means for producing oscillations including sources of potential for energizing said electrodes and a tuned circuit composed of inductance and capacitance, means for deriving from said tuned circuit a voltage which increases with frequency and another voltage which decreases with increase in frequency, separate means for rectifying said voltages, an apertured electrode in said tube for affecting the frequency of said oscillations, and means for combining the rectified voltages in opposition to each other and for applying the resultant to said apertured electrode, whereby the frequency of oscillations produced by said generator is stabilized without dependence upon amplitude variations.

4. An oscillation generator comprising an electron tube having a cathode, anode, a control grid, a screen grid and a suppressor grid, a tuned circuit coupled to said anode, cathode and control grid, means for producing an oscillatory voltage in said tuned circuit and for applying to the control grid an excitation voltage derived from said tuned circuit for maintaining oscillations, biasing means in said suppressor grid circuit, means for applying a second excitation voltage to said suppressor grid circuit means for dephasing said second excitation voltage substantially in quadrature with respect to said first excitation voltage, means for combining voltages proportional to said excitation voltages to produce two direct current voltages, one responsive to the vector sum and one

responsive to the vector difference of said proportional voltages, and means for applying the resultant of said two direct current voltages to said suppressor grid, whereby the frequency of said tuned circuit is stabilized.

5 5. An oscillation generator as claimed in claim 4, wherein the suppressor grid has a variable pitch.

10 6. An oscillation generator comprising an electron tube having a cathode, an anode, a control grid and a screen grid, a tuned circuit coupled to said cathode and control grid, means for producing an oscillatory voltage in said tuned circuit and for applying to the control grid an excitation
15 voltage derived from said tuned circuit for maintaining oscillations, biasing means in said screen grid circuit, means for applying a second excitation voltage to said screen grid circuit, means for dephasing said second excitation voltage substantially in quadrature with respect to said first excitation voltage, and means for combining voltages proportional to said two excitation voltages to produce two direct current voltages, one responsive to the vector sum and one responsive to
20 the vector difference of said proportional voltages, and means for applying the resultant of said two direct current voltages to said screen grid, whereby the frequency of said tuned circuit is stabilized.

30 7. An oscillation generator comprising an electron tube having a cathode, an anode, a control grid and a screen grid, a tuned circuit coupled to the cathode and control grid of said tube, means for producing an oscillatory voltage in said tuned circuit and applying to the control grid a voltage
35 excitation in dependence upon the voltage of said

tuned circuit for maintaining oscillations, a variable mu valve relay having its anode-cathode space connected between said screen grid and cathode, biasing means in the input circuit of said variable mu valve, means in series with said
5 biasing means for applying a second excitation voltage to said input circuit, means for dephasing said second excitation voltage substantially in quadrature with respect to said first excitation, and means responsive to the amplitude of the
10 vector sum of said first and second excitation voltages for varying the magnitude of the voltage developed by said biasing means for stabilizing said tuned circuit frequency.

8. An oscillation generator comprising an electron discharge device having a cathode, an anode and a grid, means for producing oscillations including sources of potential for energizing said electrodes and a tuned circuit composed of inductance and capacitance, means for deriving
15 from said tuned circuit a voltage which increases with frequency and another voltage which decreases with increase in frequency, separate means for rectifying such voltages, an apertured electrode in said tube for affecting the frequency
20 of said oscillations, and means for combining the rectified voltages in opposition to each other for applying the resultant to said apertured electrode, a further means for applying to said apertured electrode the voltage derived from said tuned circuit and in quadrature with the voltage across
25 said tuned circuit, whereby the frequency of oscillations produced by said generator is stabilized without dependence upon amplitude variations.

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