Oct. 25, 1949. R. W. CLARK 2,486,005

CONTROLLED GENERATOR

Filed Feb. 26, 1946

Fig. 1.

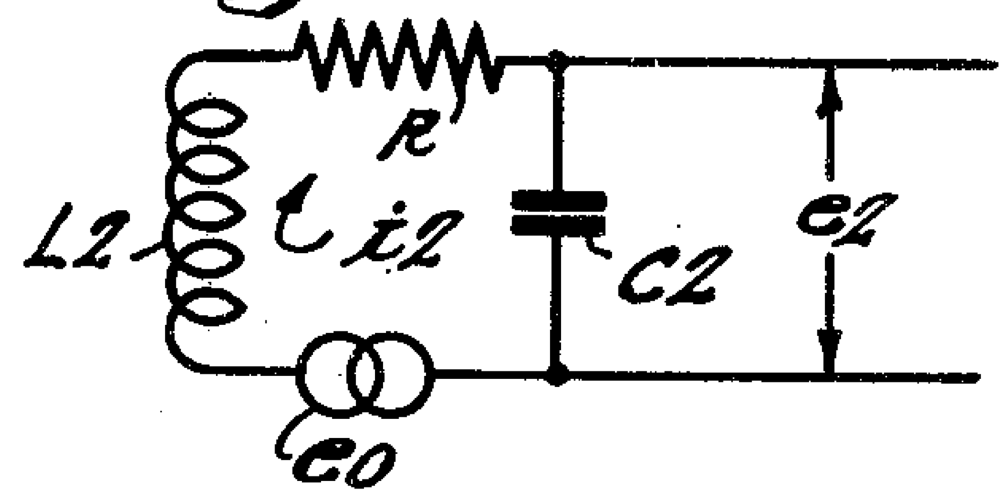


Fig. 2.

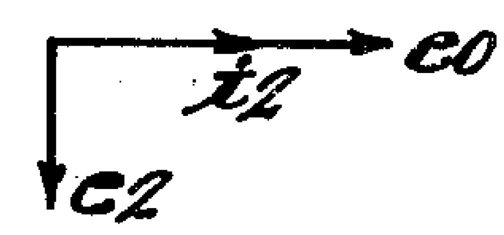


Fig. 3.

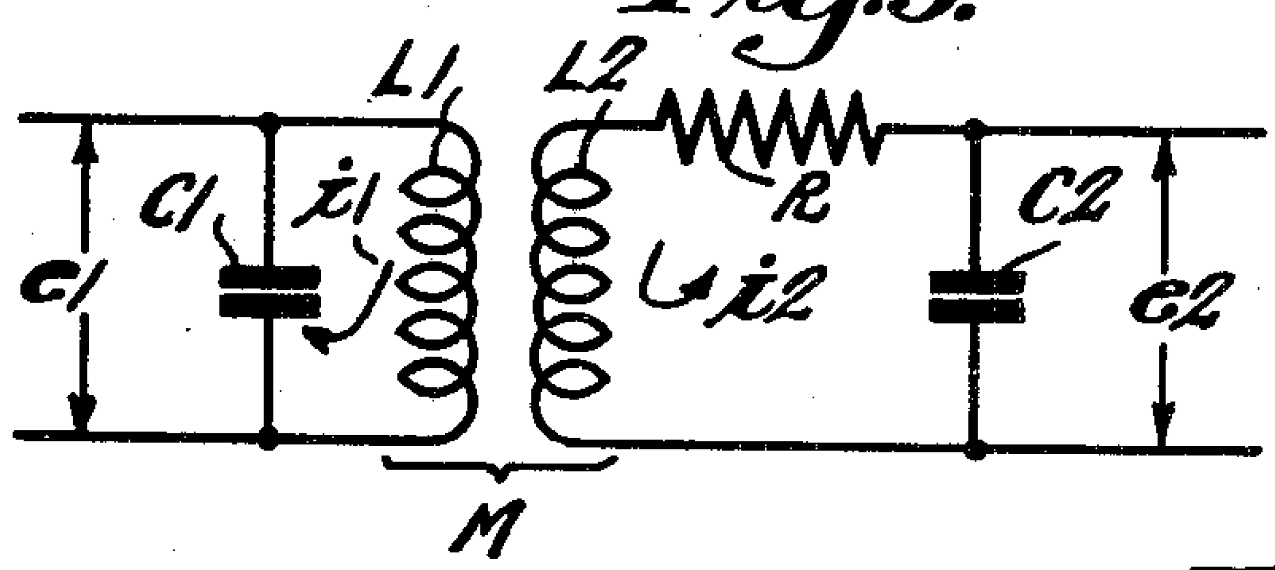


Fig. 4.

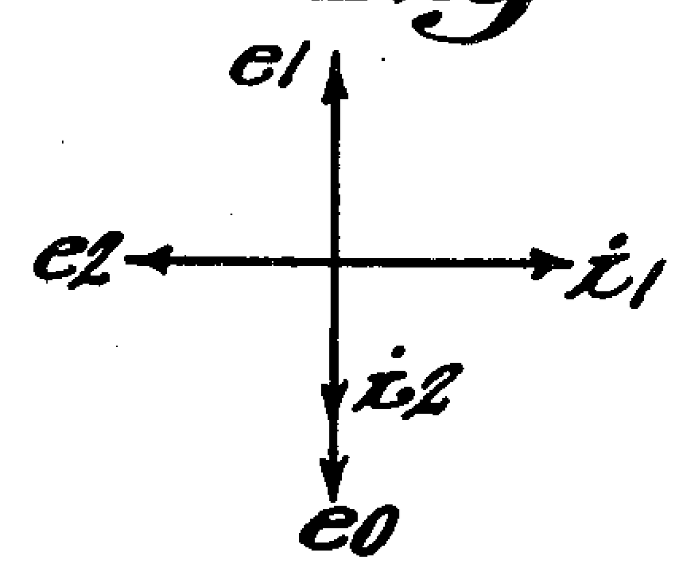


Fig. 5.

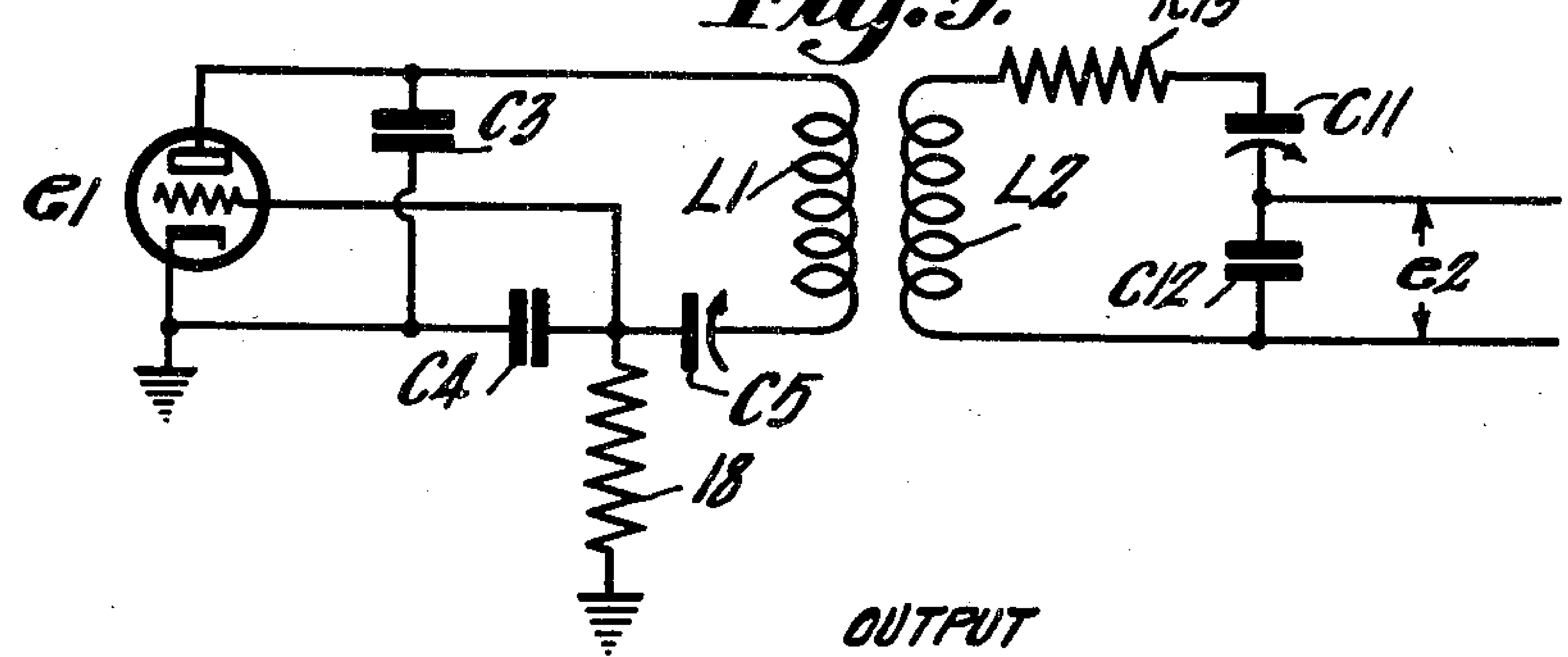
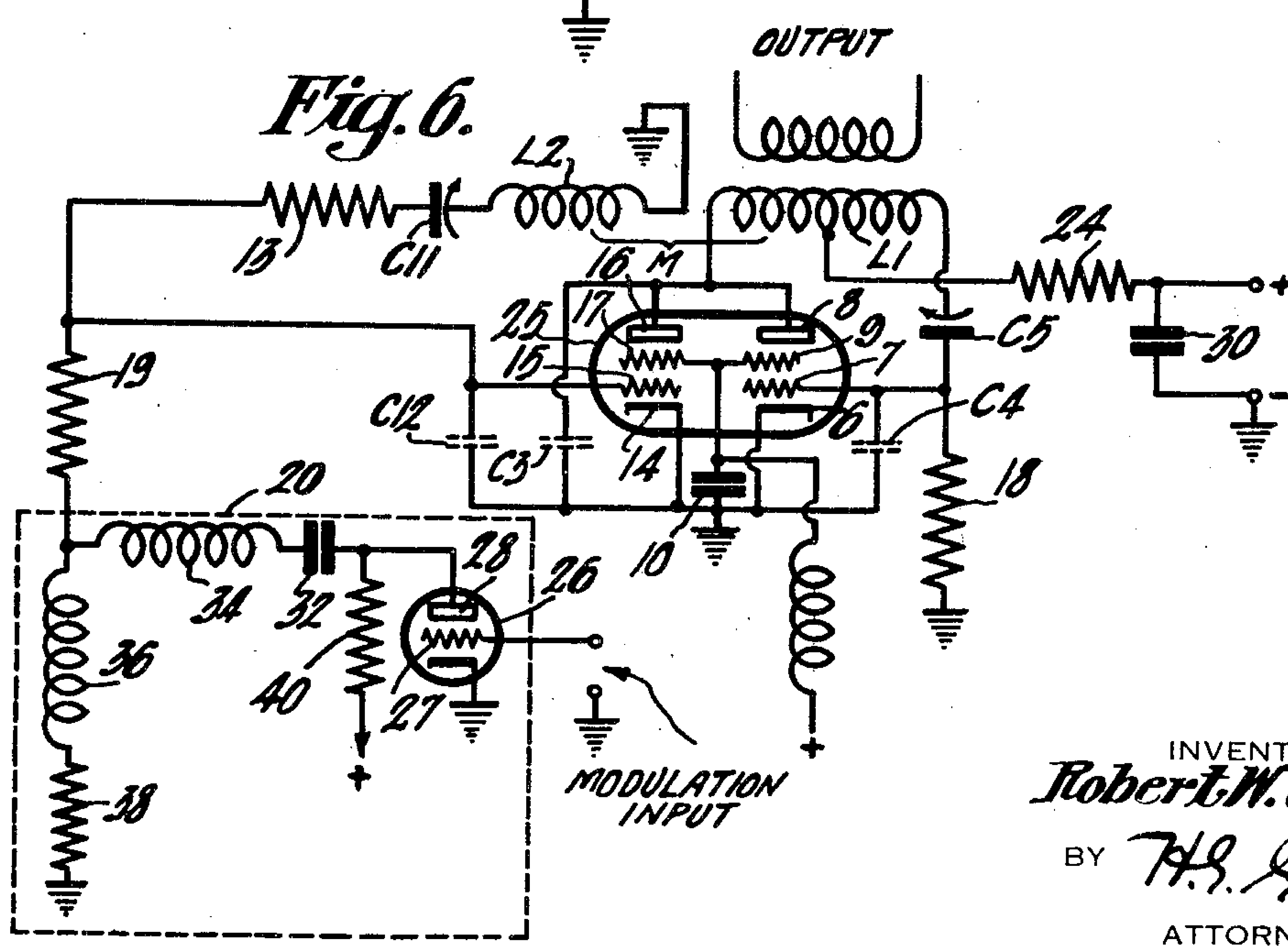


Fig. 6.



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CONTROLLED GENERATOR

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Application February 26, 1946, Serial No. 650,373

4 Claims. (Cl. 332—28)

This application relates to oscillation generators and to control circuits therefor, and in particular to ultra high frequency generators and reactance tube modulators therefor wherein a wide frequency range or band of modulating potentials may be used.

The general object of the present invention is to improve ultra high frequency generators and particularly to provide an ultra high frequency generator the frequency of which may be varied through a wide range of frequencies.

A further object of the present invention is to improve frequency determining circuits in ultra high frequency generators used in timing modulation and similar systems, and in particular to provide a frequency determining circuit in a generator wherein the ratio $\Delta F/f$ is high (where ΔF equals carrier deviation, and f equals highest modulation frequency).

A further object of the present invention is an improved voltage phasing network for deriving the phase quadrature voltage for the reactance tube control grid in ultra high frequency timing modulation systems.

The manner in which the above objects are attained will now be described. In this description reference will be made to the attached drawings wherein Figs. 1, 3 and 5 are basic circuit diagrams used in illustrating the novel features of my ultra high frequency generator and phasing network; Figs. 2 and 4 are vector diagrams used in explaining the operation of the circuits of Figs. 1, 3 and 5; while Fig. 6 shows schematically and by circuit element and circuit connection the essential features of a reactance tube timing modulated oscillator generator arranged in accordance with my invention.

The nature of operation of the circuit may be described by starting with the basic circuit diagram of Fig. 1. When the frequency F of a generator e0 is the same as the series resonant frequency of inductance L2 and condenser C2 then the current i2 is in phase with the voltage e0, and the voltage e2 across the condenser C2 will be 90° out of phase with respect to the voltage e0. This voltage relation is shown by the vectors in Fig. 2 of the drawings. In the diagram of Fig. 1 the resistor R will be referred to hereinafter as a damping resistor and this resistor serves to broaden the frequency versus voltage characteristic of the series resonant circuit.

If two circuits such as illustrated in Fig. 3 tuned to the same frequency are mutually coupled and voltage or energy e1 of the frequency F to which the circuits are tuned is supplied as shown

across the circuit including inductance L1, C1, and induced therefrom to the circuit including condenser C2 and inductance L2, the relation of the currents and voltages will be as represented by the vector diagram in Fig. 4. The voltage of frequency F induced in the circuit containing L2 and C2 may be considered the same as e0, in Fig. 1, which is an equivalent circuit. Thus e0 is effectively in series with the inductance L2 and condenser C2, which are resonant at the frequency F. In this condition then the output voltage e2 is as illustrated in Fig. 4 in phase quadrature with the voltage e1.

The manner in which the circuits and characteristics described above are applied to an oscillation generator and a reactance tube modulator therefor will now be described with reference to Figs. 5 and 6 of the drawings. As shown in Fig. 5 the capacitances C1 and C2 may be divided. Then the capacitance C2 of Fig. 3 may be comprised of capacitances C11 and C12 of Fig. 5. The capacitance C11 may be the series tuning condenser in the reactance tube phasing network, and the capacitance C12 may represent the fixed capacity between the grid and cathode of the reactance tube and distributed circuit capacities. The voltage e2 then is in quadrature with the voltage e1 which may be the voltage developed between the anode and cathode of the oscillation generating tube. The capacitance C1 of Fig. 3 is comprised of three capacitances represented by C3, C4 and C5. Of these, capacitance C3 may represent the capacity between the anodes and ground of both sections of the tube 25 of Fig. 6. The capacitance C4 may represent the capacity within the oscillator section of the tube between the control grid and ground. The capacitance C5 is the variable tuning capacitor and since it is in series with C4 the parallel resonant circuit operates at a higher frequency.

C4 and C12 are the normal tube capacities. If C5 and C11 are of the same order of magnitude as C4 and C12 respectively, the shunting effect of the tube capacities is reduced and the circuit will operate at a higher frequency than normally. I make the value of capacitance C5 approximately equal to or less than that of C4. C11 and C12 similarly are of substantially equal values. Under these conditions the capacitors C5 and C11, if variable, may be used to tune the circuits to the desired frequency F. Thus variation of C5 or C11 mutually changes the tuning of the circuit and thus the circuits may be operated at higher parallel and series frequencies respectively. Furthermore, with these series condenser arrangements larger inductances may be used for a given frequency, which results in increasing the frequency deviation obtainable. Thus my system permits a wide deviation in frequency at a carrier frequency not usually obtainable with lumped circuit elements.

An embodiment of a timing modulation generator of the reactance tube type is illustrated in Fig. 6. In Fig. 6 a single tube 25, of say type 829, has two sections, one of which includes anode 8, positive grid electrode 9, control grid 7, and cathode 6, regeneratively coupled in an oscillation generating circuit including inductance L1 and series condenser C5, connected between the anode 8 and grid 7. C4 represents the grid to ground tube capacity while 18 is a biasing resistor for the control grid 7. The high frequency oscillation generating circuit is completed by resistor 24 connected to a point on L1 and to the positive terminal of a source of direct current shunted by a bypassing condenser 30. The resistor 24 allows inductance L1 to select its own neutral point, which may not be the physical center of the inductance L1, as the frequency is varied by modulation or tuning.

The electrodes 14, 15, 16 and 17 of the other section of the tube 25 are in the reactance tube modulator circuits. The inductance L2 is coupled to the inductance L1. The inductance L2 in series with a capacitor C11 and resistor 13, is connected between control grid 15 and ground. The circuit is as a consequence effectively in shunt to the capacitor C12 between the control grid 15 and cathode 14.

Due to the mutual inductance M between the inductances L1 and L2, voltage is induced in inductance L2, which produces a current through inductance L2, capacitor C11, resistor 13 and capacitor C12. When this circuit is tuned to resonance the voltage across capacitor C12 is in phase quadrature with the voltage on anode 8. The voltage across capacitor C12 is applied between the control grid 15 and the electron emitter or cathode 14 of this section of the tube. The anode 16 of this section of the tube is connected substantially directly to the anode 8 of the oscillation generator section so that both anodes operate at high frequency voltages of the same phase. Current flow through the reactance tube section is normally in phase with the voltage on the control grid 15 so that the current through the reactance tube section is in phase quadrature with respect to the voltage on the anodes 8 and 16, thereby producing a reactive effect in the oscillation generator section. The resistance 13 is, as described hereinbefore, a damping resistor. Modulation is applied to control grid 15 through resistor 19, which isolates the capacitor C12 from the capacity to ground of the modulator circuit 20. This circuit 20 is generally one suitable for television signals, but may be changed if signals other than television are to be used. The modulator 20 comprises a tube 26 having its control grid 27 excited by modulating potentials and having its anode 28 coupled to the reactance tube by a video peaking circuit including condenser 32 and inductances 34 and 36, and resistors 38 and 40. The network is one that will give maximum band width for maximum gain, and its combination of values is well known in the art.

The advantages claimed are that with this type of tuning, the inductances are larger than if parallel tuning of a different kind were used, so with lumped inductances the circuit may be used at higher frequencies. The tuning is that

in which the inductive and capacitive reactances are made equal. An 829 tube performed satisfactorily at 156 megacycles, and it could operate satisfactorily at a higher frequency.

What is claimed is:

1. A simulated reactance comprising an electron discharge tube having a cathode, an anode-like electrode and a control grid, means for producing a reactive effect between said anode-like electrode and said cathode including a tuned circuit having a plurality of reactances, two of which are capacitive and of about like value in series, one of said capacitive reactances including the reactance between the control grid and cathode of said tube, said tuned circuit having inductive reactance equal in value to and in parallel circuit with the capacitive reactance thereof, a coupling between the tuned circuit and the anode-like electrode, and means for setting up oscillatory energy of frequency F in said tuned circuit.

2. A simulated reactance comprising an electron discharge tube having a cathode, an anode-like electrode and a control grid, means for producing a reactive effect between said anode-like electrode and said cathode including, an inductor and two series connected capacitors of about like value in parallel with said inductor in a circuit tuned to a frequency F, one of said capacitors including the reactance between the control grid and cathode of said tube, a coupling between the inductor of said tuned circuit and the anode-like electrode, and means for setting up oscillatory energy of frequency F in said tuned circuit.

3. In a timing modulation system, a high frequency oscillation generator comprising an electron discharge device having an anode, a cathode and a control grid regeneratively coupled by a tank circuit parallel tuned to a frequency F by a reactance including an inductor and the capacitance between the control grid and cathode and between the anode and cathode, means for increasing the frequency to which said circuit is parallel tuned comprising a variable capacitor in series with the reactance of said parallel tuned circuit, means for modulating the timing of the oscillations generated through a wide range comprising a reactance tube having an anode, a cathode and a control grid, connections tying the anode of the reactance tube to the anode of the first named device, a second parallel circuit tuned to said frequency F including an inductor and a capacitor in series with the capacitance between the cathode of said reactance tube and the control grid of said reactance tube, there being mutual coupling between said last named inductor and the inductor of said first parallel tuned circuit, and means for modulating the conductivity of said reactance tube in accordance with signals.

4. In a wide band frequency modulation system, a high frequency oscillation generator comprising an electron discharge device having an anode, a cathode and a control grid regeneratively coupled by a tank circuit parallel tuned to a frequency F by a reactance including an inductor and the capacitance between the control grid and cathode and between the anode and cathode, means for increasing the frequency to which said circuit is parallel tuned comprising a variable capacitor in series with the reactance of said parallel tuned circuit, means for modulating the frequency of the oscillations generated through a wide range comprising a reactance

tube having an anode, a cathode and a control grid, a second circuit tuned to the said frequency F comprising an inductor, a variable tuning capacitor and the capacitance between the control grid and cathode of said reactance tube, a coupling between said inductors, a direct connection between the anodes of said tube and said device, and means for modulating the conductivity of said reactance tube in accordance with signals which cover a relatively wide range of frequencies.

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