

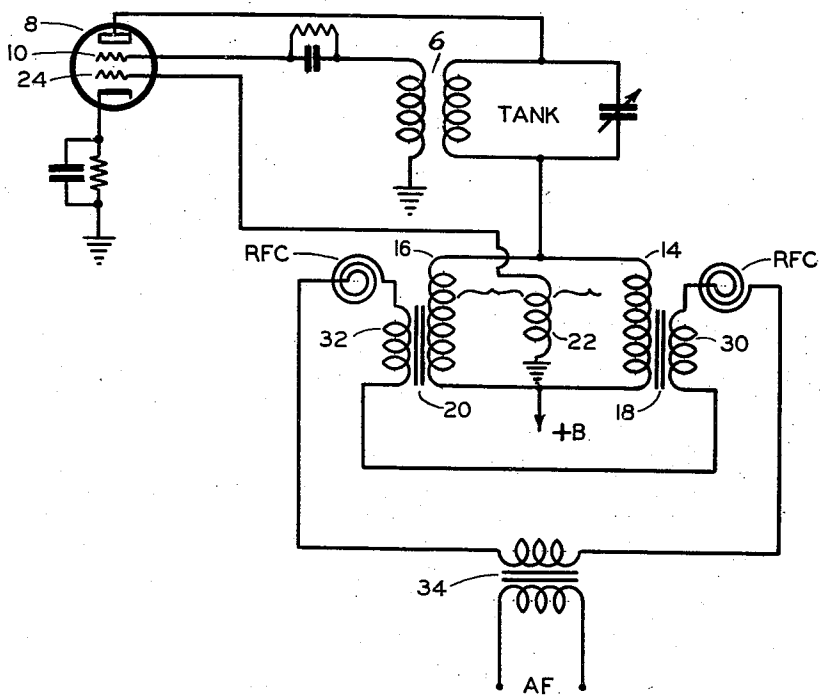
April 11, 1944.

W. VAN B. ROBERTS

2,346,331

COMBINED OSCILLATOR AND REACTANCE TUBE

Filed April 21, 1942



INVENTOR
WALTER VAN B. ROBERTS
BY *H.S. Grover*
ATTORNEY

UNITED STATES PATENT OFFICE

2,346,331

COMBINED OSCILLATOR AND REACTANCE
TUBEWalter van B. Roberts, Princeton, N. J., assignor
to Radio Corporation of America, a corporation
of Delaware

Application April 21, 1942, Serial No. 439,823

6 Claims. (Cl. 179-171.5)

An object of the present invention is to provide a frequency modulation transmitter which requires a minimum number of tubes. To this end the usual reactance tube provided in certain types of wave length modulators to alter the natural phase or frequency of the tuned circuit of an oscillator is eliminated by providing in the oscillator itself not only a regenerative feedback but also a quadrature feedback for effecting the frequency of the generated oscillations.

A further object of the invention is to provide a quadrature feedback which is under control of modulating currents and which reverses in sign with reversal of sign of the modulating current.

In describing my invention in detail reference will be made to the attached drawing wherein the single figure illustrates schematically a circuit arrangement including the features described above and others.

Referring to the drawing, the circuit which determines the unmodulated or carrier frequency is marked "Tank" and a regenerative feedback voltage is derived therefrom by coupling 6 and applied to one grid, say 10, of the tube 8 to produce oscillations. The phase of this feedback voltage is in exact opposition to the phase of the voltage across the tank circuit and is, therefore, co-linear in phase with the plate current of tube 8. The plate current, however, passes through not only the resonant tank, which acts like a resistance, but also through the parallel combination of a pair of coils, 14 and 16, wound on saturable iron cores 18 and 20. A third coil, 22, is equally coupled to the two circuit branches including the saturable core coils, but this coupling is of opposite polarity with respect to the said two coils so that no voltage is induced in the third coil 22 when the currents in the aforesaid two coils are equal. If, however, the equality of these currents is upset, a voltage will be induced in the third coil 22 which voltage will be 90° out of phase with the plate current, being 90° in advance or 90° lagging according to the direction of upset of the balance. The reason the voltage is 90° out of phase with the plate current is because the currents in the two iron core coils 14 and 16 are necessarily in phase with the plate current and the voltage induced by inductive coupling to the third coil 22 is necessarily in phase quadrature with the current in the inducing coil. This quadrature voltage, applied to a second grid 24 in the oscillator tube 8, causes the plate of the tube to draw a leading or lagging component of current and, therefore, to act like a reactance element in

shunt with the tank circuit. This, as is well known, changes the frequency of oscillation.

In order to upset the equality between the currents in the iron core coils, I provide additional windings 30 and 32 on each core arranged to be traversed by modulation current supplied by transformer 34. The modulation currents are so directed in these two windings that the saturation of one of the cores is increased, while that of the other core is decreased. This is because the direct component of plate current is also flowing in the other two windings on the cores so that the effect of the modulation current adds to the saturation of one core when it subtracts from the other core. With different degrees of saturation the effective inductance of the windings is no longer equal and, therefore, the alternating components of plate current no longer divide equally between the two parallel circuits. It should be noted that radio frequency chokes R. F. C. are included in the modulation current circuit to prevent the flow of radio frequency current therein.

For simplicity, I have shown the two feedback voltages, one regenerative and the other reactive, applied to separate grids, but it will be appreciated that if desired these two voltages may be added together and applied to a single grid with the same result.

It will be understood that the system may operate to produce frequency or phase modulated waves or waves having the characteristics of phase and frequency modulated waves by using unmodified or modified modulating potentials at 34. The term "wave length" as used in the claims is to mean phase or frequency modulation or both.

I claim:

1. A combined oscillation generator and wave length control circuit including a tube having an anode, a cathode and a plurality of control grid electrodes, a tank circuit including an inductance, a regenerative feedback from the anode of the tube to a control grid thereof by way of said tank circuit, said feedback including an inductance connected between a control grid and the cathode and coupled to said tank circuit inductance, a first reactive feedback coupling from the anode of the tube to a control grid thereof, a second reactive feedback coupling from the anode of said tube to a control grid thereof, said second reactive feedback being of a polarity opposite to said first named reactive feedback, and means for differentially varying said reactive feedbacks in accordance with control voltages.

2. In a wave generator and wave length control system, an electron discharge tube having an anode, a cathode and a plurality of control grid electrodes, a tank circuit including an inductance, a regenerative coupling from the anode of said tube to the one control grid thereof, said coupling including said tank circuit, a first reactive feedback coupling from the anode of said tube to another control grid, a second reactive feedback coupling from the anode of said tube to said other control grid, said reactive couplings providing substantially equal reactive feedback, and means for relatively varying said reactive feedback couplings in accordance with control potentials.

3. In a wave generating and wave length control system, a tube, a parallel tuned tank circuit, a regenerative coupling including said tank circuit between a tube output electrode and a tube input electrode, two iron core windings in series with said tank circuit, a third winding coupled in opposed polarity to said two windings and also coupled to an input electrode of said tube, and means for relatively controlling the saturation of the cores of said two iron core windings in accordance with control potentials.

4. In a wave generator and wave length control system, an electron discharge tube having input and output electrodes including a cathode, a tank circuit tuned to the frequency of the wave energy to be generated, connections regeneratively coupling said tank circuit between a tube output electrode and a tube input electrode and to the cathode, two windings coupling an output electrode of said tube to said tube cathode, a third winding substantially equally coupled to said two windings and also coupled to an input electrode of said tube, the windings and arrangement being such that the couplings between the third winding and said two windings are of substantially opposed polarity and substantially no voltage is induced in said third winding, a source of modulating potentials, and a coupling between said source and said two windings to differentially vary the effective inductance thereof and thereby relatively vary the couplings between said two windings and the third winding so that a resultant voltage, the phase of which varies with said differential modulation, is induced in said third winding and impressed on said last mentioned input electrode.

5. In a wave generator and wave length control system, an electron discharge tube having

input and output electrodes including a cathode, a tank circuit tuned to the frequency of the wave energy to be generated, connections regeneratively coupling said tank circuit between a tube output electrode and a tube input electrode and to the cathode, two windings coupling an output electrode of said tube to said tube cathode, a third winding substantially equally coupled to said two windings and also coupled to an input electrode of said tube, the windings and arrangement being such that the couplings between the third winding and said two windings are of substantially opposed polarity and substantially no voltage is induced in said third winding, a source of modulating potentials and a coupling between said source and said two windings to differentially vary the effective inductance thereof and thereby relatively vary the couplings between said two windings and said third winding so that a resultant voltage, substantially in phase quadrature with respect to the phase of the current to said output electrode to which said two windings are coupled and the phase of which reverses as the polarity of said differential modulation reverses, is induced in said third winding and is impressed on said last mentioned input electrode.

6. In a wave generator and wave length control system, an electron discharge tube having a cathode, two control electrodes and an output electrode, a tank circuit tuned to the frequency of the wave energy to be generated, connections regeneratively coupling said tank circuit between the tube anode and one of the tube control electrodes and to the cathode, two windings coupling said output electrode of said tube to said tube cathode, a third winding coupled in opposed relation to said two windings and also coupled to the other control electrode of said tube, the windings and arrangement being such that the couplings between the third winding and said two windings are of substantially opposed polarity and substantially no voltage is induced in said third winding, a source of modulating potentials, and a coupling between said source and said two windings to differentially vary the effective inductance thereof and thereby relatively vary the couplings between said two windings and the third winding so a resultant voltage, the phase of which varies with said differential modulation, is induced in said third winding and impressed on said last mentioned input electrode.

WALTER VAN B. ROBERTS.