

July 3, 1945.

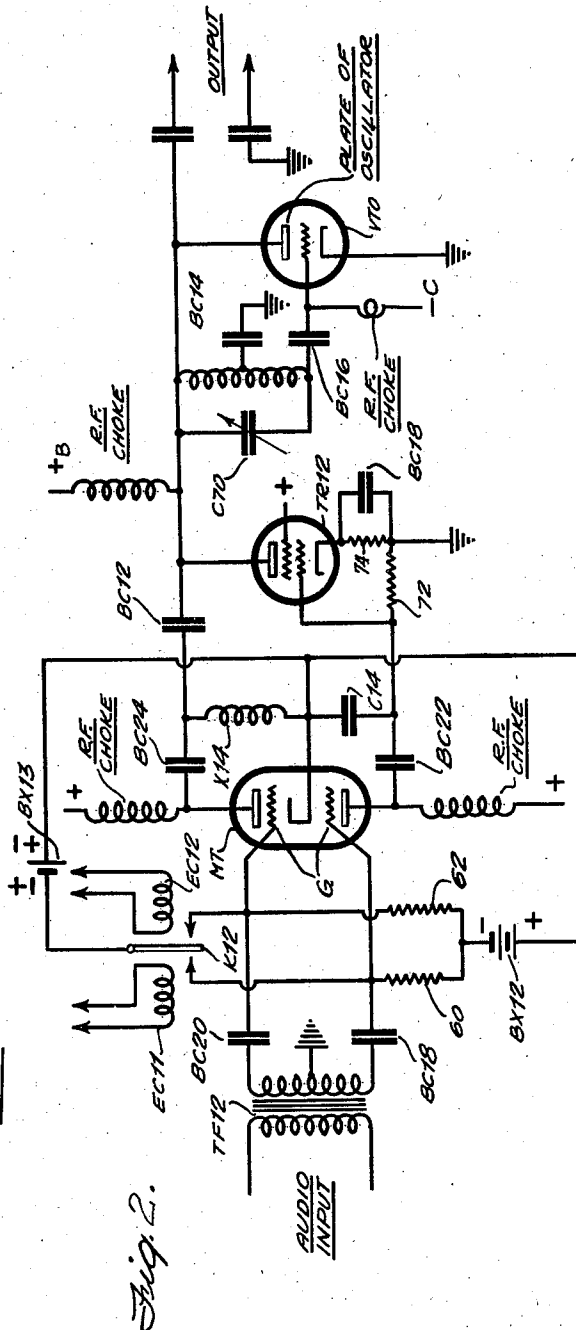
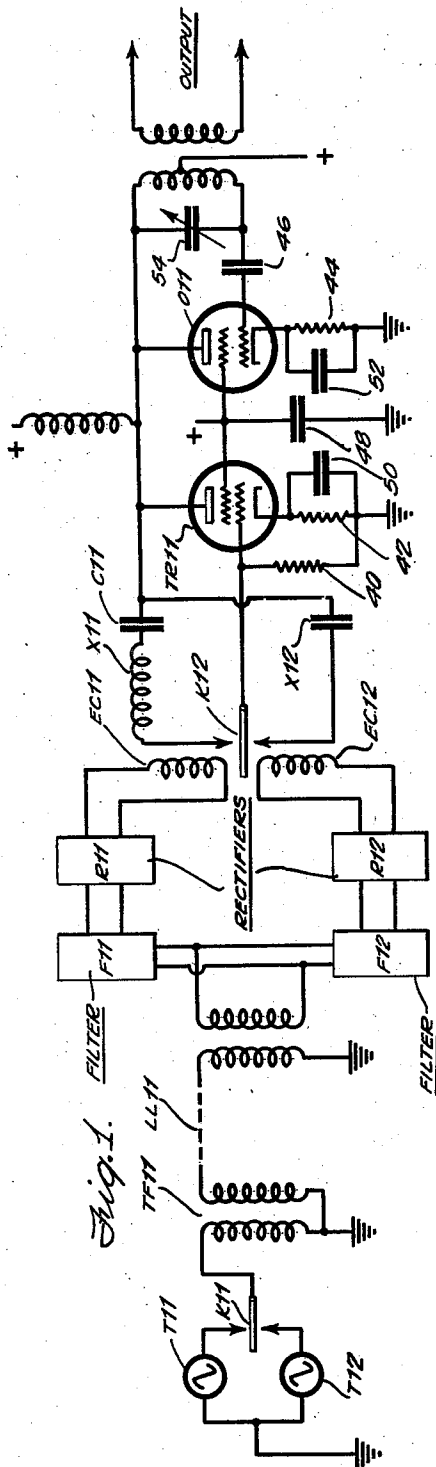
H. TUNICK

2,379,614

FREQUENCY MODULATION

Filed March 27, 1942

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

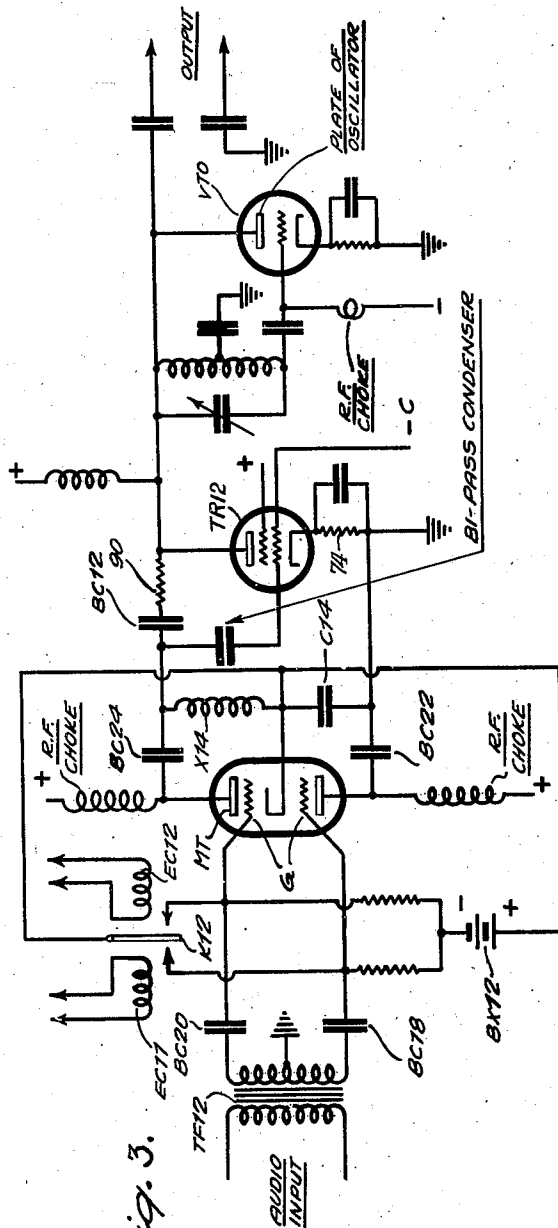


Fig. 3.

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2,379,614

FREQUENCY MODULATION

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Application March 27, 1942, Serial No. 436,423

14 Claims. (Cl. 178—66)

This is a continuation in part of my copending application Serial No. 369,800, filed December 12, 1940, now United States Patent No. 2,282,102.

My present invention relates to signaling by means of frequency modulated waves. An object of my present invention is to provide improved circuits especially adapted for telegraphic and telephonic communication by frequency shifted waves. Other objects, advantages and features of my present invention will be self-evident as the more detailed description thereof proceeds.

In the accompanying drawings:

Fig. 1 is a wiring diagram of a frequency modulation transmitter employing principles of my present invention and which is especially adapted for telegraphy; and

Figs. 2 and 3 are wiring diagrams of modifications useful for either telegraphy or telephony.

In Figure 1 manipulation of the key K11 impresses tones from the audio oscillator T11 or from the audio oscillator T12 through transformer TF11 upon land line LL11. Filter F11 passes audio tone T11 of frequency F1 generated by oscillator T11 and filter F12 passes the tone of audio frequency F2 generated by oscillator T12 into the rectifiers R11, R12 to which the filters are respectively connected. The rectified tones move key K12 up or down, putting the inductive reactance X11 or capacitive reactance X12 effectively into circuit with the electrodes of reactance tube TR11.

Oscillator O11, of the Hartley type, is thereby varied in frequency from one value to another depending upon whether reactive inductance X11 or capacity X12 is connected in the circuits. It will be appreciated that condenser C11 is merely a large by-passing condenser. Resistance 40 is of low value relative to the reactance of either X11 or X12. Resistors 42, 44 are cathode return biasing resistors, condensers 46, 48, 50 and 52 are radio frequency by-pass condensers, and condenser 54 is the usual tuning condenser. The other portions of the circuit of Figure 1 are deemed to be self-explanatory to those skilled in the art.

In the system of Figure 2, the reactance tube TR12 has its plate interconnected with its grid through the large by-passing condenser BC12, inductive reactance X14 and capacitive reactance C14. The multi-element tube MT is provided, the grids G of which are biased to cut-off by means of biasing source BX12. The key K12, as in connection with Figure 1, may be actuated electromagnetically by means of coils EC11 and EC12 connected to rectifiers such as R11, R12 and the system to the left thereof as shown in

Figure 1, but which, for the sake of simplicity, has not been duplicated in Figure 2.

With key K12 of Figure 2 in its left-hand contacting position, the lower section of the multi-element tube MT is permitted to draw current and thereby effectively short-circuits condenser C14 and makes the effective feedback path from the plate to the grid of reactance tube TR12 through inductance X14. Similarly, when key K12 of Figure 2 is moved to its right extreme position, the upper grid of tube MT causes the upper section of the control tube MT to become conductive, thereby effectively short-circuiting reactance X14 and making the effective feedback path through the capacitive reactance C14. In this way, the effective reactance of tube TR12 is changed, thereby changing the frequency of the vacuum tube oscillator VTO to which it is connected, as illustrated.

A multiplicity of tones or a complex wave, such as voice, may be used in the system of Figure 2. These complex tones or voice waves with or without amplification are fed through transformer TF12 in phase opposition to the grids GG as shown. When this is done, of course, key K12 is left in its open mid-position as shown.

Resistors 60 and 62 of Figure 2 prevent short-circuiting of battery BX12 during keying of key K12 with its contacts. If desired, an additional battery BX13 may be connected as shown in the lead to key K12.

Resistance 72 is of relatively low value with respect to the relative high inductive reactance of X14 or the relatively high capacitive reactance C14. Resistor 74 is a cathode return biasing resistor. Condensers BC18, BC20, BC22, BC24, BC12, BC14, BC16 and BC18 are large by-pass condensers. Condenser C70 is a tuning condenser.

Fig. 3 is similar to Fig. 2, but it will be noted that the reactance tube circuits have been modified.

In Figure 1 when the capacitive reactance X12 is connected between the plate and control grid, tube TR11 appears as a capacitive reactance across the tuned circuit of the oscillator, thereby lowering the frequency of oscillations generated. When inductive reactance X11 is effectively connected between the plate and grid of reactance tube TR11, the reactance tube acts as an inductance in shunt to a portion of the tuned tank circuit of oscillator tube O11 thereby lowering the effective inductance and raising the frequency of oscillations generated.

Figure 3 is similar to Figure 2. In Figure 3,

however, the reactances X14 and C14 are effectively connected between the control grid and cathode of reactance tube TR12, whereas in Figure 2 they appear across the plate and control grid of the reactance tube TR12. In Figure 3 the resistor 90 is of high value with respect to the reactance of coil X14 or the reactance of condenser C14. Also in Figure 3, condenser BC12 is a large condenser of negligible reactive value at the frequencies involved.

When the inductive reactance X14 is effectively short circuited and capacitive reactance C14 is effectively connected between the control grid and cathode of reactance tube TR12, the latter acts as an inductive reactance in parallel to a portion of the tank circuit of oscillator VTO, thereby effectively reducing the inductive reactance of the tank circuit of the oscillator and thereby effectively raising its operating frequency. Similarly, when condenser C14 is effectively short circuited out of circuit and coil X14 is effectively connected between the grid and cathode of reactance tube TR12, the frequency of operation of oscillator VTO will be lowered.

Although the various reactance tubes have been illustrated as screen grid tubes, they may, of course, be pentodes, in which case the fifth electrode is connected in the usual way directly to the cathode.

Having thus described my invention what I claim is:

1. In combination, an oscillation generator, a reactance tube operatively associated with said generator, said reactance tube having an anode, a cathode and a control electrode, an inductive phase shifting reactance, a capacitive phase shifting reactance, an unbypassed resistor having a low value with respect to either of said reactances effectively connected between said control electrode and cathode, and a keying circuit for keying either the inductive reactance or the capacitive reactance selectively into circuit between said anode and control electrode.

2. In combination, an oscillation generator, a reactance tube having an anode electrode, a cathode electrode and a control electrode for changing the frequency of oscillation of said oscillation generator, said reactance tube having its anode and cathode connected to a frequency determining circuit of said generator, a phase shifting inductive reactance, a phase shifting capacitive reactance, an unbypassed resistor effectively connected between a pair of electrodes of said reactance tube, and a keying circuit for selectively keying either the inductive reactance or the capacitive reactance into circuit with another pair of electrodes of said reactance tube said unbypassed resistor being connected so as to be effectively in series with whichever reactance is selectively keyed into circuit with said reactance tube electrodes.

3. A reactance tube circuit comprising a reactance tube having an anode, a cathode and a control electrode, a pair of serially connected reactances of opposite sign connected between a pair of electrodes of said reactance tube; a resistance of relatively high value with respect to the value of reactance of either of said reactances effectively connected between another pair of electrodes of said reactance tube, and a circuit for selectively short circuiting either of said reactances.

4. A reactance tube circuit comprising a reactance tube having an anode, a cathode and a control electrode, a pair of serially connected react-

ances of opposite sign connected between a pair of electrodes of said reactance tube, a resistance of relatively high value with respect to the value of reactance of either of said reactances effectively connected between another pair of electrodes of said reactance tube, and a circuit for variably shunting said reactances out of and into circuit.

5. A reactance tube circuit comprising a tube having an anode, a cathode and a control electrode, a pair of serially connected phase shifting reactances connected between a pair of electrodes of said reactance tube, a resistor having a high value of resistance with respect to the value of reactance of either of said phase shifting reactances effectively connected between another pair of electrodes of said reactance tube, an electron discharge device circuit effectively in shunt to one of said reactances, an electron discharge circuit effectively in shunt to the other of said reactances, and circuits for varying the conductivities of said electron discharge device circuits.

6. In combination, a resonant electrical circuit, a reactance tube having an anode electrode, a cathode electrode, and a control electrode, an inductive phase shifting reactance, a capacitive phase shifting reactance, an unbypassed resistor effectively in series with said reactances, said resistor being effectively connected between a pair of said electrodes of said reactance tube, and a keying circuit for selectively keying said reactances between another pair of electrodes of said reactance tube.

7. A reactance tube circuit comprising a reactance tube having an anode electrode, a cathode electrode, and a control electrode, a pair of serially connected reactances of opposite sign effectively connected between the anode electrode and control electrode of said reactance tube, a resistance of relatively low value with respect to the value of reactance of either of said reactances effectively connected between the control electrode and cathode electrode of said reactance tube, and a circuit for selectively short-circuiting either of said reactances.

8. A reactance tube circuit comprising a reactance tube having an anode electrode, a cathode electrode, and a control electrode, a pair of serially connected reactances of opposite sign effectively connected between the control electrode and the cathode electrode of said reactance tube, a resistance of relatively high value with respect to the value of reactance of either of said reactances effectively connected between another pair of electrodes of said reactance tube, and a circuit for selectively short-circuiting either of said reactances.

9. A reactance tube circuit comprising a tube having an anode, a cathode, and a control electrode, a pair of serially connected phase shifting reactances effectively connected between the control electrode and cathode of said reactance tube, a resistor having a high value of resistance with respect to the value of reactance of either of said phase shifting reactances effectively connected between the anode and control electrode of said reactance tube, an electron discharge device circuit effectively in shunt to one of said reactances, an electron discharge circuit effectively in shunt to the other of said reactances, and circuits for varying the conductivities of said electron discharge device circuits.

10. In combination, an oscillation generator, a reactance tube having anode, cathode and control electrodes, said reactance tube having its anode and cathode effectively connected to a frequency

determining circuit of said generator, an inductive phase shifting reactance, a capacitive phase shifting reactance, a resistor having a high value with respect to the value of reactance of either of said reactances, said resistor being effectively connected between said anode electrode and said control electrode of said reactance tube, and a keying circuit for selectively keying said reactances effectively into circuit between said control electrode and said cathode electrode of said reactance tube.

11. A reactance tube circuit comprising a reactance tube having an anode, a cathode and a control electrode, a pair of serially connected reactances of opposite sign effectively connected between a pair of electrodes of said reactance tube, a resistance of relatively low value with respect to the value of reactance of either of said reactances effectively connected between another pair of electrodes of said reactance tube, and a circuit for selectively short-circuiting either of said reactances.

12. A reactance tube circuit comprising a reactance tube having an anode, a cathode and a control electrode, a pair of serially connected reactances of opposite sign effectively connected between a pair of electrodes of said reactance tube, a resistance of relatively low value with respect to the value of reactance of either of said reactances effectively connected between another pair of electrodes of said reactance tube, and a

circuit for variably shunting said reactances out of and into circuit.

13. A reactance tube circuit comprising a reactance tube having an anode electrode, a cathode electrode and a control electrode, a pair of serially connected reactances of opposite sign effectively connected between the anode electrode and control electrode of said reactance tube, a resistance of relatively low value with respect to the value of reactance of either of said reactances effectively connected between the control electrode and cathode electrode of said reactance tube, and a circuit for selectively short-circuiting either of said reactances.

14. A reactance tube circuit comprising a tube having an anode, a cathode and a control electrode, a pair of serially connected phase shifting reactances effectively connected between the anode and control electrode of said reactance tube, a resistor having a low value of resistance with respect to the value of reactance of either of said phase shifting reactances effectively connected between the control electrode and cathode of said reactance tube, an electron discharge device circuit effectively in shunt to one of said reactances, an electron discharge device circuit effectively in shunt to the other of said reactances, and circuits for varying the conductivities of said electron discharge device circuit.

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