Sept. 24, 1935. W. T. DITCHAM 2,015,175

MODULATED CARRIER WAVE SYSTEM

Filed June 29, 1933

Fig. 1

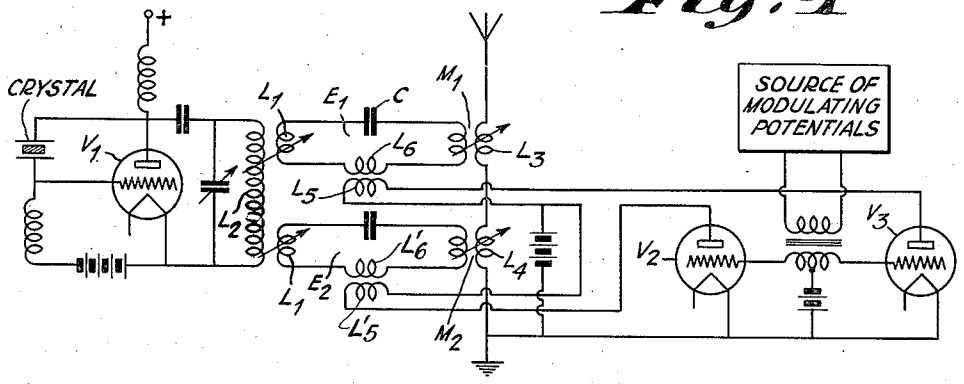


Fig. 2

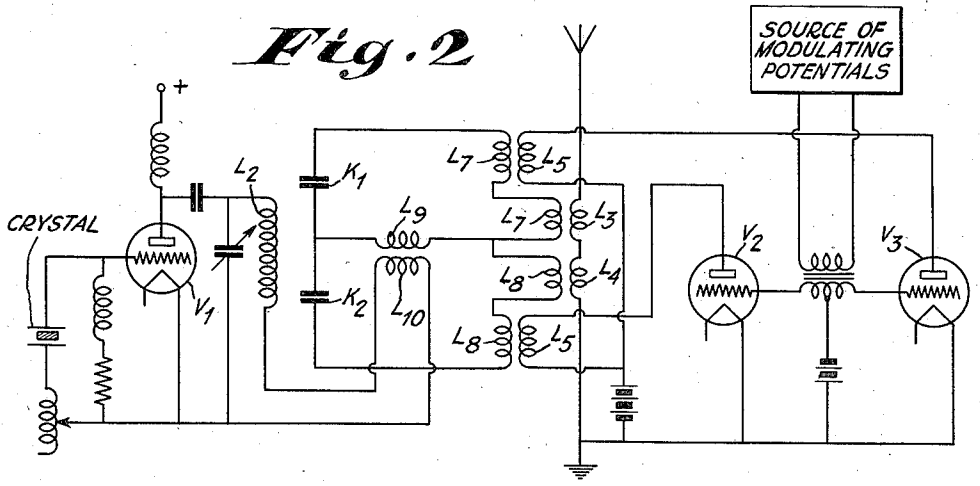
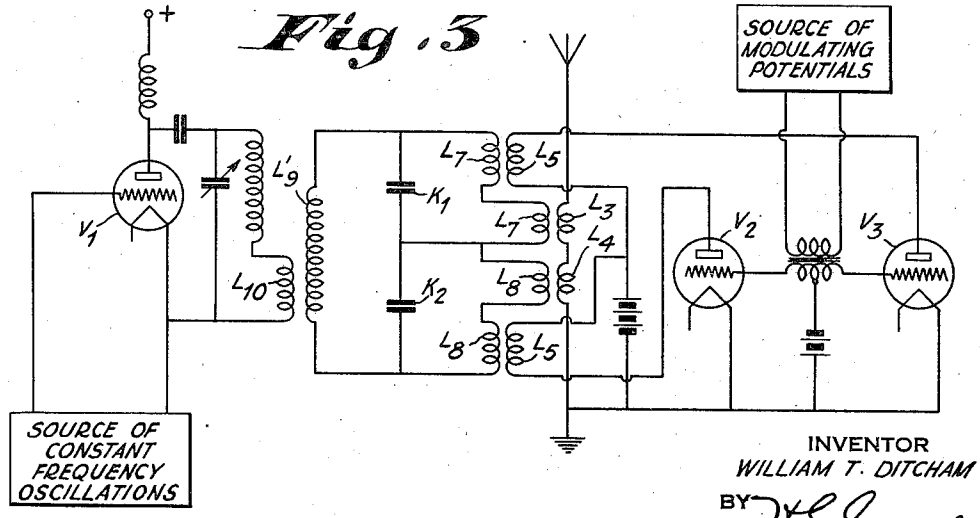


Fig. 3



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MODULATED CARRIER WAVE SYSTEM

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5 Claims. (Cl. 179—171)

This invention relates to radio and other modulated carrier wave systems and has for its object to provide an efficient and simple method for modulating a high frequency carrier wave.

According to this invention energy from a high frequency carrier wave source is transferred to a load circuit in a differential manner by means of two energy transferring circuits, each including a tuned circuit, and means are provided for simultaneously and oppositely varying the natural frequency of said tuned circuits in dependence upon the modulating potentials. The character of the energy supplied to the load circuit will be determined largely by the character of the energy in that circuit which supplies the largest amount of energy to the load circuit at a particular instant. The load circuit may be constituted for example by an aerial circuit.

The invention is illustrated in the accompanying diagrammatic drawing, throughout which like reference characters indicate like parts, and in which Figures 1 to 3 inclusive show various modifications of the modulation circuits of the present invention.

Referring to Figure 1, which shows one way of carrying out the invention, the output circuit of a high frequency thermionic valve oscillator V_1 is inductively coupled to two energy transferring circuits E_1, E_2, each consisting of a condenser C in series with inductance and each thus constituting a tuned circuit. The inductance or a portion L_1 thereof of each tuned circuit is variably coupled to the output inductance coil L_2 of the high frequency oscillator and the said two tuned circuits are also variably inductively coupled differentially at M_1 and M_2 to an aerial circuit, the differential coupling being effected by two coils L_3, L_4 in series between the aerial and earth. If these circuits E_1 and E_2 are in resonance with the exciting current from L_2 and are equally coupled thereto, as shown, no carrier wave will appear in the aerial because of the differential coupling at M_1, M_2 to the opposed inductances L_3, L_4. Two triodes V_2, V_3 are provided for modulating purposes and the modulating potentials are applied simultaneously and in phase opposition to the grids thereof, e. g., by means of a center-tapped transformer. The plate circuit of one triode contains a coil L_5, which is inductively coupled to a part L_6 of the inductance of one tuned circuit, while the plate circuit of the other triode contains a corresponding coil L'_5, which is inductively coupled to the corresponding inductance portion L'_6 in the other tuned circuit. It will thus be seen that since the modulating potentials are applied to the grids of the modulating triodes in phase opposition the effect of a given modulating potential will be to increase the inductance of one tuned circuit, say E_1, and decrease that of the other, say E_2. This say E_1, and decrease that of the other. This dephases the currents therein so that they no longer oppose in the aerial inductances L_3, L_4 and consequently the amplitude of the carrier wave in the aerial increases and decreases in accordance with the signal potentials. Suitable polarizing potentials may be applied as indicated to the anodes and grids of the said modulating triodes in order to adjust them to a suitable operating condition.

In a modification shown in Figure 2 the two tuned circuits E_1, E_2 of Figure 1 are in effect combined in a composite circuit consisting of a pair of inductances L_7, L_7 shunted by condenser K_1 in series with another pair of inductances L_8, L_8 shunted by a condenser K_2, the series connected pair of condensers being in parallel with the series connected pairs of inductances as illustrated. The junction between the condensers K_1, K_2 is connected to the junction point between the adjacent inductances L_7, L_8 through a coupling coil L_9, which is inductively coupled to a further coil L_{10} associated with the output inductances, or, as illustrated, forming part of the output circuit of the high frequency oscillator V_1. One of the inductances L_7, and one of the inductances L_8, are inductively coupled to two series connected coils L_3, L_4 in an aerial circuit as shown. These last mentioned inductive couplings are opposite in sense so that a differential effect is obtained. As in the previous construction two modulating valves V_2, V_3 are provided and modulating potentials are applied to the grids thereof in phase opposition. The output circuit of valve V_2 is inductively coupled by a coil L_5 to one of the inductances L_8 in the composite circuit, while the output circuit of the other valve V_3 is inductively coupled by a corresponding coil L_5 to one of the inductances L_7 in the composite circuit.

Figure 3 illustrates a slight modification of the last described arrangement, the junction point between the two series connected condensers K_1, K_2 in the composite circuit being directly connected without the interposition of the coil L_9 of Figure 2 to the junction point between the two series connected inductances L_7 and L_8. High frequency carrier oscillations from the drive or oscillator valve V_1 are applied to the composite circuit by inductive coupling between the output

inductance of said oscillator or a part L_{10} thereof and a further inductance L'_9 which is shunted across the two series condensers K_1, K_2.

Although in the actual embodiments described modulation is effected by oppositely varying the effective inductances in the tuned circuits, magnetic coupling being resorted to, it will be apparent that variation of the natural frequencies, of the two tuned circuits in opposite sense may equally well be effected by utilizing the modulating potentials to vary the capacities in these two circuits, or the inductance of one circuit and the capacity of the other can be varied simultaneously or both the inductance and the capacity in each circuit may be varied. The important feature is merely that the modulating potentials shall oppositely vary the relative phase of the currents in the two tuned circuits, so that these currents no longer oppose each other and there results a variation in the amplitude of the carrier wave energy fed to the aerial.

The source of high frequency carrier oscillations employed in carrying out this invention should be of such a nature as to be substantially constant in frequency and not easily varied by the effect of the modulating means employed. It is therefore preferred that the high frequency source whose output is transferred to the tuned circuits shall be not a high frequency generator but a high frequency amplifier valve "driven" by a high frequency generator and preferably the generator is maintained at substantially constant frequency by mechanically resonant means or piezo electric means or the like in manner well known per se.

Although the invention has been above described as incorporating arrangements wherein the modulating potentials are arranged to bring about opposite variations in both tuned circuits, it is not absolutely necessary for both said tuned circuits to be controlled since some results can be achieved by varying only one of the two tuned circuits. The described arrangement in which simultaneously opposite variation of both tuned circuits is obtained are, however, preferred.

The present invention is of general application to the transmission of speech or music or to the transmission of telegraphic signals or facsmile signals or the like.

Having thus described my invention and the operation thereof, what I claim is:

1. In combination a source of constant frequency carrier frequency oscillations, a pair of energy transferring circuits, each including series inductances shunted by a tuning capacity, a coupling between said source of carrier frequency oscillations and each of said energy transferring circuits, a load circuit coupled to receive energy from both of said energy transferring circuits, the sense of the various couplings being such that energy is transferred to the load circuit in a differential manner, a pair of thermionic valves, each having its output circuit associated with a different one of the energy transferring circuits so as to control the natural frequency thereof, and means for applying modulating potentials to the input circuits of said modulating valves in phase opposition whereby opposite simultaneous control of said energy transferring circuits is obtained substantially as described.

2. Apparatus as recited in claim 1 in which each modulating valve has in its plate circuit an inductance which is coupled to an inductance in a different one of the energy transferring circuits.

3. An arrangement as recited in claim 1 in which the two energy transferring circuits have portions in common.

4. A device as recited in claim 1 in which the source of oscillations is piezo-electrically or equivalently controlled as to frequency to secure constancy of frequency substantially as described.

5. An oscillation generator comprising, a thermionic tube having its electrodes connected in oscillation producing circuits including an inductance, a piezo-electric crystal in one of said circuits to insure the production of oscillations of constant frequency therein, a combined circuit comprising pairs of inductances connected in series, capacities in series shunting said pairs of inductances, an inductance connecting a point between said pairs of inductances to a point between said capacities said last named inductance being coupled to one of said first named circuits, a load circuit including a pair of inductances each of said load inductances being coupled to an inductance of each of said first named pairs of inductances, a source of modulating potentials, a pair of thermionic tubes each having control grid, cathode and anode, a circuit connecting said control grids in phase opposition to said source of modulating potentials, an inductance connected between the anode and cathode of one of said tubes, said inductance being coupled to one of the inductances of one of said pairs of inductances, and an inductance connected between the anode and cathode of the other of said tubes, said inductance being coupled to one of the inductances of the other of said pair of inductances.

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