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2,169,859

CARRIER REDUCED MODULATOR

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Fig. 1

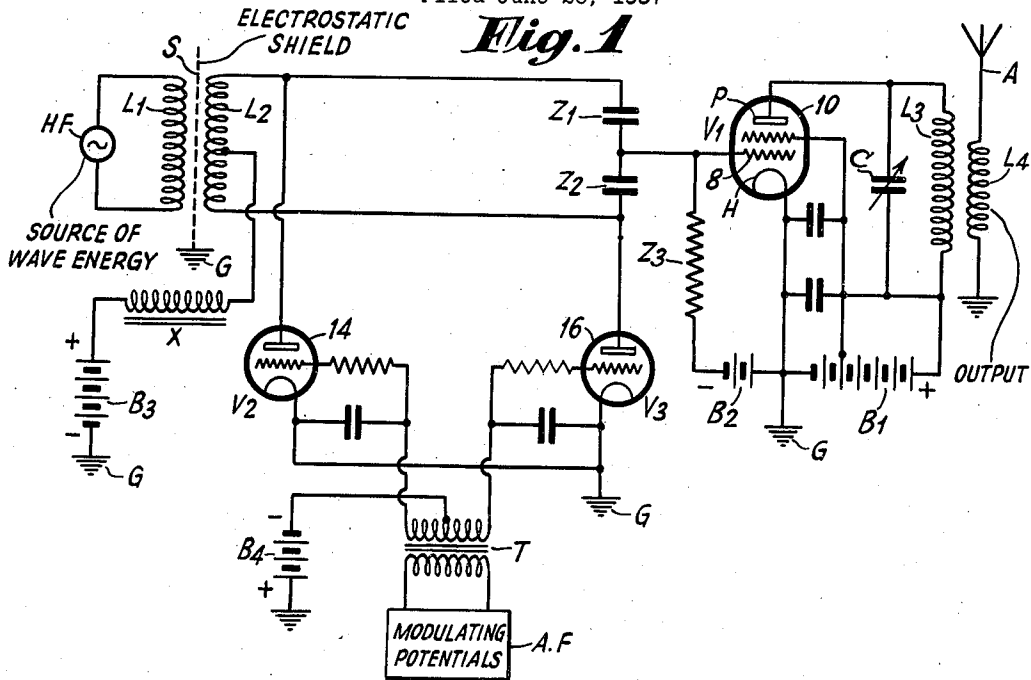
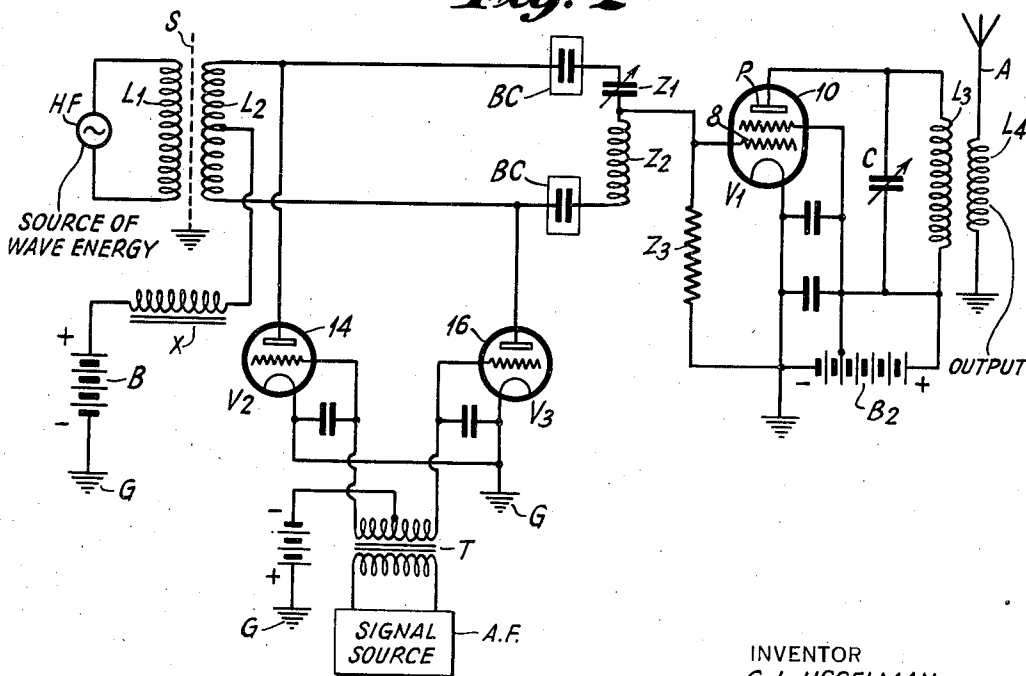


Fig. 2



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CARRIER REDUCED MODULATOR

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3 Claims. (Cl. 179-171)

This application includes a new and improved means for producing sideband modulation with the carrier reduced or suppressed, the modulation being amplitude or phase and amplitude.

In modulators of the carrier reduced or suppression type known heretofore such as shown in Carson Patents #1,343,306 and #1,343,307, two balanced tubes have been used in the modulator. In the present invention by the use of a novel circuit arrangement I accomplish sideband modulation by the use of a single tube in which modulation the carrier is reduced or entirely suppressed. In a modification, I accomplish sideband modulation accompanied by phase modulation with carrier reduction or suppression.

In describing my invention reference will be made to the attached drawing wherein,

Figures 1 and 2 illustrate the two modifications of the modulators described hereinbefore.

In Figure 1 amplitude sideband modulation with reduced carrier is accomplished.

In the arrangement of Figure 2 phase and amplitude modulation of sideband energy with reduced carrier is accomplished.

In both figures wave energy to be modulated is supplied from a high frequency source of wave energy HF to a balanced relaying circuit $L_2 Z_1 Z_2$ and from the adjacent points of impedances $Z_1 Z_2$ by way of impedance Z_3 to the control grid 8 of an electron discharge tube V_1 wherein the wave energy from the two paths are combined, repeated, or amplified. Grid bias for the control grid 8 is supplied by Z_3 from a source B_2 . The anode 10 of V_1 is connected in an alternating current circuit $C L_3$ and is supplied by potential from a source B_1 . The screen grid electrode of the tube may also be supplied by a potential from a source B_1 . By-passing condensers are connected between the screen grid and cathode and between the low potential end of the alternating current circuit $C L_3$ and the cathode. The sideband energy and reduced carrier is supplied from $C L_3$ to an inductance L_4 in a load circuit A. Modulator tubes $V_2 V_3$ have their anode to cathode impedances shunting the impedance $Z_1 Z_2$ respectively. The anode to cathode direct current circuits of $V_2 V_3$ are both completed through reactor X, source B_3 and ground. The alternating current anode to cathode circuits of $V_2 V_3$ are completed through $Z_1 Z_2$, the grid to cathode impedance of tube V_1 and impedance of Z_3 in parallel, and ground G. Modulating potentials are supplied to the grids 14 and 16 of tubes $V_2 V_3$ in phase opposition from the secondary of trans-

former T, the primary of which is coupled to a source of modulating potentials AF.

In the modification of Figure 2 the impedances Z_1 and Z_2 are capacitive and inductive in character respectively. The impedances $Z_1 Z_2$ are coupled with the terminals of L_2 by blocking condensers Bc. In this arrangement phase and amplitude modulated sidebands with reduced or suppressed carrier are produced.

In Figure 1, tubes $V_2 V_3$ are the audio frequency signal amplifier tubes. Tube V_1 and circuit L_2, Z_1, Z_2 , and Z_3 is the sideband modulator circuit in which the carrier frequency energy to be modulated flows. Circuit HF and L_1 is the carrier frequency energy source. An electrostatic shield S is placed between coils L_1 and L_2 to prevent undesirable electrostatic coupling between the carrier frequency source and the modulator circuits. Reactor X allows the center point of coil L_2 to float at carrier frequency, that is, to be above ground carrier frequency potential. This reactor X, as stated above, allows the direct current circuit to flow through the tubes $V_2 V_3$. The reactor X also insures a steady flow of current from source B_3 in that changes in direct current and/or potential therefrom are opposed by the impedance of X, this improves the modulation characteristic of the entire arrangement because when the current in one tube, say V_2 , is reduced a certain amount (by modulation) the current in V_3 is compelled to increase by a like amount.

The operation of the modulators may be best described by referring to Figure 1. Assume all cathodes are heated and all grids and anodes are supplied with proper potentials. Carrier frequency energy is supplied from source HF through coupling inductances L_1 and L_2 and from the latter through impedances $Z_1 Z_2$ to the grid of the tube V_3 and to impedance Z_3 . If no audio signal or controlling potentials is present in transformer T the two sides of the circuit $L_2 Z_1 Z_2$ are balanced relative to ground by the equal impedances to ground of tubes $V_2 V_3$. We have assumed here that the impedances $Z_2 Z_1$ are balanced relative to ground to which they are connected through Z_3 and the control grid and cathode impedance of V_1 in parallel. When signal potentials or controlling potentials are impressed from transformer T to the control grids of V_2 and V_3 then circuit $L_2 Z_1 Z_2$ is unbalanced alternately, one side being at high and the other side being at relatively low radio frequency potential with respect to ground because of the relative

change in impedances of $V_2 V_3$. This results in the combination of the carrier wave and the signal wave, which is impressed on the grid 8 of tube V_1 . The result is that tube V_1 repeats or amplifies the sideband energy impressed on the grid 8 with the carrier wave energy reduced by circuit $L_2 Z_1 Z_2$.

Sideband energy with reduced or suppressed carrier appears in the circuit $C L_3$ and may be supplied to the load A. If resistance is used for impedance Z_3 then tube V_1 must be of the type that will pass anode current without the presence of rectified current in grid 1.

By replacing the similar impedances Z_1 and Z_2 of Figure 1 by dissimilar impedances Z_1 and Z_2 as in Figure 2, a phase shift of the wave energy supplied by each branch to grid 8 with respect to the wave energy from HF is accomplished and phase as well as amplitude modulation of the sidebands supplied to $C L_3$ is produced with reduced or suppressed carrier energy. In this case, a resistance is used at Z_3 to supply the necessary impedance.

In modifications, the tube V_1 may be replaced by triodes or tubes having a different number of electrodes. In the case triodes are utilized it may be desirable to neutralize the effect of grid to anode capacity in a well known manner.

In both modifications the circuit $C L_3$ may be connected to said load by way of filters, amplitude limiters, or amplifiers, one or more of which may be used between the modulator stage V_1 and the antenna.

I claim:

1. In a modulation system, a source of wave energy to be modulated, a combining tube having a control grid and a cathode, a reactance coupled to said source of wave energy, impedances of different character coupling said reactance to the control electrode of said tube, a connection between the cathode of said tube and a point of symmetry on said reactance so that both sides of said circuit are substantially balanced, and means for unbalancing said circuit in accordance with signal frequencies, whereby sideband energy, the amplitude and phase of which varies in accordance with signal oscillations, and carrier energy

of relatively small amplitude appears in the output circuit of said tube.

2. In a modulation system, a source of wave energy to be modulated, a combining tube having a control electrode and a cathode, a reactance coupled to said source of wave energy, an inductive reactance and a capacitive reactance coupling the respective terminals of said first reactance to the control electrode of said tube, a connection between the cathode of said tube and a point of symmetry on said first reactance so that both sides of said circuit are substantially relatively balanced, and means for relatively unbalancing said circuit in accordance with signal frequencies, whereby sideband energy, the amplitude and phase of which varies in accordance with signal oscillations, and carrier energy of relatively small amplitude appears on the control electrode of said tube.

3. In a signalling system, a source of wave energy of carrier wave frequency to be modulated, an electron discharge tube having a control grid, a cathode and an anode, an output circuit coupled with the anode and cathode of said tube, a reactance coupled to said source of wave energy, an inductive reactance coupling a point on said first reactance to said control grid, a capacitive reactance coupling a point on said first reactance to said control grid, means coupling a point on said first reactance to the cathode of said tube, said last point being selected so that said reactance is substantially electrically symmetrical with respect to said cathode, a pair of electron discharge devices each having input and output electrodes, circuits connecting the output electrodes of said tubes in series with said first named reactance, means connecting a point of electrical symmetry on said last named circuit to the cathode of said first named tube, a source of modulating potentials, and means coupling said source of modulating potentials substantially in phase opposition to the input electrodes of said pair of tubes whereby sideband energy modulated in phase and amplitude and carrier wave energy of relatively small amplitude is produced in said output circuit.

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