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W. H. T. HOLDEN

CARRIER AMPLITUDE CONTROL SYSTEM

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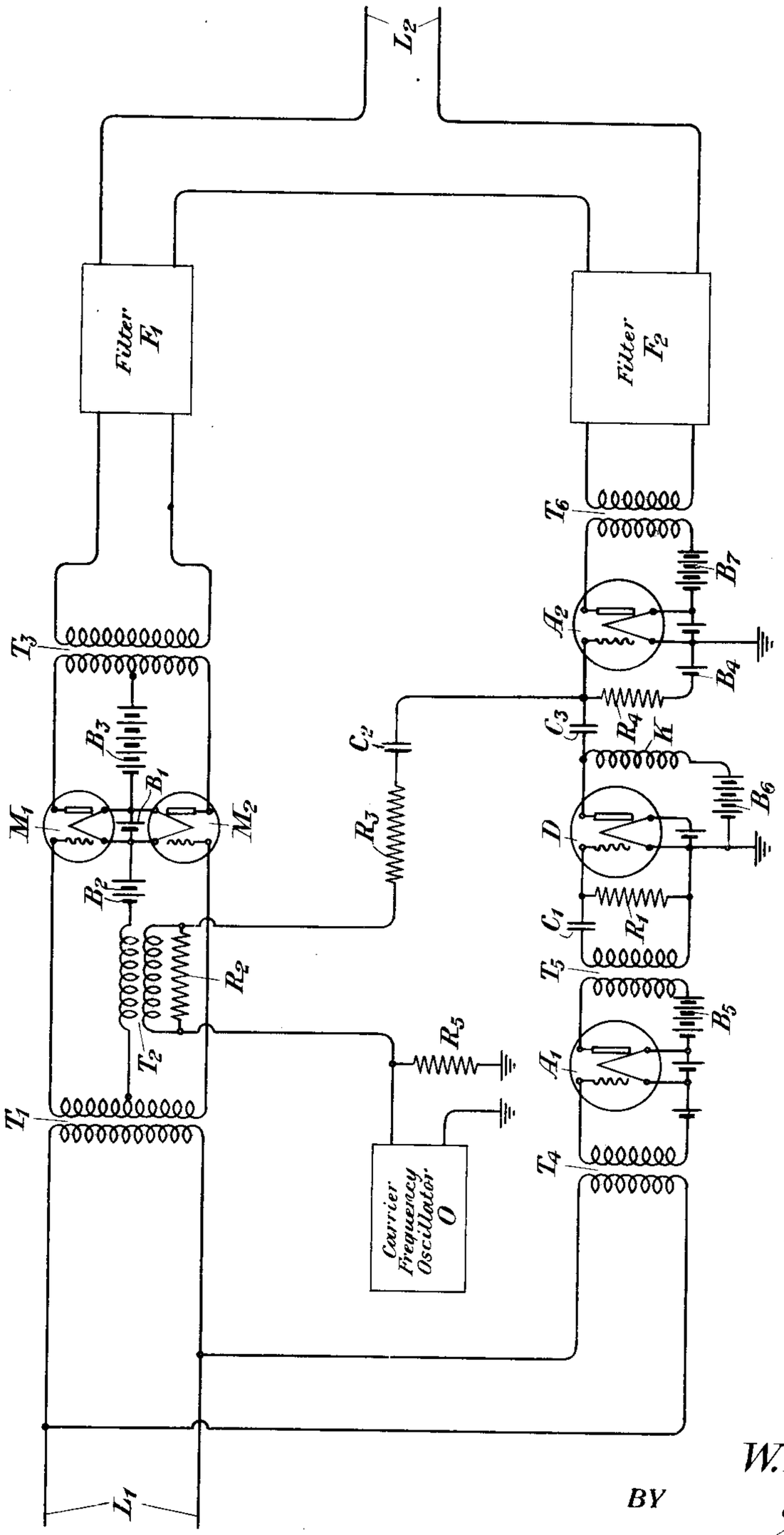

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CARRIER AMPLITUDE-CONTROL SYSTEM.

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This invention relates to signaling systems, and more particularly to arrangements in such systems for controlling the amplitude of the carrier wave in accordance with the amplitude of low frequency signals.

In radio and carrier telephone and telegraph systems in which the carrier frequency is transmitted modulated by low frequency signals, especially in systems in which the amplitude of the carrier frequency received at a receiving station is considerable, it has been discovered that, during intervals when no low frequency signals are modulated on the carrier frequency, the carrier frequency becomes modulated by currents arising in the amplifiers and detectors employed at the receiving station from what is known as "noise." By virtue of the modulation of the carrier frequency by such currents, it has been found that the "noise" heard at the receiving station increases as the amplitude of the carrier frequency increases. When the carrier frequency becomes modulated by low frequency signals, the "noise" may be comparatively small; yet it is desirable to minimize the "noise" during the silent intervals in the program, or during the intervals when the amplitude of the low frequency signals is smaller than usual.

In this invention there is disclosed a system in which the amount of carrier radiated depends upon the level of the low frequency signals supplied to the system to a considerably greater extent than is ordinarily the case.

It is an object of this invention to vary the amplitude of the carrier wave inversely with variations in the amplitude of low frequency signals. In other words, it is an object of the invention to decrease the amplitude of the carrier wave as the level of the low frequency signals decreases, and vice versa.

It is an object of this invention to reduce the amount of noise which would normally be brought in at a radio receiver when a large amount of carrier is being transmitted during the quiet intervals in the program.

It is a further object of this invention to provide a sufficient amount of carrier to the system to satisfactorily demodulate one or both of the side bands that are transmitted in a signaling system without objectionable distortion when relatively high levels of news, music, or the like are being transmitted.

And it is a further object of this invention to raise the energy level of the side band at the same time that the energy level of the carrier is lowered, and vice versa, in a system in which a single side band is transmitted so as to secure the same variation in level upon demodulation at the receiving end that exists at the transmitting end upon modulation.

Other objects and features of this invention will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing showing only one embodiment of the invention suitable for controlling the carrier frequency in accordance with low frequency signals.

Referring to the drawing, the reference character L_1 represents leads connected to a low frequency signaling source, which may be, for example, a voice frequency signaling source. A transformer T_1 connects this low frequency signaling source to a balanced modulator having two three-element thermionic tubes M_1 and M_2, each having a filament, a grid and a plate, the filaments being heated by a common battery B_1. The tubes M_1 and M_2 are preferably similar and equal in their structure and characteristic and may be replaced by a single duplex tube having a single filament, two grids and two plates. The input circuits of these tubes M_1 and M_2 are arranged in parallel with respect to the secondary winding of a transformer T_2, which is in series with the battery B_2 in the common conductor of the input circuits of these tubes. The secondary of the transformer T_1 consists of two windings which may, for example, be wound in the same direction, one in the input circuit of the tube M_1 and the other in the input circuit of the tube M_2. The output circuits of these tubes are also connected through the primary winding of a transformer T_3 in parallel with respect to a common plate battery B_3. A filter F_1 is connected to the secondary winding of the transformer T_3. This filter may be of any well-known type which will suppress all frequencies above and below a predetermined band having definite limits, and freely transmit all frequencies within these limits. Such a filter is disclosed in

the United States patent to G. A. Campbell, No. 1,227,113, dated May 22, 1917.

The leads L_1 are also connected through transformer T_4 to an amplifier A_1 for amplifying the signals coming in over the leads L_1. This amplifier may be of any type well known in the art, preferably a vacuum tube amplifier. An oscillator is represented by the reference character O, which oscillator supplies the carrier frequency to be employed in the system. This oscillator may be of any well-known type, preferably a vacuum tube oscillator, setting up oscillations of constant frequency.

A detector D and an amplifier A_2, each having a plate, a filament and a grid, are together employed for controlling the amplitude of the carrier frequency in accordance with the amplitude of low frequency signals, as will be explained more fully in the description hereinafter following.

The output of the amplifier A_1 is connected to the grid and filament of the detector D through a condenser C_1 and a resistance R_1. The output of the oscillator O is connected to the input circuit of the amplifier A_2 by the flow of current in the circuit including the primary winding of the transformer T_2, which is in parallel with a resistance R^2, a resistance R^3, a condenser C_2, a resistance R_4, a battery B_4 and ground, the resistance R_4 and the battery B_4 being directly connected between the grid and filament of the amplifier A_2. The anodes of the amplifier A_1, the detector D and the amplifier A_2 are supplied with direct current potential from batteries B_5, B_6 and B_7 through the primary winding of a transformer T_5, a choke coil K and the primary winding of a transformer T_6, respectively. The plate of the detector D is directly connected to the grid of the amplifier A_2 through a condenser C_3 which prevents the potential of the battery B_6 from being applied to the grid of the amplifier A_2. The output of the amplifier A_2 is connected through transformer T_6 to a filter F_2 which may be of any well-known type, preferably of the type disclosed in the patent to G. A. Campbell above referred to, freely transmitting the carrier frequency of the oscillator O and substantially suppressing all other frequencies. The output of the filter F_2 is connected with the output circuit L_2 in series with the output of the filter F_1

The condenser C, and the resistance R, are of such values that the potential applied to the grid and filament of the detector D varies with the syllabic frequency (the amplitude of the low frequency signals). Consequently a corresponding variation will take place in the plate-filament impedance of the detector D. But the input impedance of the amplifier A_2 depends upon the impedance of resistance R_4, and resistance R_4 is in parallel with the plate-filament impedance of the detector D. Inasmuch as the plate-filament impedance of the detector D varies with the syllabic frequency (the amplitude of the low frequency signals), averaged over a period determined by the time constant of the condenser C_1 and the resistance R_1, hence the greater the amplitude of the low frequency signals becomes, the greater will be the plate-filament impedance of the detector D, and the greater will be the input impedance of the amplifier A_2. Consequently the amplitude of the carrier frequency will increase as the amplitude of the low frequency signals increases, and vice versa. Thus it will be noted that the detector D and the amplifier A_2 together form an arrangement which is employed for controlling the amplitude of the carrier frequency transmitted by the amplifier A_2 in accordance with the low frequency signals coming in over the leads L^1.

The carrier frequency is also transmitted to the primary winding of the transformer T_2 by virtue of the presence of the primary winding of the transformer T_2 in the circuit including the output of the carrier frequency oscillator O, the resistance R_3, the condenser C_2, the resistance R_4 and ground. Some of the current in the input of the oscillator O is shunted by a resistance R_5 which is connected across the terminals of the oscillator O through ground. By virtue of the connection between the output of the oscillator O and the transformer T_2, the grids of the tubes M_1 and M_2 are both in phase with respect to the carrier frequency transmitted by the oscillator O. The oscillations of the carrier frequency therefore flow in opposite directions in the input circuits of the tubes M_1 and M_2. As the low frequency signals come in over the leads L_1, the grid of one of the tubes M_1 or M_2 becomes positive while the grid of the other becomes negative, so that the resistance of one increases while the resistance of the other decreases. This then causes an increase in the amplitude of the oscillations of the carrier frequency flowing in the input circuit of the tube in which the grid is positive and a corresponding decrease in the amplitude of the oscillations of the carrier frequency in the input circuit of the tube in which the grid is negative, and the tubes M_1 and M_2 are actuated only during the time that low frequency signals are coming in over the leads L_1.

As has already been stated, the impedance of the resistance R_4 increases when the amplitude of the low frequency signals coming in over the leads L_1 increases, and vice versa. Therefore, when the impedance of the resistance R_4 increases, less current will flow in the circuit interconnecting the carrier frequency oscillator, the primary winding of the transformer T_2, the resistance R_3, the condenser C_2, the resistance R_4 and

ground. Therefore, the products of modulation resulting from impressing the carrier frequency of the oscillator O and the low frequency signals coming in from the leads L_1 upon the balanced modulator decrease. Obviously, when the impedance of the resistance R_4 decreases, the products of modulation will increase. Since in this particular arrangement the filter F_1 is so related to the balanced modulator as to transmit one side band resulting from modulation, the energy level of that side band will increase and decrease as the amplitude of the carrier frequency passing the amplifier A_2 decreases and increases, respectively. The output of the filter F_1, which is the above-mentioned side band, and the output of the filter F_2, which is the carrier frequency of the oscillator O, are united in the receiving circuit L_2, the energy level of the side band transmitted by the filter F_1 varying inversely with the amplitude of the carrier frequency transmitted by the filter F_2.

While the arrangement as disclosed herein involves the transmission of a single side band along with the carrier frequency, the principles of this invention may be applied equally well to a system in which both side bands are transmitted along with the carrier frequency.

While the arrangements of this invention have been shown with particular reference to the control of a carrier frequency employed in a transmission system in accordance with low frequency signals, it is to be understood that the invention may be embodied in other systems, and in other and different organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a signaling system, a source of signaling oscillations, a high frequency wave, means for controlling the amplitude of said high frequency wave in accordance with the amplitude of the oscillations of said signaling source, and a modulator for superimposing said signaling oscillations on said controlled high frequency wave, the amplitude of said high frequency wave impressed on said modulator decreasing as the amplitude of the oscillations of said signaling source increases, and vice versa.

2. In a signaling system, a source of voice frequency oscillations, a high frequency wave, a pair of thermionic devices, means for impressing said high frequency wave and said voice frequency oscillations on said pair of thermionic devices so that the amplitude of said high frequency wave is controllel by the amplitude of said voice frequency oscillations, means for varying the amplitude of the high frequency wave inversely with variations in the amplitude of said voice frequency oscillations, a modulator for modulating said high frequency wave controlled in the latter manner by said voice frequency oscillations, a band filter for suppressing said high frequency wave and one side band thereof resulting from modulation and transmitting the other side band thereof, and means for combining the high frequency wave controlled by the said pair of thermionic devices with the side band of the high frequency wave transmitted by said filter.

3. In a signaling system, a source of voice frequency oscillations, a high frequency wave, means for impressing said high frequency wave and said voice frequency oscillations on a pair of thermionic devices so as to control the amplitude of said high frequency wave by the amplitude of said voice frequency oscillations, and a modulator for modulating said high frequency wave by said voice frequency oscillations, the amplitude of said high frequency wave modulated by said modulator varying inversely with the amplitude of said voice frequency oscillations.

4. In a signaling system, a source of voice frequencies, a carrier frequency, means for varying the amplitude of the carrier frequency in accordance with the voice frequencies, means for varying the amplitude of the carrier frequency inversely with variations of the voice frequencies, a modulator for modulating said carrier frequency varied in the latter manner by said voice frequencies, a band filter for substantially suppressing said carrier frequency and one side band and for transmitting the other side band resulting from modulation, and means for combining and transmitting said carrier frequency controlled in accordance with the voice frequencies and the side band thereof resulting from modulation.

5. In a system for the transmission of signals, a source of voice frequencies, a carrier frequency, means for decreasing the amplitude of the carrier frequency as the amplitude of the voice frequencies increases, and vice versa, means for modulating the said carrier frequency varied in the above manner by said voice frequencies, means for substantially suppressing the carrier frequency and one side band and for transmitting the other side band resulting from modulation, means for increasing the amplitude of the carrier frequency as the amplitude of the voice frequency increases, and vice versa, and means for combining the carrier frequency controlled in the latter manner with the side band of the carrier frequency resulting from modulation.

6. In a signaling system, a source of signaling oscillations of varying amplitude, a source of high frequency oscillations, a thermionic device upon which said high frequency oscillates are impressed, said ther-

mionic device being employed for regulating the amplitude of said high frequency oscillations impressed thereon in accordance with the signaling oscillations, means for modulating the regulated high frequency oscillations with the signaling oscillations, means for deriving one side band of said modulated high frequency oscillations from the products of modulation, and means for recombining the regulated high frequency oscillations and the side band thereof resulting from modulation.

7. In combination, a source of low frequency signals of varying amplitude, a high frequency oscillator, two three-element vacuum tubes each having a plate, a filament and a grid, a source of low frequency signals being connected to the grid and filament of one of the vacuum tubes so as to effect changes in the potential of the grid with respect to the filament of that tube at a rate corresponding to variations in the amplitude of the low frequency signals, the high frequency oscillator being connected to the grid and filament of the other three-electrode vacuum tube, said tubes being so connected that changes in the plate-filament impedance of the tube to which the source of low frequency signals is connected effect corresponding changes in the potential of the grid with respect to the filament of the tube to which the high frequency oscillator is connected, and a modulator for combining the low frequency signals with the wave of the carrier frequency oscillator so as to produce a side band of said wave, said side band varying inversely with the amplitude variations of the carrier frequency brought about by said vacuum tubes.

8. In a system for controlling the amplitude of a carrier frequency in accordance with low frequency signals of varying amplitude, in combination, two three-electrode vacuum tubes each having an anode, a cathode and a grid, the source of low frequency signals being connected to the grid and cathode of one of the vacuum tubes, the carrier frequency generator being connected to the grid and cathode of the other vacuum tube, said vacuum tubes being so related that variations in the potential between the grid and cathode of the vacuum tube to which the source of low frequency signals is connected cause corresponding variations in the amplitude of the current flowing between the anode and cathode of the vacuum tube to which the carrier frequency generator is connected, and a modulator for modulating the low frequency signals with the carrier frequency, the amplitude of the carrier frequency at said modulator varying inversely with the changes in amplitude of the low frequency signals.

9. In a system for controlling the amplitude of a carrier frequency wave, in combination, a source of low frequency signals of varying amplitude, a carrier frequency generator, two three-electrode vacuum tubes each having an input circuit and an output circuit, the source of low frequency signals being connected to the input circuit of one of the vacuum tubes and a carrier frequency generator being connected to the input circuit of the other of the vacuum tubes, said vacuum tubes being so related that variations in the potential in the input circuit of the vacuum tube to which the source of low frequency signals is connected cause corresponding variations in the current in the output circuit of the vacuum tube to which the carrier frequency generator is connected, and a modulator to which the source of low frequency signals and the carrier frequency generator are connected, the amplitude of the carrier frequency at said modulator varying inversely with the amplitude variations of the low frequency signals, said modulator modulating the low frequency signals and the carrier frequency.

10. A system for controlling the amplitude of a carrier frequency in accordance with low frequency signals of varying amplitude, comprising two three-electrode vacuum tubes placed in tandem with respect to the source of low frequency signals so that the plate and filament of the first vacuum tube are in parallel relationship with the grid and filament of the second vacuum tube, the source of low frequency signals being connected to the grid and filament of the first vacuum tube and the carrier frequency oscillator being connected to the grid and filament of the second vacuum tube, means connected to the second vacuum tube for freely transmitting the carrier frequency controlled as to its amplitude and substantially suppressing all other frequencies, and a modulator for modulating the low frequency signals with the controlled carrier frequency.

In testimony whereof, I have signed my name to this specification this 26th day of March, 1926.

WILLIAM H. T. HOLDEN.