

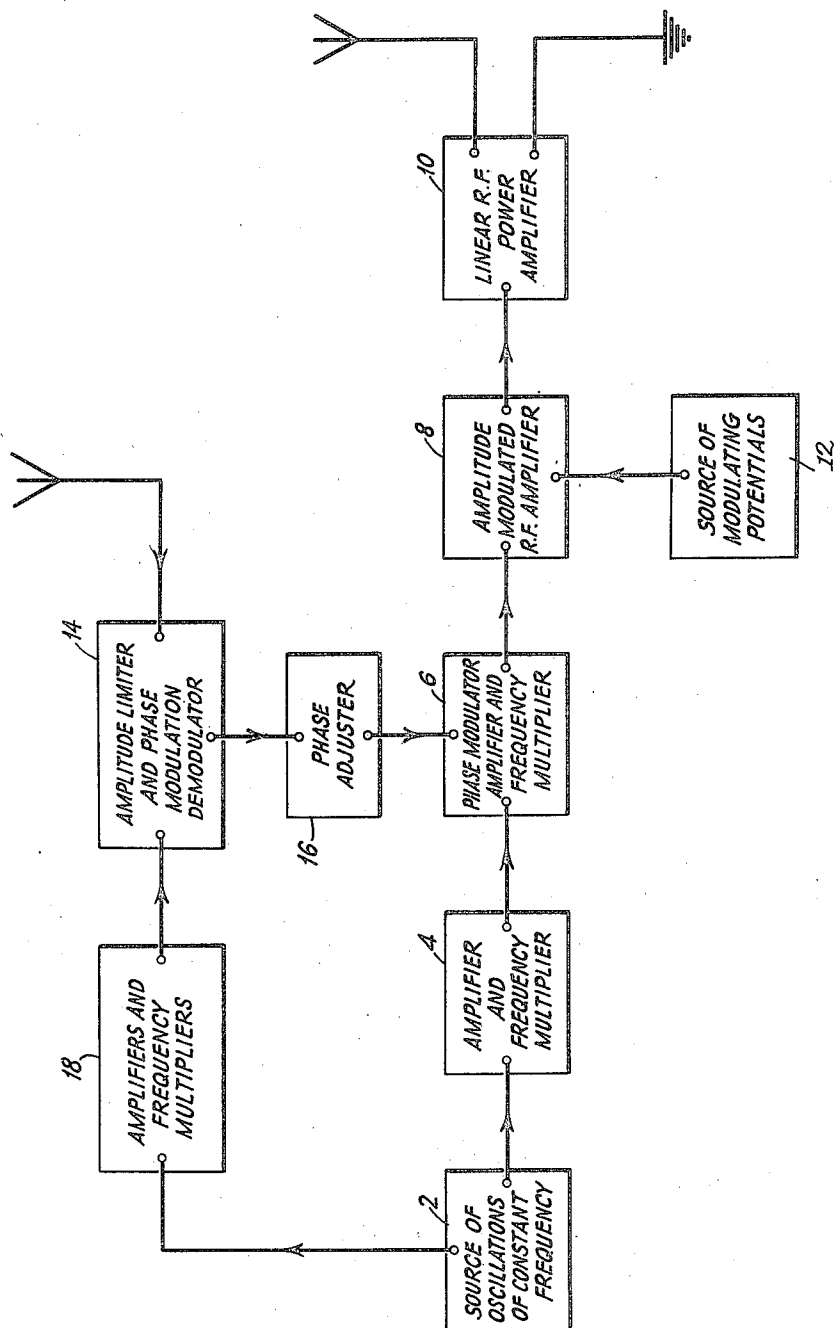
Oct. 17, 1939.

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2,176,587

METHOD OF AND MEANS FOR MODULATING WAVE ENERGY

Filed Dec. 21, 1936



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2,176,587

METHOD OF AND MEANS FOR MODULATING
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Application December 21, 1936, Serial No. 116,860

7 Claims. (Cl. 179—171.5)

This invention relates to the art of wave energy modulation and in particular to a modulation scheme which includes means for correction of distortion caused by inherent phase modulation of wave energy being modulated in amplitude at signal frequency.

In the usual type of amplitude modulated wave energy transmitters, care is taken to prevent amplitude distortion rising in the signal due to non-linearity in any of the signalling equipment and against frequency discrimination, etc. In amplitude modulated wave transmitters of some types, means is also provided to eliminate hum in the modulated wave energy caused by fluctuations in filament heating or electrode charging potential sources. However, quite often there may be distortion due to undesired simultaneous phase modulation which causes a distortion of the amplitude modulated wave energy that goes out of the transmitter unrecognized and undetected. The primary object of the present invention is to provide a method of and means for detecting this simultaneous phase modulation and to provide a method of and means for correcting this undesired simultaneous phase modulation at the transmitter.

Various methods may be used to accomplish detection of the undesired phase modulation after the amplitude modulation of the wave energy has been limited out and to feed the audio output of the phase modulation detector back to the transmitter to excite or energize a phase modulator in the proper phase relation to compensate or correct or buck out the simultaneous undesired phase modulation which occurred in the transmitter during the amplitude modulation process. There are many circuits for detecting phase modulation and circuits for phase modulating the wave energy in a transmitter and I do not limit the present invention by any particular method of or means for demodulating phase modulated wave energy or for phase modulating wave energy because any suitable phase modulated wave energy demodulator and any suitable phase modulator may be used in combination to produce the desired result. For example, I may impress the amplitude modulated wave energy with the incident phase modulation from any point in the transmitter following the modulator stage on the circuits of a phase modulation receiver of the type disclosed in Crosby United States applications #588,309 filed January 23, 1932, now Patent #2,081,577 dated May 25, 1937; #618,154 filed June 20, 1932; and

#616,803 filed June 13, 1932, now Patent #2,065,565 dated December 29, 1936.

The voltage components in the output of said receivers, characteristic of the incident phase modulation in the amplitude modulator may be brought back to a selected stage in the modulator and used to phase modulate the wave therein in a sense to oppose and balance or compensate out the said incident phase modulation. To accomplish this modulation, I may use a phase modulator of the type disclosed in Goldstine applications #654,372 filed January 31, 1933, now Patent #2,067,081 dated January 5, 1937; #679,916 filed July 11, 1933, now Patent #2,067,082 dated January 5, 1937; #710,239 filed February 8, 1934, now Patent No. 2,111,587 dated March 22, 1938; and Crosby applications #588,309 filed January 23, 1932, now Patent #2,081,577 dated May 25, 1937; #690,330 filed September 21, 1933; and Usselman United States applications #637,923 filed October 15, 1932; 630,179 filed August 24, 1932, now Patent #2,058,928 dated October 27, 1936; and Usselman Patents #2,036,165 dated March 31, 1936; #2,048,900 dated July 28, 1936.

As stated above, I do not limit my invention to the particular type of phase modulated wave demodulator or to a particular type of phase modulator or to the point at which the amplitude modulated wave with the incident phase modulation is derived from a transmitter or to the point at which the component characteristic of the inherent phase modulation derived at the output of the demodulator is returned to the transmitter for modulation purposes. However, I do have a preferred form of incident phase modulation correction circuit to be used with my amplitude modulated transmitter.

One method of accomplishing the primary object of the present invention and incidental objects, is to take a voltage from the crystal oscillator of the transmitter, which voltage is free of phase modulation, and amplify it and multiply its frequency until it is of the same frequency as the output of the transmitter. Then by properly phasing this voltage from the crystal unit relative to the carrier of the modulated wave, which has been suitably limited as to amplitude to remove therefrom the amplitude modulation or has been passed through balancing means to remove the amplitude modulation, the phase modulated energy component may be obtained by combination of the voltages. As disclosed in the receiver applications referred to hereinbefore, combining of these voltages in phase quadrature

will produce a resultant which changes in amplitude in a manner characteristic of the incident or undesired phase modulation on the limited energy obtained from the amplitude modulated transmitter output. The resultant energy varying in amplitude is then fed back in the proper phase or sense to a point in the transmitter and used to modulate the carrier wave being passed thereby in a sense to cancel the incident or undesired phase modulation of the transmitter. Preferably, this modulating energy is returned to an amplifier and/or frequency multiplier stage somewhere between the crystal unit and the power amplifier stage.

In describing an embodiment of my invention reference will be made to the single figure of the drawing which shows, by means of rectangles, the essential units of an amplitude modulator with an incident phase modulation correction circuit as outlined above.

Referring to Figure 1, 2 is a source of oscillations of constant frequency which is to be amplitude modulated. 4 is an amplifier and if desired, a frequency multiplier which increases the amplitude and, if desired, the frequency of the oscillations at the output of 2. 6 is an additional amplifier and, if desired, frequency multiplier, to further increase the amplitude and frequency of the oscillatory energy in the output of 4. The phase modulation, in a proper sense to correct the incident phase modulation produced in amplitude modulating the wave in the following stage, is also accomplished in the amplifier and/or frequency multiplier in 6, as will appear more in detail hereinafter. Wave energy from the output of 6 is impressed upon an amplitude modulator 8 which is also connected with a source of modulating potentials 12. The output of 8 is connected with a power amplifier 10 which is, in turn, connected with a transmission line or aerial system or any load circuit.

During the amplitude modulation process accomplished in 8 in accordance with potentials in 12 incident or accidental, undesired phase modulation may be accomplished. This phase modulation appears on the wave energy supplied from the output of 10. To detect this phase modulation I may provide a phase modulation demodulator 14 having a pick-up device deriving energy from the output of 10. This pick-up device may comprise an antenna in the field of the antenna connected with 10. The phase modulated wave demodulator in 14 may take any known form and may, for example, be of the type disclosed in the receiver applications referred to above. The phase modulation demodulator includes a limiter and its output is supplied to the unit 6 to phase modulate the wave energy therein to eliminate incident or accidental phase modulations on the output of 10.

If the output of 14 is linear and there is no phase shift produced in the process of demodulating the phase modulation on the wave the demodulated output of 14 may be impressed directly on 6. If there has been some phase shift then 14 is connected to 6 by way of a phase adjuster of any known type such as a filter of the required characteristics so that the modulating energy is of the proper phase. This method and means for phase modulating the wave energy in 6 may be as disclosed in the phase modulation applications referred to above. When the demodulator in 14 is of the heterodyne type beating oscillations may be supplied from an amplifier and frequency multiplier 18 in turn

excited by wave energy of constant frequency from 2. The receiver, however, may have a separate source of oscillations for beating purposes, or may make use of transmitter carrier wave energy from which modulation components have been removed.

In operation, the output of 14 is made of sufficient amplitude to just compensate or buck out the inherent phase modulation accomplished in 8. The amplitude of the output of 14 may be regulated by regulating the input thereof or the amplification of the wave in the demodulator. The phase of the energy in the output 14 is adjusted in 16 to have a sense opposed to the inherent or accidental phase modulation accomplished in 8.

Although my invention is directed primarily to a means for compensating inherent phase modulation accomplished in the amplitude modulator it will be understood that my invention may be also used to buck out phase modulation occurring in any stage in the transmitter as a result from any cause, such as hum produced by filament heating and electrode exciting circuits or due to microphonics arising in tubes, or other disturbances.

Another method of reducing the incident phase modulation is to have a phase modulation receiver and introduce a portion of the modulating potentials from 12 through a phase shifter to a phase modulator. The phase and amplitude of the source of modulating potentials introduced into the phase modulation is adjusted until the output of the phase modulation receiver gives a minimum output. Hum may also be introduced into the phase modulator at the proper frequency, phase and amplitude to reduce the output of the phase modulation demodulator to minimum.

I claim:

1. The method of signalling by means of wave energy the amplitude of which is advertently modulated in accordance with signals and the phase of which is inadvertently varied during said modulation process which includes the steps of, limiting the amplitude of said modulated wave energy, demodulating the amplitude limited wave energy to obtain voltages characteristic of said inadvertent phase variations, additionally modulating said wave energy in accordance with said obtained voltage, and adjusting the phase of said obtained voltages so that said additional modulations oppose said original inadvertent phase variations.

2. The method of signalling by means of wave energy the amplitude of which is advertently modulated in accordance with signals and the phase of which is inadvertently varied in accordance with said signals which includes the steps of limiting the amplitude of said modulated wave energy, demodulating the amplitude limited wave energy to obtain voltages characteristic of said inadvertent phase modulations additionally phase modulating said wave energy in accordance with said obtained voltages, and adjusting the phase of said obtained voltages so that said additional modulations oppose said original inadvertent phase variations.

3. In an amplitude modulated transmitter system, a source of oscillations, an amplitude modulator coupled thereto to modulate the amplitude of oscillations from said source, a source of modulating potentials coupled to said amplitude modulator, an output circuit coupled to said amplitude modulator, a phase modulator interposed be-

tween two of said first named elements, an amplitude limiter excited by wave energy from said amplitude modulator, a phase modulation demodulator excited by energy from said amplitude limiter, and a circuit coupling the output of said demodulator to said phase modulator to feed the output of said demodulator to said phase modulator in such a sense as to oppose unwanted phase modulation of said oscillations.

4. In an amplitude modulation system, a source of oscillations of constant frequency, a phase modulator having its input coupled to said source of oscillations, said phase modulator having an output, an amplitude modulator having an input coupled to said phase modulator output, said amplitude modulator having an output, a source of modulating potentials coupled to said amplitude modulator, a power amplifier coupled with the output of said amplitude modulator, said power amplifier having an output, a phase modulated wave demodulator having an input coupled to the output of said power amplifier, said phase modulation demodulator being of the heterodyne type and being coupled by way of amplifiers and frequency multipliers to said source of oscillations and a phase adjuster coupling the output of said demodulator to said phase modulator to supply potentials from said demodulator to said phase modulator of a phase such as to compensate undesired phase modulation in said system.

5. In an amplitude modulation wave transmitter, means for amplifying and modulating the amplitude of wave energy and amplifying the modulated wave energy, said means inherently producing undesired phase variations of said wave energy, phase modulation receiving means including amplitude limiting means coupled to said first named means at a point following the

modulating means, and phase adjusting means coupling said phase modulation receiving means to said first named means to phase modulate said wave energy in a sense to oppose said inherent phase variation.

6. In an amplitude modulated transmitter system, a source of oscillatory energy to be modulated, an amplitude modulator coupled thereto to modulate said wave energy in accordance with signals, an output circuit coupled to said amplitude modulator responsive to said modulated wave energy, a phase modulator interposed between two of said aforesaid units, an amplitude limiter excited by modulated energy from said amplitude modulator, a phase modulation demodulator excited by energy from said amplitude limiter, a phase adjuster coupled to said phase modulation demodulator, and a coupling between said phase adjuster and said phase modulator to supply modulating potentials from said demodulator to said phase modulator in a sense to oppose unwanted phase modulation in said system.

7. The method of signaling by means of oscillatory energy and modulating potentials which includes the steps of, modulating the amplitude of said oscillatory energy in accordance with said modulating potentials, said modulation process inadvertently producing undesired modulation of the phase of said oscillatory energy, demodulating the modulated oscillatory energy to obtain therefrom potentials characteristic of the unwanted phase modulations of said oscillatory energy and additionally modulating said oscillatory energy in accordance with said obtained potentials and in a sense to oppose said undesired phase modulations thereon.

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