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MODULATION AND RELAY

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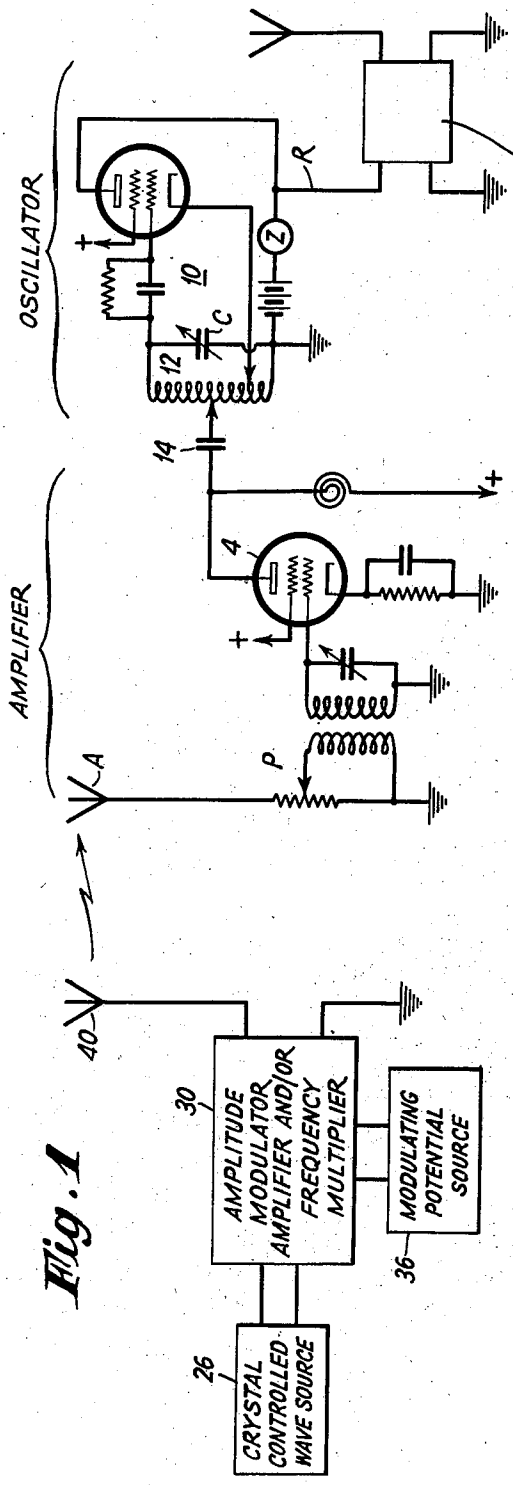


Fig. 1

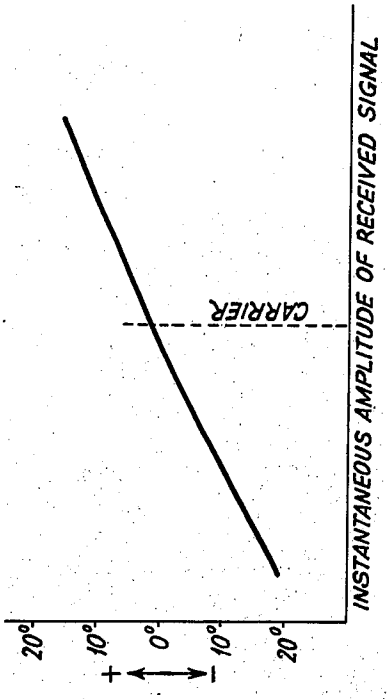


Fig. 2

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MODULATION AND RELAY

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4 Claims. (Cl. 250—15)

This application concerns a new and improved method of and means for the conversion of amplitude modulation to phase modulation and the use of the same in a relay system.

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

Fig. 1 illustrates a new and improved means for converting amplitude modulation to phase modulation and radiating the resulting modulation; and

Fig. 2 is a graph showing the relation between the instantaneous amplitude of the controlling wave and the phase of oscillations controlled thereby in my process of conversion from amplitude to phase modulation.

Fig. 1 shows a set-up which I made to produce known frequencies for receiver calibration. The idea was to lock the oscillator 10 with a broadcast signal thus providing oscillator harmonics of accurately known frequencies. The broadcast signal picked up by antenna A is preferably amplified in an amplifier 4 of any approved type and amplified voltages supplied to a point on the oscillator circuit 12 by way of coupling condenser 14. The harmonic components of oscillator plate current passing through an impedance Z produced enough voltage on a short wire R extending in the vicinity of the receiver to provide a good level of signal to the receiver.

The arrangement has been in service with good success for the intended purpose but in operating the set-up an unexpected phase modulation of the harmonics was observed. In the first place, it was found that with a fairly strong broadcast signal the synchronizing action was so strong that the oscillator was held in synchronism over a considerable range of adjustment of condenser C. When this condenser was adjusted a little to either side of the setting at which the oscillator frequency was naturally equal to the broadcast frequency, it was found that the harmonics of the oscillator were modulated in phase in accordance with the envelope of the broadcast signal. The amount of amplitude modulation, however, was extremely small, due perhaps to the voltage impressed on the oscillator by the amplifier, compared with the oscillator voltage being small.

Fig. 2 shows how this phase modulation may be explained. Taking the phase of the oscillator corresponding with the unmodulated broadcast carrier as a reference phase, the relative phase of the oscillator voltage varies as a function of the instantaneous voltage of the broadcast wave as shown by the curve. This is because magnitude of the "pulling-in" effect is proportional to the strength of the broadcast waves. Thus, as the broadcast waves swing above and below their carrier amplitude, the phase of the oscillation generator voltage swings back and forth with respect to its mean position.

The amount of phase modulation observed on the lower harmonics was probably not very large but on higher harmonics, such as about the tenth to twentieth, the phase swing must have been quite large as the phase modulated signals were very excellently demodulated by a simple mistuning of the receiver in either direction from the carrier frequency.

When the foregoing effects are to be utilized in a phase modulation transmitter, the system has the advantage of permitting the controlling oscillator, that is the oscillator supplying the waves which are amplitude modulated, to be crystal controlled, thus keeping the mean frequency of the controlled oscillator 10 crystal stabilized.

The system may be used to relay signals from one point to another at ultra-high frequencies. When so used, the apparatus comprising antenna A and the circuits coupling it to R may be located at a high elevation and may pick up amplitude modulated waves from any high frequency transmitter system, such as shown in Fig. 1. The transmitter has a crystal controlled wave source 26 which may comprise a crystal controlled oscillator and frequency multipliers if desired. The oscillators are amplitude modulated in 30 by modulating potentials from 36. The unit 30 may also include frequency multipliers. Modulated waves are radiated from antenna 40.

When the method is used in a phase modulation transmitter station as distinguished from a relay system, the amplitude modulator output instead of being radiated as by an antenna 40 may be supplied by a coupling of any type from the output of 30 to the input of amplifier 4 to control the oscillator 10. Of course, the amplifier 4 may, in this case, be included in the unit 30.

I claim:

1. In a high frequency modulated wave relaying system, a receiver excited by wave energy of substantially fixed frequency the amplitude of which is varied at signal frequency, a source of oscillations of a frequency slightly different than the frequency of said received wave energy, means coupling said receiver to said source of oscillations to entrain the latter by the received wave energy to an average frequency synchronism, whereby the oscillations of said source are controlled as to phase in accordance with varia-

tions in the amplitude of the received wave energy, and phase modulated wave translating means coupled to said source of oscillations.

2. In means for converting an incoming amplitude modulated wave of one frequency to a phase modulated wave of a second and relatively high frequency, means for receiving and amplifying said incoming amplitude modulated wave, a local oscillation generator of the type adapted to be locked in frequency synchronism by an alternating current control voltage, means coupling said receiving and amplifying means to said oscillator to entrain said oscillator by said received and amplified amplitude modulated wave whereby the oscillations of said source are controlled as to phase in accordance with variations in the amplitude of the received wave energy, a frequency multiplier coupled to said local oscillator and means for utilizing the multiplied oscillations coupled with said frequency multiplier.

3. In means for converting amplitude modulated radio frequency waves to phase modulated radio waves without detection, a source of amplitude modulated radio waves, a receiver for said amplitude modulated waves including a source of oscillations of a frequency slightly different than the frequency of said received wave energy, means coupling said receiver to said source of oscillations to entrain the latter by the received wave energy to an average frequency synchronism, whereby the oscillations of said source are controlled as to phase in accordance with variations in the amplitude of the received wave energy, and phase modulated wave utilizing means.

4. In a radio relay system, a transmitting station radiating amplitude modulated waves, a repeater station for receiving the amplitude modulated waves, means at said repeating station for converting the amplitude modulated waves directly to phase modulated waves without detection, means for utilizing said phase modulated waves at said repeating station to provide a phase modulated radiation from said repeating station, and a receiving station for receiving the waves radiated by said repeating station.

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