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E. W. KENEFAKE
FREQUENCY MODULATION

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Fig. 1.

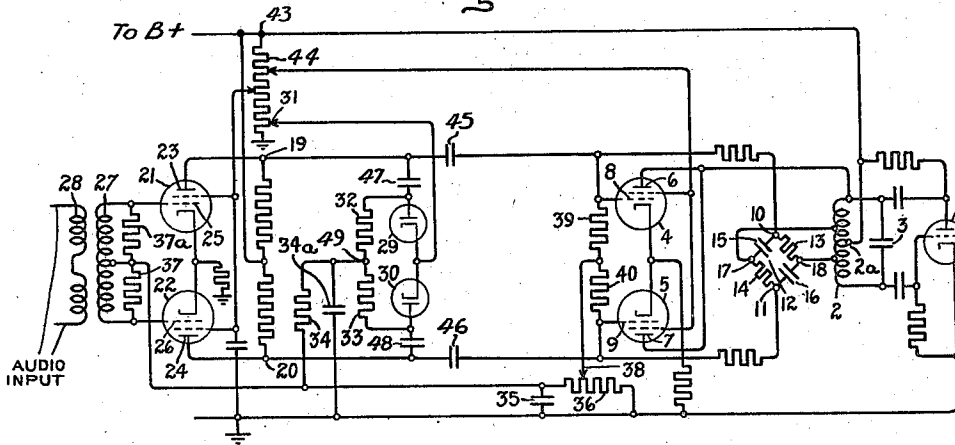


Fig. 2.

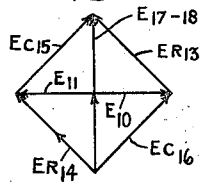
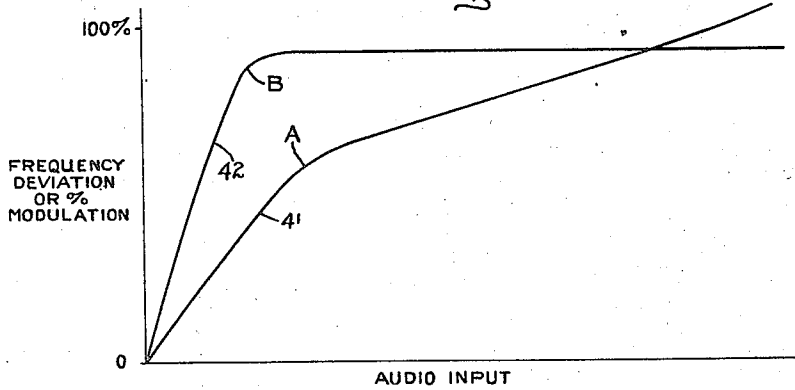


Fig. 3.



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FREQUENCY MODULATION

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2 Claims. (Cl. 179—171.5)

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The present invention relates to frequency modulation transmitters and is particularly concerned with preventing overmodulation.

The object of my invention is to provide a control for preventing overmodulation which permits higher modulation percentages in the normal operating range.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 is a diagram of a frequency modulation oscillator having a modulation control embodying my invention; Fig. 2 is a diagram explaining the operation of the phase shift network supplying the reactance tubes; and Fig. 3 is a diagram explaining the performance of the modulation control.

Referring to the drawing there is shown an oscillator 1 having a frequency determining circuit comprising an inductance 2 and a shunt condenser 3. Operating potential for the oscillator is supplied in conventional manner from the upper terminal 43 of a power supply potentiometer 44 which is connected to a suitable source of B+ operating potential (not shown). Associated with the frequency determining circuit are push-pull reactance tubes 4, 5 having anodes 6, 7 excited in phase with the oscillator output from one end of the inductance 2 and having grids 8, 9 excited in phase quadrature with the oscillator output from diametral terminals 10, 11 of a phase shift network comprising a bridge 12 having equal impedance arms consisting of resistances 13, 14 and condensers 15, 16. Intermediate terminals 17, 18 of the bridge are connected to taps on the inductance 2 on opposite sides of a center tap 2a connected to the power supply. Equal currents flow through the arms of the bridge between terminals 17, 18 which, as shown in Fig. 2, lead the voltage between the terminals by 45°. The voltage E_{11} at terminal 11 is therefore equal and opposite to the voltage E_{10} at terminal 10 and both voltages are displaced in phase exactly 90° from the output of the oscillator appearing across the inductance 2. The tubes 4 and 5 accordingly draw reactive current which simulates a reactance connected across the frequency determining circuit of the oscillator.

The amount of reactive current through the tubes 4, 5 (and hence the variation in the oscilla-

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tor frequency) is controlled by varying the potential on the grids 8, 9 in accordance with an audio signal coupled to the grids 8, 9 through blocking condensers 45 and 46 from output terminals 19, 20 of a push-pull audio amplifier. The amplifier comprises devices 21, 22 having anodes 23, 24 connected to the terminals 19, 20 and grids 25, 26 connected to the secondary 27 of a transformer having a primary 28 connected to the source of audio signals (not shown, but indicated by "Audio input"). With this arrangement, the potential on the grids 8, 9 varies in magnitude and frequency with the amplitude and frequency of the audio signals to modulate the frequency of the oscillator by causing the oscillator frequency to vary or deviate from the mean frequency in accordance with the audio signals.

In frequency modulation, the maximum deviation of the transmitted frequency must be restricted to avoid distortion at the receiver. The frequency deviation should, however, be as large as possible since the signal intensity increases with the magnitude of the frequency deviation. Frequency deviation is equivalent to modulation percentage in amplitude modulation.

The frequency deviation is restricted (overmodulation is prevented) by an over modulation voltage developed by an automatic volume control comprising diodes 29, 30 connected between the audio amplifier output terminals 19, 20 and a source 31 of voltage positive with respect to ground which determines the point at which the automatic volume control becomes effective. Positive half cycles of the audio signals of greater voltage than the voltage 31 cause diodes 29, 30 to draw current through condensers 47, 48, thereby to develop negative voltages with respect to ground at junction 49 between resistances 32, 33. These voltages are applied through a filter 34, 34a to a time constant network consisting of a condenser 35 shunted by a resistance 36. The voltage of the condenser 35 is coupled through conventional loading resistances 37 and 37a and primary winding 27 to the audio amplifier grids 25, 26 reducing the audio amplifier output. This reduces the audio signal voltages applied to the grids 8, 9 of the reactance tubes and tends to decrease the effective reactance of the tubes. A portion of the voltage of the condenser 35 determined by the adjustment of a slider 38 on the resistance 36 is applied through resistances 39, 40 to the grids 8, 9 of the reactance tubes, reducing the reactive current through the tubes and further decreasing the effective reactance. The over-modulation control voltages applied to the audio amplifier

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and to the reactance tubes both tend to decrease the frequency deviation (the modulation percentage) for strong signals by decreasing the effective reactance connected across the frequency determining circuit of the oscillator. Other arrangements for obtaining over-modulation control voltages are known.

The performance of the modulation control is illustrated in Fig. 3. Curve 41 is typical of the modulation control obtainable by applying the over-modulation control voltage to either the audio amplifier or to the reactance tubes. The curve has a relatively steep slope to point A at which the automatic volume control becomes effective (when the positive half cycles of the audio signals exceed the voltage 3f). As the audio input increases, the automatic volume control voltage reduces the modulation, but at very large signal inputs the modulation exceeds the desired limit. In order that this type of control be effective, the point A must correspond to a relatively low modulation percentage so the transmitter is not as effectively used in the normal operating range. Curve 42 is typical of the modulation control obtainable by applying the over-modulation volume control voltage to both the audio amplifier and the reactance tubes. This curve has a steeper slope to point B, the point at which the automatic volume control becomes effective, and thereafter remains substantially constant corresponding to a constant modulation percentage. The modulation percentage for very strong signals is kept below the desired limit. It will be noted that the modulation percentage for low signal inputs is higher than for curve 41 and the transmitter is therefore used more effectively to transmit information in the normal operating range.

It is obvious that the curves 41, 42 are subject to modification. For equivalent designs, the curve 42 always exhibits better performance than the curve 41.

While I have shown particular embodiments of my invention, it will be understood that many modifications may be made without departing from the spirit thereof, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

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1. The combination, in a frequency modulation transmitter, of a source of carrier wave oscillations to be modulated, a reactance tube modulator having a grid and cathode, said modulator being connected to said source to vary the frequency thereof in accordance with the potential between said grid and cathode, an audio amplifier, means to supply audio signal oscillations through said amplifier to said grid and cathode of said modulator, means to rectify the audio signal output from said audio amplifier when it exceeds a predetermined level to produce unidirectional control potentials, and two unidirectional current circuits one connected to impress said control potentials between said grid and cathode of said modulator with polarity to reduce the extent of modulation produced thereby and the other connected to impress said unidirectional potentials upon said audio amplifier with polarity to reduce the amplification thereof.

2. In a frequency modulation transmitter, an audio amplifier having a grid circuit coupled to a source of modulation signals and an anode circuit, a reactance tube modulator having an input circuit coupled to said anode circuit and an output circuit, an oscillator having a frequency-determining element interconnected with said output circuit, said oscillator being frequency-modulated by modulation signals supplied from said source through said amplifier to said modulator, a modulation signal detector connected to said anode circuit, said detector having a delay bias thereon and developing negative unidirectional control potentials by rectification of the amplified modulation signals only when said signals exceed said bias, and circuits for simultaneously impressing said potentials back upon said grid circuit and forward upon said input circuit to reduce both the audio gain and the degree of frequency modulation, respectively.

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The following references are of record in the file of this patent:

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