

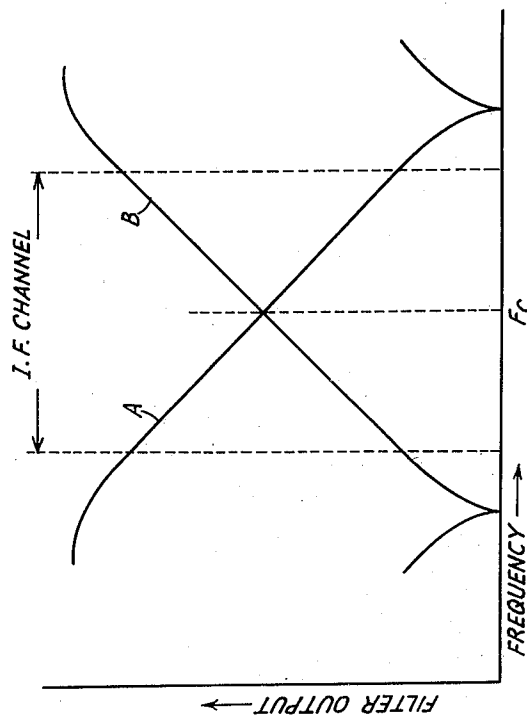
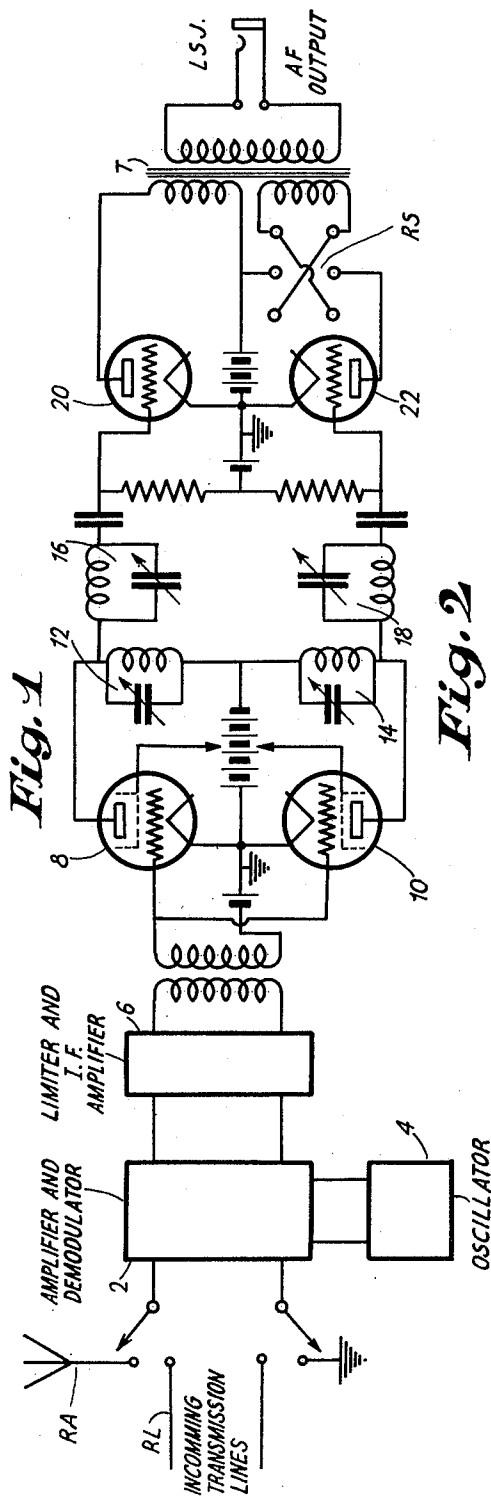
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DETECTION OF FREQUENCY MODULATED SIGNALS

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DETECTION OF FREQUENCY MODULATED SIGNALS

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6 Claims. (Cl. 250—20)

This application discloses a new and improved method of and means for converting frequency modulation on a wave into amplitude variations for signalling purposes. This means involves the use of reactive circuits connected and tuned in a novel manner so that as to the frequency of the wave to be analyzed, the linear portions of their resonant curves intersect at the carrier wave frequency. One of the reactive circuits has a peak response just above the maximum frequency of the frequency modulated waveband to be demodulated and minimum response at a frequency just below the lower frequency of the frequency modulated wave to be amplified. The other reactive circuit has similar peak and minimum response points but in a reversed sense, so that the linear portions of their frequency response characteristics are sloped in the opposite direction and intersect at the mean frequency of the wave to be demodulated. The wave energy is applied to these reactive circuits and from the same by way of rejector reactances to the control electrodes of rectifiers. The rejector circuits are tuned to resonance above and below the highest and lowest frequency of the wave energy respectively. This permits control of the slopes of the circuits and of the points of cutoff of the higher and lower frequencies. The reactances are so tuned that the desired steep slope between peak and rejection point is obtained. The outputs of the reactances are rectified and combined in phase opposition. Frequency modulations on the wave are passed in different degree by the reactances so that differential energy is passed to the output circuit. The amplitude of the output energy varies linearly as the frequency of the applied wave varies.

Any amplitude modulation on the wave inherently produced at the transmitter or caused during transmission causes similar variations at the outputs of the reactances, but these variations being similar are canceled in the outputs of the demodulators which are in phase opposition.

The novel receiver of the invention may, due to the operation characteristics just described, be readily adapted to the reception of amplitude modulated waves by connecting the outputs of the demodulators in parallel to add rather than oppose.

Any harmonic frequencies in the frequency modulated wave are balanced out due to the opposed but similar resonant characteristics of the reactances. The similar but opposed resonant characteristics result in a combined characteristic which is more nearly linear.

Other advantages to be obtained by the use of my novel method and means for demodulating or analyzing frequency modulated wave energy will be apparent from the following detailed description thereof and therefrom when read in connection with the drawing, in which:

Fig. 1 illustrates diagrammatically the essential features of a demodulator circuit arranged in accordance with the principles of my invention; while

Fig. 2 shows curves illustrating the operation of portions of the circuit of Fig. 1.

Referring to the drawing, and in particular to Fig. 1, RA is an antenna system on which frequency modulated wave energy may be received. The receiver 2 may be connected to the antenna RA or to an incoming line RL on which frequency modulated waves are impressed. The receiver 2 may be of the tuned radio frequency type, including radio frequency amplifiers and the demodulator, or may be as shown, of the heterodyne type. In the latter case, the receiver 2 includes radio frequency amplifiers and a demodulator cooperating with an oscillator in 4 to produce intermediate frequency energy and supply the same to an intermediate frequency amplifier and limiter in 6. This limiter may take the form of overloaded amplifier tubes connected in such a manner as to produce a constant output regardless of the changes in amplitude at the input. The intermediate frequency amplifier and limiter 6 has an output circuit coupled to an input circuit connecting the control grids of the tubes 8 and 10 in parallel, as shown. The anodes of the tubes 8 and 10 are connected by tuned reactive circuits 12 and 14 to their respective cathodes. The tubes 8 and 10 may be of the screen grid type and have their screen grid electrodes energized from the plate potential source, as shown. The anode of tube 8 may be connected by a tuned rejector circuit 16 to the control grid of tube 20, while the anode of tube 14 may be connected by a second tuned rejector circuit 18 to the control grid of tube 22. The anodes of tubes 20 and 22 are connected as shown with the primary winding of a transformer T, the secondary winding of which is connected to a jack LSJ by means of which the audio frequency output may be supplied to any utilization circuit. The circuit connecting the primary winding of the transformer T to the anode and cathode of tube 22 may include the reversing switch RS by means of which the anode circuits may be connected in push-pull for the reception of frequency modulated waves or in parallel for the reception of amplitude modulated waves.

In operation, the circuits 12 and 14 are preferably tuned to resonance at frequencies below and above the lowest and highest frequencies, respectively, of the wave of intermediate frequency supplied to the control grids of tubes 8 and 10. When these circuits are tuned, as stated, the parallel circuit 16 is tuned to resonance at a frequency above the highest intermediate frequency modulation frequency, while the parallel tuned circuit 18 is tuned to resonance at a frequency lower than the lowest frequency of the intermediate frequency energy. When so tuned, the circuits 12, 16 and 14, 18 will have frequency response characteristics as illustrated by the characteristic curves A and B, respectively, of Fig. 2.

In operation, energy of an intermediate frequency is fed to the two coupling tubes 8 and 10 having the conversion filters 12, 16 and 14, 18 in their plate circuits for converting the frequency modulation into amplitude modulation. The carrier frequency FC is caused to fall at the middle of the linear portions of the sloping characteristics of the tuned circuits connected as shown. By adjusting the tuned circuits so that the points of maximum and minimum output fall outside of the intermediate frequency channel, only the linear portions of the characteristics are utilized. The outputs of the filters 12, 16 and 14, 18 are fed to the detectors 20 and 22 of Fig. 1, whose audio outputs are combined with the transformer T in push-pull or parallel combination, depending upon the switch RS. With the switch in the push-pull position, frequency modulation may be received and amplitude modulation balanced out. With the switch in the push-pull position, second harmonic square law detector distortion is completely balanced out. With the switch in the parallel position, amplitude modulation may be received and frequency modulation balanced out.

The receiver 2, 4, 6 may be replaced by a tuned radio frequency receiver in which case the frequency modulated wave energy applied to the input of tubes 8 and 10 may be of higher frequency. In this case, the operation of the system will be the same as in the case of a receiver of the heterodyne type, as described above.

What is claimed is:

1. In a frequency modulated wave demodulating system, a source of frequency modulated carrier wave energy, two parallel capacitive and inductive reactances in series connected in parallel with said source, one of said capacitive and inductive reactances being tuned to a frequency above the upper frequency of said frequency modulated wave, the other of said parallel capacitive and inductive reactances being tuned to a frequency below the lowest frequency of said frequency modulated wave, a pair of rectifiers having input and output electrodes, a circuit connecting the output electrodes of said rectifiers in push-pull relation, separate parallel reactance units connecting the input electrodes of each of said rectifiers to the outer terminals of said two first named series reactances, one of said last named parallel reactance units being tuned to a frequency above the highest frequency of the frequency modulated wave to be demodulated, the other of said last named parallel reactances being tuned to a frequency below the lowest frequency of the frequency modulated wave to be demodulated.

2. In a frequency modulated wave demodulating system, wave receiving means, wave amplifying

means, an output circuit connected with said wave amplifying means, a pair of tubes each having a control electrode, a cathode and an anode, a circuit connecting the control electrodes of said tubes in parallel, a coupling between said last named circuit and said output circuit, a reactance tuned to a frequency above the highest frequency of the wave connected between the anode and cathode of one of said tubes, a reactance tuned to a frequency below the lowest frequency of the wave connected between the anode and cathode of the other of said tubes, a pair of rectifier tubes each having a control grid and an anode, a reactance tuned to a frequency above the highest frequency of said wave connecting the control grid of one of the tubes of said last named pair of tubes to the anode of one of the tubes of said first named pair of tubes, a reactance tuned to a frequency below the lowest frequency of said wave connecting the control grid of the other tube of said last named pair of tubes to the anode of the other tube of said first named pair of tubes, and a circuit connected with the anodes of said last named pair of tubes.

3. In a frequency modulated wave demodulating system, wave receiving means, wave amplifying and wave frequency reducing means connected with said receiving means, an output circuit connected with said wave reducing means and amplifying means, a pair of thermionic tubes each having a control electrode, a cathode and an anode, a circuit connecting the control electrodes of said tubes in parallel, a coupling between said last named circuit and said output circuit, an impedance tuned to a frequency above the highest frequency of the reduced wave connected between the anode and cathode of one of said tubes, an impedance tuned to a frequency below the lowest frequency of the wave of reduced frequency connected between the anode and cathode of the other of said tubes, a pair of rectifier tubes each having a control grid, a cathode and an anode, a resistance connecting the control grid of each of said last named tubes to its cathode, an impedance tuned to a frequency below the highest frequency of said wave of reduced frequency connecting the control grid of one of said last named tubes to the anode of said one of said first named pair of tubes, an impedance tuned to a frequency above the lowest frequency of the wave of reduced frequency connecting the control grid of the other of said last named tubes to the anode of said other of said first named pair of tubes, and a circuit connecting the anodes of said last named pair of tubes in push-pull relation.

4. In a frequency modulated wave demodulating system, a source of frequency modulated carrier wave energy, two reactances connected with said source, means for tuning the first of said reactances to a frequency above the highest frequency of said frequency modulated wave, means for tuning the second of said reactances to a frequency below the lowest frequency of said frequency modulated wave, a pair of rectifiers each having input and output electrodes, a circuit connecting the output electrodes of said rectifiers in push-pull relation, a third reactance connecting the input electrode of one of said rectifiers to said first of said two reactances, means for tuning said third reactance to a frequency below the highest frequency of the frequency modulated wave to be demodulated, a fourth reactance connecting the input electrode of the other of said rectifiers to the second of

said two reactances, and means for tuning the said fourth reactance to a frequency above the lowest frequency of the frequency modulated wave to be demodulated.

- 5 5. In a frequency modulated wave demodulating system, an impedance tuned to a frequency differing from the mean frequency of said wave by a frequency greater than the maximum modulation frequency, means for applying a frequency
10 modulated wave to be demodulated to said impedance, a rectifier having input terminals, a second impedance tuned to a frequency differing from the mean frequency of said frequency modulated wave by a frequency greater than
15 the maximum modulation frequency of said wave connecting one terminal of said first named impedance to an input terminal of said rectifier and a connection between the other terminal of said first named impedance and another terminal
20 of said rectifier.

6. In a system for converting frequency modulations on a carrier wave into characteristic amplitude variations, a pair of reactances, one tuned above and the other below the mean frequency of said carrier wave, a connection between
5 one terminal of one of said reactances and one terminal of the other of said reactances, means for applying said wave energy in phase to the remaining terminals of said reactance, two impedances across which potentials for utilization
10 may be produced, a third reactance tuned to a frequency below the mean frequency of said wave connecting one of said impedances to said one of said reactances of said first pair of reactances, and a fourth reactance tuned to a
15 frequency above the mean frequency of said wave connecting the other of said impedances to the other said reactance of said first pair of reactances.

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