

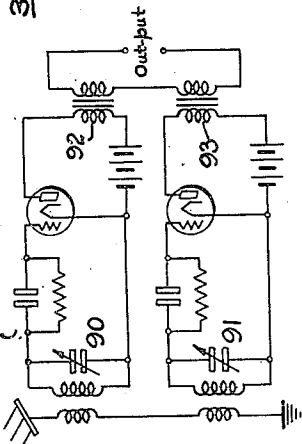
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RADIO COMMUNICATION SYSTEM

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RADIO COMMUNICATION SYSTEM

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My invention relates to a communication system involving frequency modulated waves, more particularly to a system embodying a receiving circuit of improved characteristics.

5 An object of my invention is to provide appropriate means and circuit connections for the improved reception of a frequency modulated carrier.

10 Another object of my invention is to provide a receiver circuit for use in combination with a frequency modulating transmitter system, which receiving system shall have improved operating characteristics.

15 A still further object of my invention is to provide a circuit for the reception of frequency modulated energy which shall be highly selective in character.

20 A further object of my invention resides in a method of discriminating between amplitude and frequency modulation.

Additional objects of my invention will be disclosed in the following description taken in connection with the accompanying drawing, in which,—

25 Fig. 1 is a diagrammatic view of a transmitting system illustrating a preferred embodiment of my invention.

30 Figs. 2 and 3 are curves illustrative of the manner in which signals transmitted from a system arranged according to my invention are received by a radio receiver.

Fig. 4 is a diagrammatic view of a preferred form of receiver to be used with my transmitting system.

35 Referring specifically to Fig. 1 of the drawing, a microphone 1 is connected to the primary 2 of an audiofrequency transformer 3 through a current source 4. The secondary 5 of the transformer 3 forms the input circuit of a thermionic device 6 comprising a filament 7, a grid 8 and a plate 11, the secondary 5 being connected between the grid 8 and the filament 7 thereof. A battery 12 provides biasing potential for the grid 8 of the thermionic device 6 and another battery 13 provides filament power. A source of plate potential 14 is provided, the negative terminal 15 thereof being connected to the filament 7 while the positive terminal 16 is connected, through an actuating winding 17, to the plate 11. 40 A second thermionic device 18 comprising a filament 21, a grid 22 and a plate 23, has an input circuit comprising a movable electrode 24 a piezo electric-crystal 25 and a fixed electrode 26. The movable electrode 24 is connected to the grid 22 45 while the fixed electrode 26 is connected, through

a conductor 27, to the filament 21, the electrodes 24 and 26 constituting a variable condenser, the dielectric of which comprises the piezo-electric crystal 25.

5 A resistor 28, in series with a source of grid-biasing potential 27 is also connected between the grid 22 and filament 21. A battery 32 provides filament power while plate potential for the thermionic device 18 is provided by a source 33 which may be either a generator or a high-potential battery. The output circuit of the thermionic device is coupled to a harmonic producer 34 which, in turn, controls a power amplifier 35. The power amplifier is coupled, through 10 an inductor 36, to a radiating structure which may comprise an antenna 37, an inductor 38 and a counter-poise or ground 41. 15

In order that the operation of the transmitting circuit of my invention may be clearly understood, it will be assumed, that the speech-amplifier device 6 has been energized, that the crystal controlled oscillator 18 has been set into operation, and that the harmonic producer 34 and power amplifier 35 are together cooperating to transmit a carrier wave from the radiating 20 structure, if the microphone 1 is energized, variable potentials will be placed upon the grid 8 of the speech amplifier 6, and the plate current therein will vary both in amplitude and in frequency, in accordance with the energization of the microphone. The varying plate current causes a variation in the magnetic field of the coil 17 and, consequently, a varying pull upon the movable electrode 24. 25

It is evident from a consideration of the previous part of this specification that the oscillation frequency of the quartz crystal 25 will be varied by an amount depending upon the magnitude of the movement of the electrode 24. The rate of this variation will be determined by the frequency 30 applied to the coil 17. 40

Inasmuch as the frequency of the transmitted wave depends upon the oscillation frequency of the crystal, it will thus be seen that such frequency will be modulated to a degree determined 45 by the magnitude of voice or other currents supplied to the control coil 17, while the rate of modulation will be determined by the frequency of the current in the coil.

The usual radio receiving set for use in connection with a transmitter of the type described depends for its selectivity on an impedance characteristic which varies with the impressed frequency. In Fig. 2 is shown a curve in which 50 the X-axis represents frequency and the Y-axis 55

represents relative admittance. At the point R, which is usually known as the resonance point, the admittance is greatest; that is, the receiver gives the greatest response. At frequencies higher or lower than this point, the response is progressively less, the amount being largely determined by the design of the receiver itself. If, therefore, a receiver is tuned to respond to a frequency represented by the point R to the normal or unmodulated wave emitted by a transmitter controlled by a device constructed according to my invention, it will give but slight response provided the transmitted wave is not greatly modulated on each side of such frequency. However, should the receiver be tuned to respond to a frequency corresponding to the point S on the curve, it is seen that it would respond readily to the signals, since any shift of frequency causes the admittance value of the receiver to vary proportionately to the slope of the resonance curve.

Should the receiver be tuned to the point T, it will be seen that the response will again become very slight, as the slope of the curve at this point and beyond is quite small.

From the conditions explained above, it is apparent that a receiver tuned to a transmitter constructed according to my invention will be more selective than if tuned to the wave of a transmitter of the usual type, the difference being caused by the fact that, under the usual conditions, the response at the receiver is proportional to the strength of the emitted wave and the height of the resonance curve at the particular frequency in question. In the case of my improved modulation system, the response is proportional to the product of the above values and the sloping of the resonance curve, this latter factor introducing an additional degree of selectivity.

It is also possible to further increase the selectivity at the receiver by taking advantage of the differential action between two receivers 90 and 91 (Fig. 4) so tuned that their resonance curves are spaced as shown in Fig. 3. In an arrangement of this type, the emitted wave is at a frequency indicated by the point S₁. The receivers 90 and 91 are connected with their respective output circuits 92 and 93 arranged in opposition and by reason of this connection, their net response will be proportional to the difference between the two waves, while their response to ordinarily modulated waves will be substantially zero.

It is also possible to increase the frequency shift at the receiving station by causing a locally generated constant-frequency oscillator to interact with the incoming carrier wave.

It will be apparent from the above description that the receiving circuit disclosed fulfills the objects of my invention both as to the results obtained and the method of obtaining the same.

Although I have illustrated and described a specific embodiment of my invention, I realize that certain modifications thereof will be suggested to those skilled in the art. My invention, therefore, is not to be limited except insofar as is necessitated by the prior art and by the spirit of the accompanying claims.

I claim as my invention:

1. Frequency modulated signal receiving means comprising a pair of circuits tuned to frequencies lying either side of the operating range of frequency to receive frequency modulated signals and having corresponding output circuits differentially coupled to one another.

2. In a radio system in which a transmitter radiates energy at a high frequency and in which said frequency is shifted between predetermined limits in accordance with signals, receiving means comprising two receivers, one of said receivers having a resonant circuit tuned to one of said limits and the other of said receivers having a resonant circuit tuned to the other of said limits, and means for connecting the outputs of said two receivers in opposition.

3. In a radio system in which a transmitter radiates energy which is frequency modulated, receiving means comprising two receivers, one of said receivers having a circuit which is resonant near the upper limit of said frequency modulation, the other of said receivers having a circuit which is resonant near the lower limit of said frequency modulation, said circuits being so adjusted that the lower portions only of the frequency-response curves overlap, and means for connecting the outputs of said two receivers in opposition.

4. In a radio system in which a transmitter radiates energy which is frequency modulated, receiving means comprising two circuits responsive to said frequency modulated energy throughout its frequency range, one of said circuits having its maximum response at a frequency near the upper limit of said frequency modulation, the other of said circuits having its maximum response near the lower limit of said frequency modulation, the outputs of said two circuits being connected in opposition.

5. In a radio system in which a transmitter radiates energy which is frequency modulated in accordance with signals, receiving means comprising two receivers, each of said receivers having a circuit which is responsive to said frequency modulated energy throughout its frequency range, the circuit in one of said receivers being resonant near the upper limit of said frequency modulation, and the circuit in one of said receivers being resonant near the lower limit of said frequency modulation, the outputs of said receivers being connected in opposition.

6. The method of discriminating between amplitude modulation and frequency modulation when analyzing frequency modulated energy which includes supplying the energy in a desired phase relation to each of two circuits tuned to frequencies lying either side of the operating range of frequency, and combining the outputs from the two circuits in an opposite phase relation.

7. The method of obtaining a symmetrical and substantially straight resonance characteristic for analyzing frequency modulated energy which includes supplying the energy in one phase relation to each of two circuits having intersecting resonance curves with maxima lying either side of the operating range of frequency, and combining the outputs from the two circuits in an opposite phase relation.

8. The method of obtaining symmetrical and substantially straight resonance and symmetrical detection characteristics for analyzing and rectifying frequency modulated energy which includes supplying the energy cophasially to each of two circuits having intersecting resonance curves with maxima lying either side of the operating range of frequency, detecting the outputs from the two circuits, and combining the detected outputs in phase opposition.

9. An analyzer for energy which is frequency modulated in accordance with a desired signal

comprising a resonant circuit tuned to a frequency lying at one side of the operating range of frequency, another resonant circuit tuned to a frequency lying at the other side of the operating range of frequency, means to supply the frequency modulated energy to the two circuits in a desired phase relation, and means for combining the outputs from the two circuits in an opposite phase relation to obtain energy modulated in amplitude in accordance with the desired signal.

10. An analyzer for energy which is frequency modulated in accordance with a desired signal comprising two resonant circuits having intersecting resonance curves with maxima lying

either side of the operating range of frequency, means to supply the frequency modulated energy to the two circuits in one phase relation, and means for combining the outputs from the two circuits in an opposite phase relation to obtain energy modulated in amplitude in accordance with the desired signal.

11. The method of receiving frequency modulated carrier waves which consists in passing said waves through paths responding in the same sense to changes in amplitude of the carrier but in opposite sense to changes in frequency thereof and combining the responses of said paths to produce the signal.

FRANK CONRAD. 15