

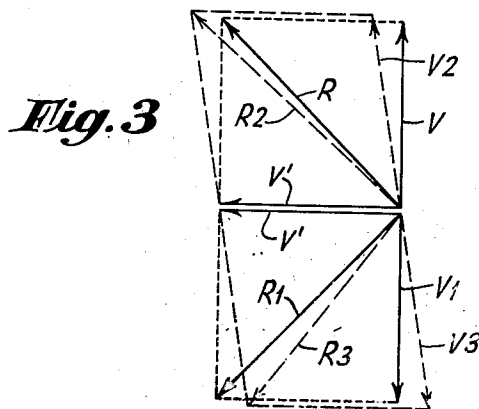
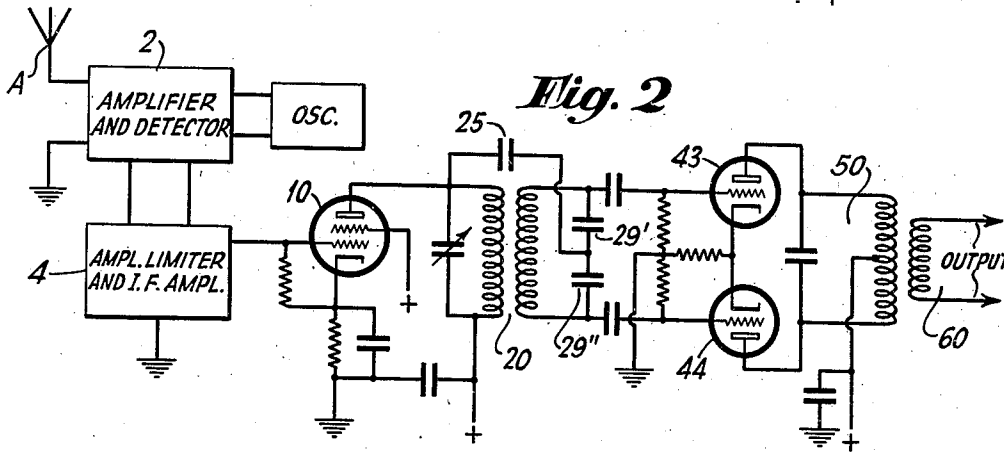
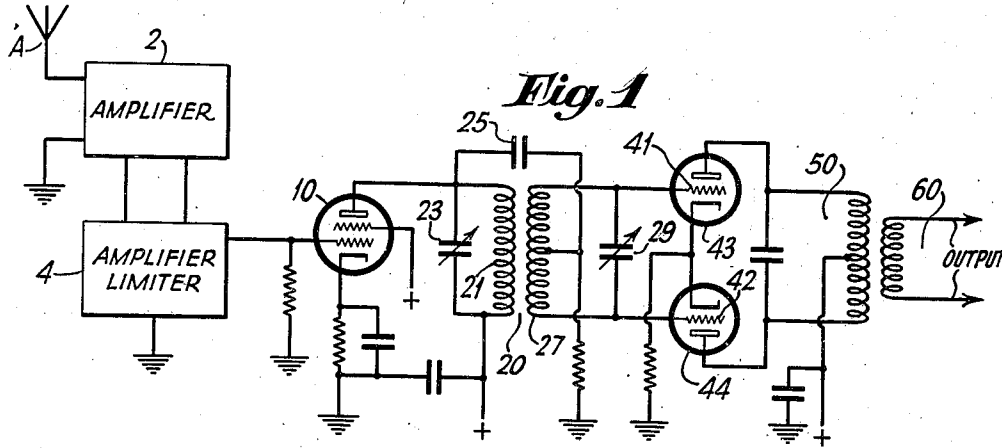
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FREQUENCY MODULATING RECEIVER

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FREQUENCY MODULATING RECEIVER

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2 Claims. (Cl. 250-27)

This application concerns a new and improved method of and means for demodulating frequency modulated waves. The method and means involved here is simple in nature and efficient in operation and by utilization of my method and means a linear reproduction of the voltages used in frequency modulating wave energy may be obtained at the receiver.

In describing my invention, reference will be made to the attached drawing wherein Figures 1 and 2 illustrate two modifications of my frequency modulated wave receiving means and Figure 3 is a vector diagram used in illustrating the operation of the detecting means of the receivers of Figures 1 and 2.

The frequency modulated waves to be modulated are picked up by aerial A and amplified in 2, if desired, and impressed on an amplitude limiting device 4. This limiting device may be of any known type such as, for example, an overloaded thermionic tube system, or a system including automatic volume control. In this device the amplitude of the frequency modulated wave is increased the desired amount and caused to be substantially constant.

The frequency modulated waves limited in 4 are applied to the grid of an amplifier tube 10 wherein they are amplified and set up characteristic voltages in a frequency discriminating circuit 20. This circuit comprises an inductance 21 tuned by a condenser 23, the parallel circuit being tuned to the mean frequency of the frequency modulated waves supplied to 10. This mean frequency may be referred to as the carrier frequency in the absence of modulation thereon. The winding 21 is coupled inductively to the winding 27 to induce therein voltages which due to the coupling as shown and transformer action are in phase opposition on the grids 41 and 42 of the pair of detector tubes 43 and 44. These voltages may be represented by the vectors V and V' in Figure 3 of the drawing.

Voltages characteristic of the frequency modulated waves supplied to 10 are also impressed from the high potential end of winding 21 on a coupling condenser 25 and thence on a point on inductance 27 and from inductance 27 in phase on the grids 41 and 42. These in-phase voltages may be represented by the vectors V' and V' in Figure 3 of the drawing.

This coupling system as described forms a highly efficient though simple frequency discriminating network wherein the resultant phase of the voltages applied to the grids 41 and 42 is a

function of the deviations of the frequency modulated wave from its mean frequency.

In receivers known heretofore, the proper phase relationship of the voltages on the grids of the detector tubes is obtained by phase shifting networks in circuits external to the coupling circuits connected with the detector tubes or by means of said phase shifting networks and additional coupling tubes connected between the wave amplifier part of the system and the detectors.

Thus we see that each of the tubes 43 and 44 is supplied with two characteristic voltages due to the novel but simple coupling circuit comprising condensers 23 and 25 and inductances 21 and 27. The applied voltages are in phase quadrature. This produces on the grids resultant voltages represented by vectors R and R' in Figure 3.

Now, assume the frequency of the voltages applied to tube 10 shifts in either direction from its mean frequency under the influence of the signal modulations. The circuit 23, 21 is no longer tuned to the wave frequency and consequently a shift in the phase of the voltage induced in the inductance 23 is produced and this phase shifted voltage is impressed in phase opposition on the tubes 43 and 44. The phase opposition voltages have, under the influence of frequency modulation, changed with respect to the corresponding voltages applied through these elements in the unmodulated state. These new voltages may be represented by V2 and V3 in Figure 3.

The voltages supplied by coupling condenser 25 in the presence of this frequency modulation or variation however has substantially the same phase as the corresponding voltage applied in the absence of frequency modulation of the carrier. The voltage supplied by 25 may again be represented in Figure 3 by the vectors V' and V'.

The resultant voltages are shifted as shown at R2 and R3 in Figure 3. Thus a resultant voltage is produced in the differential output circuit 50, the amplitude of which varies in accordance with frequency variations of the applied wave. Amplitude modulation of the original signal which may be present at the frequency demodulator is balanced out in the output circuit of tubes 43 and 44.

In describing applicant's invention the tubes 43 and 44 have been referred to as detector tubes and are in this case biased to operate on the curved portion of their characteristics. The detectors may be diodes, triodes or pentode tubes.

In the modification shown in Figure 2, the fre-

quency discriminating network is intended to operate at a frequency different than the frequency of the transmitted wave. To obtain this operation the aerial A is connected to an amplifier and detector tube of the heterodyne type and the amplitude limiter of 4 also is of the intermediate frequency amplifier type. The condenser 25 feeds to a middle tap on condenser 29 which is illustrated as condensers 29' and 29''. This circuit functions the same as the circuit in Figure 1 where the condenser 25 feeds to the tap on inductance 27. The remaining portions of the circuit in Figure 2 are similar to the corresponding portions of Figure 1 except as indicated otherwise above.

What is claimed is:

1. In a system for demodulating wave energy modulated in frequency at signal frequency, a pair of electron discharge detector tubes each having at least a control grid, a cathode, and an anode, an output transformer having a primary winding, an output circuit including said primary winding coupling said anodes in push-pull relation, a circuit including an inductance parallel tuned to the mean frequency of said wave energy, means for impressing said frequency modulated wave energy to be demodulated on said parallel tuned circuit, a second inductance inductively coupled to said first named inductance, capacitive means in shunt to said second named inductance for tuning said second named inductance to resonance at the mean frequency of said wave energy whereby voltages of the frequency of said wave energy are induced in said second named inductance which voltages at the terminals of said second named inductance are of opposed phases which vary when the mean frequency of the induced voltage changes, a path of negligible impedance at said signal frequency between said first inductance and a predetermined point on said capacitive means whereby voltages of the frequency of said wave energy and of substantially fixed like phase are impressed on the terminals of said second inductance irrespective of changes in the frequency of said wave energy, means connecting one of the

terminals of said second inductance to the control grid of one of said tubes, means connecting the other terminal of said second inductance to the control grid of the other tube, and said predetermined point having an alternating potential substantially equivalent to the alternating potential at the mid-point of said second named inductance.

2. In a system for demodulating wave energy modulated in frequency at signal frequency, a pair of electron discharge detector tubes each having at least a control grid, a cathode, and an anode, an output transformer having a primary winding, an output circuit including said primary winding coupling said anodes in push-pull relation, a circuit including an inductance tuned to the mean frequency of said wave energy, means for impressing said wave energy to be demodulated on said tuned circuit, a second inductance inductively coupled to said first named inductance, series capacities connected in shunt to said second inductance for tuning said second inductance to resonance at the mean frequency of said wave energy whereby voltages of the frequency of said wave energy are induced in said second named inductance which voltages at the terminals of said second named inductance are of opposed phases which vary when the mean frequency of the induced voltage changes, a path of negligible impedance at said signal frequency connecting said first named inductance to a point between said shunt capacities whereby voltages of the frequency of said wave energy and of substantially like fixed phase are impressed on the terminals of said second inductance irrespective of changes in the frequency of said wave energy, means connecting one of the terminals of said second inductance to the control grid of one of said tubes, means connecting the other terminal of said second inductance to the control grid of the other tube, resistive means connecting said control grids together and a connection between a point on said resistive means and the cathodes of said tubes.

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