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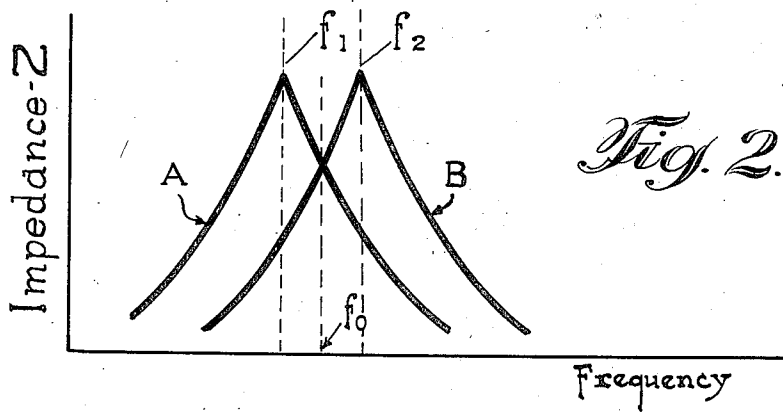
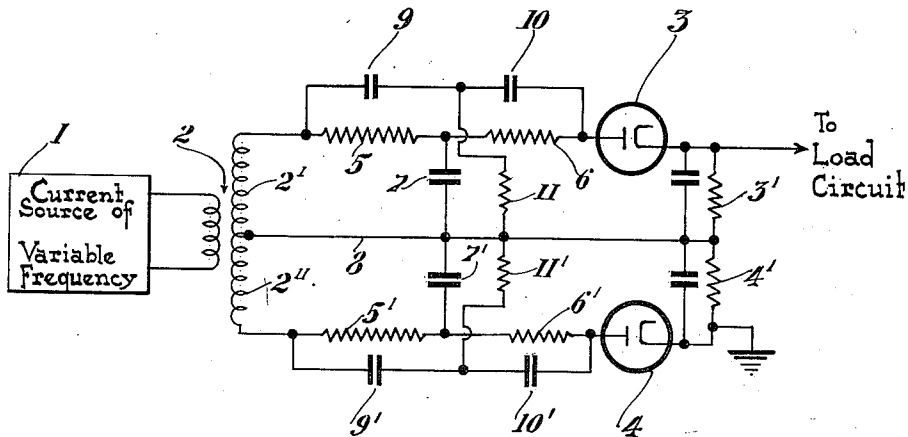
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2,323,609

DISCRIMINATOR CIRCUIT

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Fig. 1.



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DISCRIMINATOR CIRCUIT

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7 Claims. (Cl. 250—40)

My present invention relates to frequency discriminator networks, and more particularly to resistance-capacity discriminator networks.

One of the main objects of my present invention is to provide a resistance-capacitance discriminator for converting frequency-variable waves into waves of constant mean frequency but variable amplitude.

Another important object is to provide a discriminator-rectifier for frequency modulated waves, and the discriminator section employing solely resistance and capacity elements.

Still another object of the invention is to provide a discriminator for frequency-variable waves comprising a pair of opposed rectifiers; the input network for each rectifier being free of inductance.

Still other objects of the invention are to improve generally the simplicity and efficiency of discriminator networks, and to provide such networks in a form economically and readily manufactured.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

In the drawing:

Fig. 1 shows a circuit embodying the invention.

Fig. 2 graphically presents the impedance-frequency characteristic of the discriminator.

Referring, now, to Fig. 1, there is shown the discriminator-rectifier circuit of my present invention. Let it be assumed that the numeral 1 schematically designates a current source of variable frequency. Such a source may be of low frequency, or it may be of high frequency. For example, source 1 could be the intermediate frequency (I. F.) amplifier of a superheterodyne receiver operating in the frequency modulation (FM) band of 42 to 50 megacycles (mc.). In such a receiver the input transformer 2 would have its primary winding in the plate circuit of a limiter tube, and the latter would have its input circuit fed with the FM waves whose center, or midband, frequency would be of I. F. value. In the assigned FM band, an overall frequency deviation range of 200 kilocycles (kc.) is permitted. Actually, the carrier, or center, frequency is devi-

ated 75 kc. to each side thereof in accordance with the amplitude of the modulation signals.

Hence, the transformer 2 will be designed so as to pass efficiently the extremes of the deviation range. The discriminator acts to transform, or convert, the FM waves into amplitude modulated waves whose carrier has a frequency equal to the center frequency of the FM waves. The variable amplitude waves may then be rectified to provide the original modulation signals. This general process of FM detection is well known. My invention relates to the discriminator section of the detector circuit. From a generic viewpoint, the invention contemplates the use of inductance-free networks in the discriminator. Specifically, solely resistance-capacitor networks are employed.

As shown in Fig. 1, the rectifiers 3 and 4 are separately fed with converted FM wave energy through the separate halves of the discriminator. Thus, the secondary winding of transformer 2 is tapped at its midpoint to divide the winding into an upper section 2' and a lower section 2''. The midtap is connected to the junction of resistor loads 3' and 4'. The upper end of resistor 3' is connected to the cathode of rectifier diode 3, while the anode of the latter is connected to the upper end of winding section 2' through the series resistors 5 and 6 of a T filter. The common leg of the filter consists of condenser 7 connected from the junction of resistors 5 and 6 to the common connection path 8.

The T filter 5—6—7 is well known per se. Those skilled in the art of constructing filters know the characteristics thereof. An inverted T filter is associated with filter 5—6—7. The inverted filter consists of series condensers 9 and 10 arranged in shunt across the series resistors 5 and 6. The junction of condensers 9 and 10 is connected by the common filter resistor 11 to the common path 8. Now, it will be seen that rectifier 3 is provided with an input network which consists of at least a pair of inversely related T filter networks. The "Impedance-frequency" characteristics of the composite network 5 to 11 is represented in Fig. 2 by curve A. From this curve it is readily apparent that the network impedance has a relatively sharp peak value at a predetermined frequency f_1 . The impedance falls away rapidly on either side of f_1 .

To secure complete discrimination it is only necessary to provide a composite network 5' to 11' which is an exact replica of network 5 to 11. As shown in Fig. 1 the duplicate composite network 5' to 11' is inserted in the input of rectifier 4. The

constants of network 5' to 11' are so chosen that the "Impedance-Frequency" characteristic shows a maximum value at frequency f_2 displaced from value f_1 by a predetermined frequency magnitude. Curve B in Fig. 2 denotes the characteristic of the input circuit of rectifier 4. The frequency values f_1 and f_2 are so related that they are located at, or even beyond, the extremities of the frequency deviation range of the applied frequency-variable waves.

Thus, in FM reception the spacing between f_1 and f_2 would exceed 150 kc. The mean, or cross-over, frequency f_0 represents the center frequency of the applied waves. At that point the impedances of the input networks of the rectifiers are equal. Since the load resistors 3' and 4' are connected in polarity opposition, the rectifier voltages developed across these loads will oppose and cancel at f_0 . Each load resistor is shown bypassed by its appropriate condenser for carrier currents. The cathode end of resistor 4' is grounded, and the voltage taken off at the cathode end of resistor 3' will vary in conformance with the modulation signals applied to the carrier at the FM transmitter. It will be clear from Fig. 2 that, as the applied wave energy deviates in frequency to the left or right of f_0 , there will be more voltage delivered to one rectifier than to the other. Further, it will be seen from Fig. 2 that the voltage delivered to each rectifier will depend on the extent of deviation from the center frequency f_0 . These are the necessary conditions for detecting FM waves.

There is employed in the present invention a pair of rectifiers; each rectifier has an input network whose response characteristic may be represented by a sloping curve; and the input networks essentially employing resistance-capacity elements. Specifically, each input network consists of parallel T filter networks of the resistor-capacity type. Those skilled in the filter art will readily be able to choose the proper constants for the composite networks, since calculations are available to determine $f_1-f_0-f_2$. Reference in this connection is made to Proceedings of the I. R. E. for January, 1940, an article by W. N. Tuttle entitled "Bridged T and parallel T null circuits for measurement at radio frequencies." It is to be clearly understood that my invention is applicable to frequencies in the audio range as well.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What I claim is:

1. In combination with a source of frequency-variable waves, a pair of opposed rectifiers, a discriminator network comprising a parallel T filter circuit having an impedance-frequency response curve which maximizes sharply at a predetermined frequency, a second parallel T filter

circuit having an impedance-frequency response curve which maximizes sharply at a predetermined frequency spaced from the first frequency by an amount which is at least equal to the range of frequency variation of said waves and connections between each filter circuit and a respective one of said rectifiers.

2. In combination with a pair of opposed rectifiers, a parallel T filter of the resistance-capacity type connected to one rectifier, a second parallel T filter of the same type connected to the second rectifier, the impedances of the filters maximizing at frequencies spaced a predetermined frequency value apart and connections between each filter circuit and a respective one of said rectifiers.

3. A frequency discriminator network comprising input terminals and output terminals, a pair of parallel T filter sections arranged in shunt relation between the input terminals and output terminals, and the sections maximizing in impedance at spaced predetermined frequencies.

4. In combination with a source of frequency-variable waves, a parallel T filter circuit connected to one rectifier and having an impedance-frequency response curve which maximizes sharply at a predetermined frequency, a second parallel T filter circuit connected to the second rectifier and having an impedance-frequency response curve which maximizes sharply at a predetermined frequency spaced from the first frequency by an amount which is at least equal to the range of frequency variation of said waves, and means coupling said source to said filter circuits.

5. In combination with a pair of opposed rectifiers, a filter of the resistance-capacity type connected to one rectifier, a second filter of the same type connected to the second rectifier, the impedances of the filters maximizing at frequencies spaced a predetermined frequency value apart, and a source of frequency modulated waves coupled to both filters.

6. A frequency discriminator network comprising input terminals and output terminals, a pair of parallel T filter sections arranged in shunt relation between the input terminals and output terminals, the sections being constructed and arranged for maximizing in impedance at spaced predetermined frequencies, and a source of frequency-variable waves coupled to said sections.

7. In combination with a source of frequency-variable waves, a discriminator network comprising a parallel T filter circuit composed of solely resistance and capacity and having an impedance-frequency response curve which maximizes sharply at a predetermined frequency, a second parallel T filter circuit composed of solely resistance and capacity and having an impedance-frequency response curve which maximizes sharply at a predetermined frequency spaced from the first frequency by an amount which is in excess of the range of frequency variation of said waves.

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