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FREQUENCY CHANGING SYSTEM

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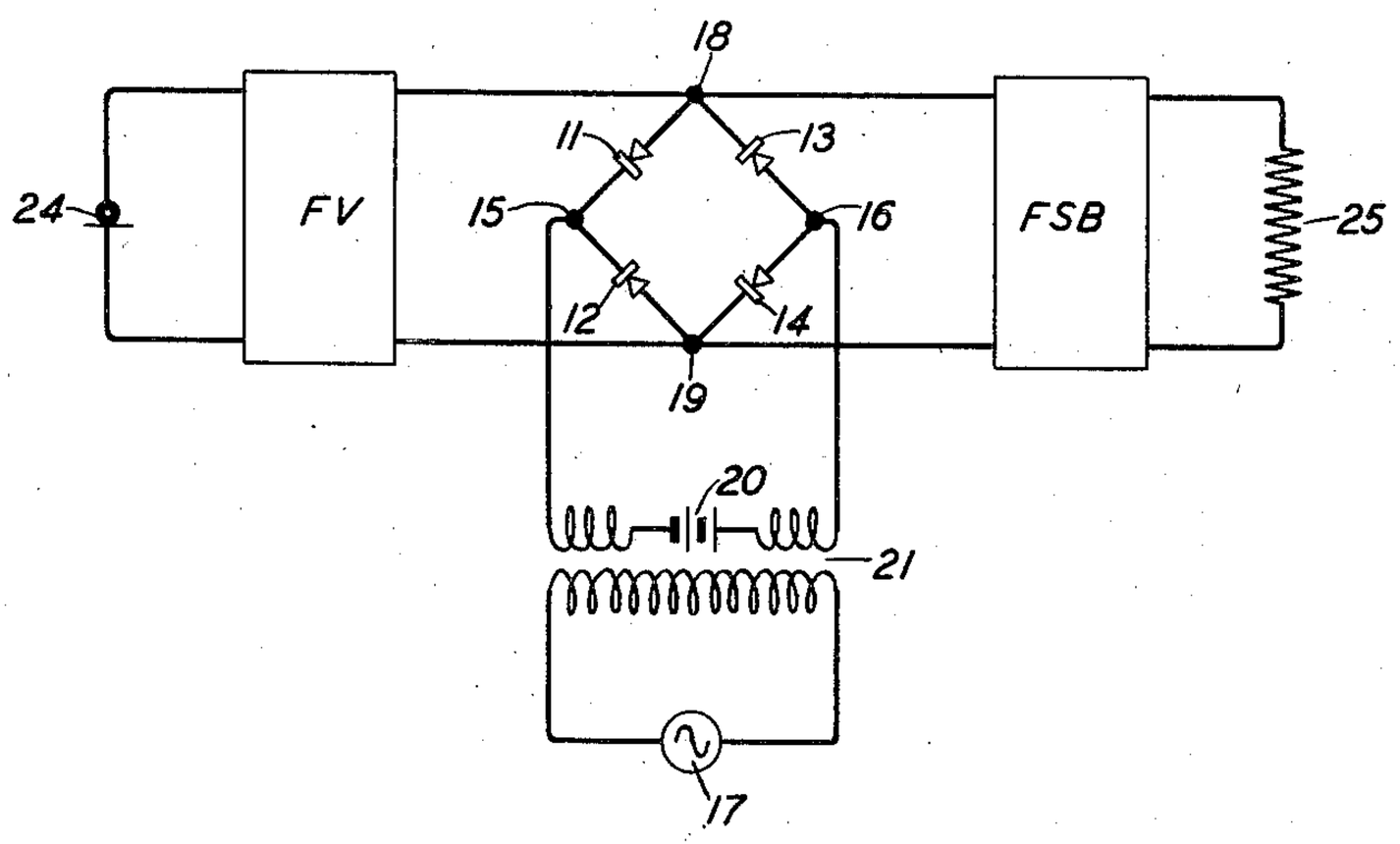

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FREQUENCY CHANGING SYSTEM

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7 Claims. (Cl. 179—171)

This invention relates to frequency changing systems, such as modulators, demodulators, or detectors of the carrier suppression type and more particularly to those employing physically inert non-linear resistance elements as modulating devices.

An object of the invention is to improve the economy, stability and reliability of modulating or frequency changing systems.

Another object is to secure increased suppression of the carrier wave from the output of a modulator.

In accordance with the invention a number of non-linear resistance elements are arranged in the form of a Wheatstone bridge and interposed between an input circuit and an output circuit. A carrier wave is applied to the bridge network from a source which is connected in conjugate relation to the output circuit, thereby insuring carrier suppression. A suitable biasing means is provided to insure the operation of the resistance elements over a range of continuously variable resistance values.

The invention will be more fully understood from the following detailed description of a circuit in which the invention is embodied and by reference to the accompanying drawing in the single figure of which the preferred embodiment is shown.

The figure shows a modulating system in which a Wheatstone bridge network containing physically inert non-linear resistance elements is connected in shunt relation to a pair of filters. The input filter FV is adapted to pass a band of signal frequencies from a source 24 such as a microphone and is directly connected to the output filter FSB, which latter passes a band of side frequencies lying adjacent to the carrier. The filter is connected to a load impedance 25. The leads joining the filters are connected also to points 18 and 19, respectively, which are two diagonally opposite corners of the bridge. The bridge comprises the physically inert non-linear conductors 11, 12, 13 and 14.

Terminals 15 and 16 constitute the remaining two corners of the bridge. A carrier generator 17 is connected through a transformer 21 to the bridge terminals 15 and 16. A polarizing battery 20 is inserted in series with the secondary winding of transformer 21 and preferably between two balanced sections of said winding.

The non-linear resistance elements 11, 12, 13 and 14 may be of any known type. For this purpose copper oxide rectifiers are found to be well adapted. It is not necessary, however, that the non-linear conductor be a rectifier, but any non-linear device may be used including one which conducts equally well in either direction. An example of the latter class of non-linear conductors is a compound commonly known as "thyrite" prepared as described in United States Patent No. 1,822,742, issued September 8, 1931 to K. B. McEachron. Notwithstanding the symmetry of conduction, an element of such material has a variable resistance, the value of which is dependent upon the impressed voltages.

In case the elements 11, 12, 13 and 14 are rectifiers or asymmetrical conductors of any kind the rectifiers are to be poled in a particular manner, as for example, according to the drawing in which rectifiers 11 and 12 are so poled, as indicated by arrows, that each is conductive in the direction toward the common terminal 15 and rectifiers 13 and 14, also indicated by arrows, are so poled that each is conductive away from the common terminal 16. The polarizing battery 20 is poled in such manner as to pass current through all the rectifiers in the conductive direction.

In case the elements 11, 12, 13 and 14 are symmetrical conductors the arrows in the drawing may be disregarded since the elements will be characterized by no polarity. It is therefore immaterial in which direction the battery 20 is poled.

In the operation of the system described signals or modulating currents are supplied from the source 24. These currents after passing through the filter FV establish an alternating potential of signal frequency across each non-linear conductor. The carrier voltage applied to the bridge by the generator 17 causes the non-linear conductors to vary their resistance in a cyclical manner in synchronism with the alternations of the generator. The varying resistance of the bridge network produces a variation or modulating action by which the carrier currents and modulating currents are combined in the well known manner to produce a signal modulated carrier wave.

Due to the conjugate relation of the carrier generator to the line terminals 18 and 19 and the filter FSB, no unmodulated carrier component is allowed to be transmitted to the load circuit 25. The modulated wave produced is therefore of the suppressed carrier type.

For best operation of the system the biasing battery should be of sufficient voltage so that the combined voltage of the battery and the induced wave in the secondary of transformer 21 arising

from generator 17 will always be unidirectional and the current through the non-linear conductors will never become reversed. I have found that the carrier voltage impressed upon the individual non-linear conductor should be preferably greater than the modulating voltage, although the adjustment of these voltages need not be very critical.

I have also found that the bridge arrangement may be balanced to a high degree of accuracy by the use of four substantially identical resistance elements produced in a similar manner from similar materials. Moreover, after a balance has once been secured the balanced condition is substantially permanent. The system constitutes an improvement over a balanced arrangement employing vacuum tubes, as the latter must be readjusted at frequent intervals to maintain a good balance.

The system illustrated will function equally well as a demodulator and may be so used by supplying a side band current to the filter FSB and connecting the filter FV to a receiver. In this case the side band wave is demodulated with the carrier wave in the non-linear conductors, producing a wave which contains the demodulated signals as a component.

What is claimed is:

1. A modulating system of the carrier suppression type comprising a source of modulating waves, an input circuit selective to said waves, an output circuit selective to a desired modulated wave, a balanced bridge network comprising four physically inert, non-linear resistance elements interposed between said input and output circuits, and a source of carrier waves connected to said bridge network in conjugate relationship to said output circuit, whereby carrier waves are modulated by combination with modulating waves in said non-linear resistances and modulated waves free from unmodulated carrier are transmitted to said output circuit.

2. A modulating system as in claim 1, in which the non-linear resistance elements are polarized by means of a direct current whereby said elements are adjusted to a range of continuously variable resistance values.

3. A modulating system as in claim 1, in which the non-linear resistance elements are rectifying devices polarized by a voltage tending to maintain a direct current in the conducting direction through the rectifying devices.

4. A modulating system of the carrier suppression type comprising a source of signal waves, an input circuit selective to the signal waves, an output circuit selective to a desired modulated wave, a bridge network of similar rectifying devices in parallel with said input and output circuits, and a source of carrier waves connected to the bridge in conjugate relation to said output circuit to effect suppression of the carrier waves in said output circuit, said rectifying devices being so disposed and poled that the bridge network substantially short-circuits said output circuit once during each cycle of the carrier wave, whereby said signal waves are interrupted in such manner as to form a modulated wave in said output circuit.

5. A modulating system of the carrier suppression type comprising a source of modulating waves, an input circuit selective to said waves, an output circuit selective to a desired modulated wave, a normally balanced bridge network of two-terminal non-linear resistance elements interposed between said input and output circuits and a source of carrier waves connected to said bridge network in conjugate relationship to said output circuit whereby carrier waves are modulated by combination with modulating waves in said non-linear resistances and modulated waves free from unmodulated carrier are transmitted to said output circuit.

6. A modulating system of the carrier suppression type comprising a source of modulating waves, an input circuit selective to said waves, an output circuit selective to a desired modulated wave, a normally balanced bridge network of solid non-linear resistance elements interposed between said input and output circuits and a source of carrier waves connected to said bridge network in conjugate relationship to said output circuit, whereby carrier waves are modulated by combination with modulating waves in said non-linear resistances and modulated waves free from unmodulated carrier are transmitted to said output circuit.

7. A modulating system of the suppressed carrier type comprising four rectifiers serially connected in a closed loop in the manner of a Wheatstone bridge and being so poled that each rectifier is flanked by two adjacent rectifiers the conductive directions of which are opposed to one another around the loop, a source of signal waves and a load circuit parallel connected in that diagonal of the bridge determined by the two corners each lying between adjacent rectifiers whose conductive directions around the loop are the same, and a source of carrier waves connected in the remaining diagonal whereby the bridge network substantially short-circuits said output circuit once during each cycle of the carrier waves and said signals are interrupted in such manner as to form a modulated wave in said output circuit.

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