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2,365,672

VIBRATING RELAY MODULATOR CIRCUIT

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FIG. 1

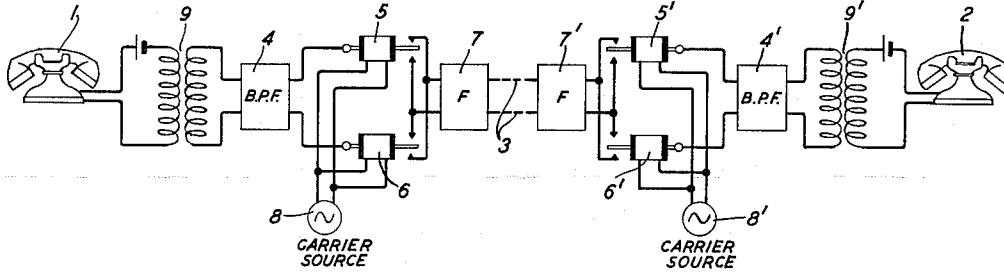


FIG. 2

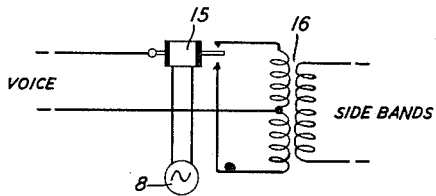


FIG. 3

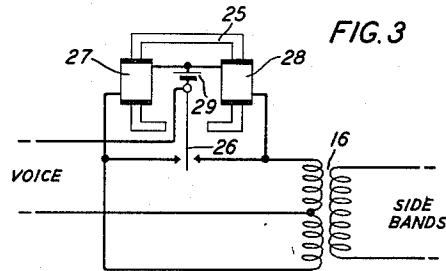


FIG. 5

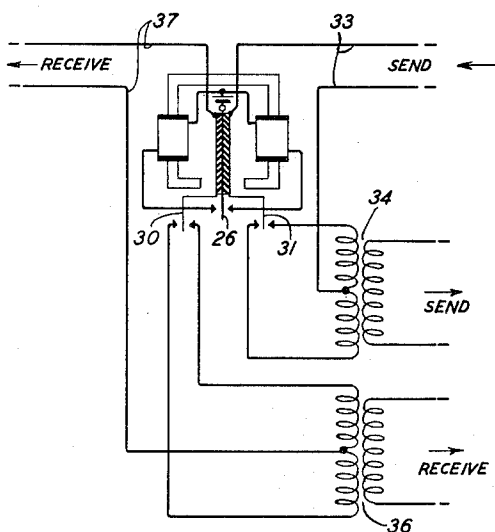
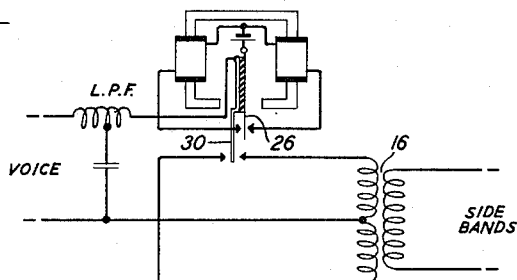


FIG. 4



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VIBRATING RELAY MODULATOR CIRCUIT

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5 Claims. (Cl. 179—1.5)

The present invention relates to modulation and demodulation of sustained electrical waves by signals such as speech.

An object of the invention is a two-way modulating circuit of simple and compact construction, for particular application where comparatively low carrier frequencies are involved.

One use to which the invention is adapted, though not limited, is the inversion of the frequencies of speech in order to secure privacy of transmission. In such systems using variable electrical resistance devices, such as vacuum tubes and the like, it is necessary to balance the circuits carefully to prevent some uninverted speech from being sent or to take other precautions such as by using successive modulation with frequency shift, which adds complication. It is desirable also to suppress the unmodulated carrier either by appropriate balance or frequency shifting and filtering.

The present invention does not need to provide special means for suppressing the direct voice transmission, for this component is not produced in the circuit, and in certain forms of the invention the unmodulated carrier component likewise is not generated.

More specifically, the invention makes use of a vibrating relay as the modulator or demodulator and this relay may either be driven from a source of carrier waves or it may be self-vibrating at the carrier frequency. The vibrating contacts make and break at carrier frequency the continuity of a circuit carrying the speech or other signal currents and thus chop the signal currents and reverse the polarity of alternate segments to provide a modulated wave. On receiving a modulated wave, the vibrating relay does the reverse of this and produces full wave rectification by reversing the polarity of every other segment of the modulated current.

The nature and objects of the invention will appear more clearly from the following detailed description of typical embodiments illustrated in the accompanying drawing.

Fig. 1 shows in simplified schematic form a two-way telephone system using speech frequency inversion at both terminals by employment of a modulating circuit according to this invention; and

Figs. 2 to 5, inclusive, show modified or alternative forms of modulating circuit.

In Fig. 1, telephones 1 and 2 are shown in communication with each other by means of line 3 and terminal equipment at the ends of the line. This latter, referring to the terminal

at the left, comprises band-pass filter 4, relay modulators 5, 6, voice band filter 7, and carrier source 8. The same elements are indicated by similar numbers (primed) at the opposite station.

The relays 5 and 6 are polarized and throw their armatures one way on positive half waves of the carrier and the opposite way on negative half waves of the carrier. Upper and lower contacts are thereby closed when the armatures are thrown upward and downward. The two armatures operate as a double-pole, double-throw switch and reverse the polarity with which speech is sent to or received from the line, such reversals occurring at the carrier rate.

When, therefore, a speech wave is sent through transformer 9 from subscriber's set 1, it is chopped at the carrier frequency and the segments resulting from the chopping process are sent to line with every other segment in reversed polarity.

If the essential speech band for the purposes of the system of Fig. 1 is taken as comprising the range of 200 to 2,700 cycles per second, the filter 4 will be designed to pass this band. The frequency of source 8 will then be 2,900 cycles, which is the frequency of vibration of relays 5, 6. The frequency components resulting from the relay switching of these voice currents comprise an upper side-band extending from 3,100 to 5,600 cycles and a lower side-band extending from 2,700 to 200 cycles representing inverted frequency speech. There are also higher frequency components of no interest here. There is no unmodulated carrier frequency component, however, and there is no direct transmission of normal speech. The low-pass filter 7 has a pass range up to 2,700 cycles.

At the opposite station the source 8' has the same frequency as source 8 and the two should be run in close frequency agreement with each other. Relays 5' and 6', therefore vibrate in unison with relays 5 and 6 and rectify the transmitted inverse side-band to reproduce the normal speech which passes through filter 4' to subscriber's set 2.

In Fig. 2 a single-pole rather than a double-pole switch is shown, comprising relay 15 fed from carrier source 8 and having a vibrating armature in one side only of the line. The opposite side of the line goes to the middle tap of transformer 16, while the two outer terminals of the tapped winding connect to opposite contact points of the relay armature. Except for these

differences the circuit operates the same as that of Fig. 1.

Fig. 3 illustrates a simple and compact modulator requiring no separate oscillator but employing a self-vibrating relay 25 in which the tongue 26 is a vibrating element which determines the frequency of oscillation. For this purpose, the relay tongue may be mechanically resonant at the frequency of oscillation. Battery 29 energizes the windings 27 and 28 alternately as the tongue makes contact with the respective fixed terminals to which these windings are individually connected. When the tongue is thrown to the right, for example, an impulse of current is sent from the battery 29 through winding 28 in such direction as to repel the tongue to the left, the tongue being, of course, polarized magnetically. The speech circuit connections are as in Fig. 2.

In the circuit of Fig. 4 the relay is self-vibrating at the carrier frequency as in Fig. 3 but differs in having a pair of electrically isolated vibrating tongues or contact springs 26 and 30. The spring 26 makes and breaks the battery circuit through the relay windings to maintain the tongue in vibration as in Fig. 3. Spring 30 insulated from the battery circuit makes and breaks the voice connections to the opposite ends of the winding 18. This avoids the generation of unmodulated carrier frequency current in the output coil 16.

Many variations can be made of the basic circuit arrangement to meet specific requirements. Fig. 5 illustrates how a vibrating relay similar to that of Fig. 4 but having an additional contact spring 31, besides springs 26 and 30, may be used to provide one set of contacts serving as a modulator circuit in a sending circuit and a second set of contacts serving independently as the demodulating circuit in the receiving side of the system. The sending circuit comes in at 33 from a microphone or line and one side is connected to the mid-tap on sending coil 34 while the other side leads to the vibrating contact 31 which makes and breaks alternate connections to the outside terminals of coil 34. The receiving branch comes in through coil 36 from the side-band or inverted speech circuit, with the mid-tap connection going to one side of the voice circuit 37 and the outside terminals of coil 36 going to the fixed points with which the vibrating spring 30 makes and breaks connections. Spring 30 is connected permanently to the opposite side of receiving line 37 which may lead to a receiver or telephone line. The tongue 26 operates as in Fig. 4 to maintain the vibrations at the carrier frequency but is insulated from tongues 30 and 31.

The invention is not limited to the use of the relay at the frequencies mentioned but may be used at any frequency within the operating range of available relays. Without intending to limit the invention to any particular relay construction, the relay may, as an example, use a driving

or vibrating mechanism of the type disclosed in H. C. Harrison Patent 2,275,625, March 10, 1942 with a tongue or tongues suitably attached to and driven by the vibrating element, in known manner.

What is claimed is:

1. A modulator-demodulator comprising a circuit for modulating signal waves and a circuit for demodulated carrier waves, said carrier wave circuit connected across a pair of fixed contacts, a relay having a movable contact element mounted for movement between said fixed contacts, said element having fixed electrical connection to said modulating signal circuit, a relay winding for vibrating said element to make contact alternately with said two fixed contacts at carrier frequency, and means to energize said winding by current of carrier frequency, whereby said relay converts signal currents into signal modulation carrier side-bands for transmission and converts received side-bands into signals.

2. A modulator-demodulator according to claim 1 in which said means to energize said relay comprises a source of direct current, relay windings connected to said source and an interrupter in circuit with said source and windings, said interrupter operated from the vibrating element of the relay.

3. A relay having a vibrating contactor between fixed contacts, a self-interrupting energizing circuit for said relay for maintaining said contactor in vibration at a constant frequency F , a circuit for signals having a band of frequencies S , lower than F , connected to the contactor of said relay, and a circuit for modulated signals of frequencies $F+S$ and $F-S$ connected to said fixed contacts.

4. In a modulating-demodulating circuit, a signal circuit, a circuit for modulated carrier waves, a transformer having a center-tapped first winding, and a second winding connected to said latter circuit, said signal circuit having one side connected to the center tap of said first winding and its other side connected to a movable member adapted to vibrate between and make contact alternately with a pair of fixed contacts, the two outer terminals of said center-tapped winding being connected to said pair of fixed contacts, and means to vibrate said member between said contacts at a carrier frequency.

5. A modulator-demodulator comprising a double-pole, double-throw switch comprising two metal tongues each having one end relatively fixed and the opposite end vibratable between fixed contacts located on opposite sides of the tongue, electromagnetic driving means for vibrating said tongues in unison at a carrier frequency to make contact alternately with said fixed contacts, a circuit for signal waves connected to said tongues and a circuit for modulated waves having its opposite sides connected to pairs of said fixed contacts which are alternately closed by different tongues.

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