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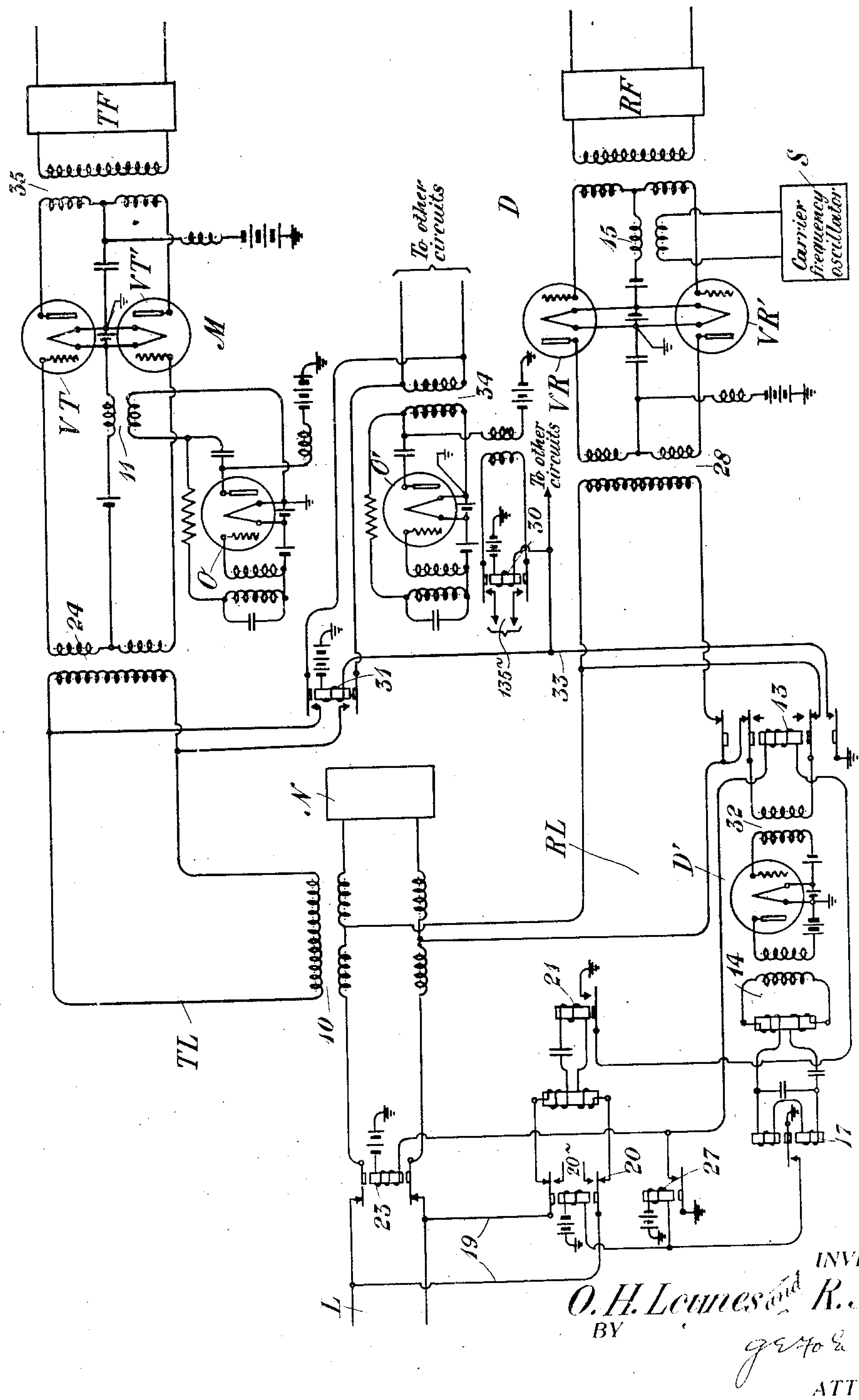

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RINGING ARRANGEMENT FOR CARRIER CIRCUITS.

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This invention relates to signaling circuits and more particularly to arrangements for transmitting ringing signals over multiplex carrier circuits.

In multiplex carrier circuits of the type in which the carrier is suppressed at the transmitting station, difficulty has been encountered in transmitting ringing signals, for the reason that the filters in such circuits are usually designed so as to cause a high attenuation to the carrier current but under this condition the filters also cause a rather high transmission loss to frequencies near the carrier frequency, with the result that it becomes difficult to transmit a side band obtained by modulating the carrier current in accordance with the usual ringing current of 20 cycles or 135 cycles.

In accordance with the present invention this difficulty is overcome by so arranging the circuit that an intermediate carrier current, having a frequency of, say, a thousand cycles and lying well within the voice range, is modulated by a ringing frequency of, say, 135 cycles. The modulated intermediate carrier is then impressed upon the modulator to modulate the normal carrier assigned to that channel. One of the side bands resulting from the last step of modulation will then be freely transmitted through the filter and will carry components corresponding to the ringing frequency which may be detected at the receiving station.

The invention will now be more fully understood from the detailed description thereof when read in connection with the accompanying drawing, the figure of which illustrates a circuit diagram embodying a preferred form of the invention. Referring to the drawing, L designates a low frequency transmission line associated with the transmitting channel TL and a receiving channel RL of the carrier system through the usual hybrid coil 10. The line L is balanced by a network N so that the transmitting channel TL and receiving channel RL will be substantially conjugate with respect to each other. The transmitting channel TL includes the usual type of balanced modulator M, comprising vacuum tubes VT and VT′. An oscillator O is associated with the balanced input circuit of the modulator M through a transformer 11 and thus supplies the carrier frequency assigned to the channel.

The receiving channel includes the usual balanced demodulator D, comprising vacuum tubes VR and VR′. A suitable source of carrier frequency S is associated with the input circuit of the balanced demodulator D through a transformer 15, the carrier frequency being thus supplied to the receiving channel to take the place of the carrier component which is suppressed at the modulator of the transmitting station.

In order that a ringing signal may be transmitted over the channel TL an oscillator O′ is provided for generating an intermediate carrier current, the frequency of which lies within the voice range. This source may be of any frequency range well within the voice range and in the case illustrated is assumed to have a frequency of a thousand cycles. A relay 30 is provided which is common to all of the transmitting channels of the multiplex circuit and this relay responds whenever a ringing signal comes in over any line, such as L, which is multiplexed for transmission over the same carrier circuit. When so energized the relay 30 connects a ringing source, which may be, for example, of a frequency of 135 cycles, to the plate circuit of the tube O′ to modulate the oscillations generated by said tube O′. A relay 31 is also provided, this relay being individual to the line L and responsive to a ringing signal incoming from said line. When the relay 31 is energized it connects the oscillator O′ to the input transformer 24 of the modulator M so that the modulated intermediate carrier frequency of 1,000 cycles will be impressed upon the modulator to modulate the normal carrier frequency impressed upon said modulator by the oscillator O.

The apparatus for receiving the ringing signal comprises a detector D′ bridged through a transformer 32, across the receiving channel RL on the output side of the demodulator D. The demodulator D, when a ringing signal is received, operates to detect the intermediate frequency of 1,000 cycles modulated by the ringing frequency. This intermediate modulated frequency is then impressed upon the detector D′, which operates to detect the 135 cycle frequency in accordance with which the intermediate frequency is modulated. An alternating current relay 17 is provided which operates in response to the detected 135 cycle frequency to impress a ringing current upon the line L.

Further details of the apparatus will be understood from the description of the operation which is as follows: Ringing current incoming from the line L is impressed over the back contacts of relay 20 upon an alternating current relay 21. Relay 21 closes a circuit over its front contact through relays 13 and 23 in series. Relay 23, upon being energized, disconnects the line L from the hybrid coil 10. Relay 13, at its inner contacts, disconnects the detector D′ from the output transformer 28 of the demodulator D and at its outer upper contact disconnects the demodulator D from the hybrid coil 10. At its outer lower contact, relay 13 connects ground to a conductor 33, thereby completing the circuits of relays 30 and 31 respectively. Relay 30, upon being energized, connects a source of ringing current having a frequency of 135 cycles, for example, to the plate circuit of the oscillator O′. The oscillator O′ normally generates an intermediate carrier frequency of, say, 1,000 cycles and this frequency is modulated by the 135 cycle source, with the result that frequencies of 1,000 cycles, 1,135 cycles and 865 cycles respectively are impressed upon the output transformer 34 of the oscillator O′. Relay 31, upon being energized, connects the output transformer 34 to the input transformer 24 of the modulator M, so that the three frequencies above referred to are impressed upon the modulator M and modulate the normal carrier frequency supplied to the modulator from the oscillator O.

If the normal carrier frequency supplied to the modulator M be assumed to be 10,000 cycles, for example, there will appear in the output transformer 35 as a result of the final modulating operation, an upper side band comprising the frequencies 11,135 cycles, 11,000 cycles and 10,865 cycles, and a lower side band comprising the frequencies 8,865 cycles, 9,000 cycles and 9,135 cycles. The carrier frequency component of 10,000 cycles will be substantially suppressed by reason of the balanced arrangement of the modulator. The filter TF, which is associated with the output circuit of the modulator M, is arranged to pass only one side band, say, the upper side band. Consequently, the lower side band frequencies 8,865 cycles, 9,000 cycles, 9,135 cycles, together with the original frequencies of 1,000 cycles, 865 cycles, and 1,135 cycles will be suppressed by the filter. The upper side band frequencies of 11,135 cycles, 11,000 cycles and 10,865 cycles, it will be observed, fall well within the range of free transmission of the output filter, whose range of free transmission may be, for example, from 10,200 cycles to 12,200 cycles.

The receiving operation is as follows: Assuming that frequencies of 11,135 cycles, 11,000 cycles and 10,865 cycles are transmitted from the distant station, these frequencies pass through the band filter RF on the input side of the demodulator D and are then impressed upon this demodulator. In the case assumed, a frequency of 10,000 cycles will be supplied to the demodulator from the source S and will beat with the received frequencies so that components of the detected currents will appear in the output circuit of the demodulator corresponding to 1,135 cycles, 1,000 cycles and 865 cycles. These three frequencies will pass through the transformer 28 and thence through the transformer 32 to the input circuit of the demodulator D′, which detects a component corresponding to 135 cycles. This component is impressed upon the alternating current relay 17, which is tuned to 135 cycles. The relay 17, upon being energized, completes circuits for the relays 20 and 27. Relay 27 completes a circuit of relay 23, which operates to disconnect the line L from the hybrid coil 10. Relay 20, on the other hand, connects a ringing source of 20 cycles, for example, to the line L over the conductors 19 so that ringing current is transmitted to the line L.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit and scope of the appended claims.

What is claimed is:

1. The method of transmitting a ringing frequency lower than the ordinary telephone range over a carrier system, in which a carrier frequency is modulated in accordance with speech and the carrier and frequencies in the neighborhod of the carrier are suppressed, which consists in modulating an intermediate carrier current having a frequency well within the telephone range in accordance with the ringing frequency, and then modulating the normal carrier of the carrier channel in accordance with the modulated intermediate frequency to produce a side band containing components from which the ringing frequency may be detected.

2. The method of transmitting a ringing frequency lower than the ordinary telephone range over a carrier system in which a carrier frequency is modulated in accordance with speech and the carrier and frequencies in the neighborhood of the carrier and frequencies lying within one side band are suppressed by means of a filter, which consists in modulating a carrier current having a frequency lying well within the

telephone range in accordance with the ringing frequency, and modulating the normal carrier frequency of the carrier channel in accordance with the modulated intermediate frequency to produce side bands, one of which lies well within the range of free transmission of the filter.

3. In a signaling system, a carrier channel including a modulator for modulating a carrier frequency in accordance with speech, means associated with said modulator for suppressing the carrier and frequencies in the neighborhood of the carrier, means to generate an intermediate carrier frequency well within the ordinary telephone range, means to modulate said carrier frequency in accordance with a ringing frequency below the ordinary telephone range, and means to modulate the normal carrier of the channel in accordance with the modulated intermediate frequency to produce side bands, at least one of which lies well within the range of free transmission of the channel.

4. In a signaling system, a carrier channel including a modulator for modulating a carrier frequency in accordance with speech, means associated with said circuit for suppressing the carrier and frequencies in the neighborhood of the carrier, means to generate an intermediate carrier frequency well within the ordinary telephone range, means to modulate said carrier frequency in accordance with a ringing frequency below the ordinary telephone range, means to modulate the normal carrier of the channel in accordance with the modulated intermediate frequency to produce side bands, at least one of which lies well within the range of free transmission of the channel, a demodulator at a receiving station for detecting a component corresponding to the modulated intermediate carrier, means for producing from the detected component the ringing frequency, and means responsive to the ringing frequency for transmitting a ringing signal.

5. In a signaling system, a carrier channel, a source of carrier frequency therefor, a balanced modulator upon which said carrier frequency may be impressed and modulated in accordance with speech, the circuit of said modulator being so balanced as to substantially prevent the transmission of the modulated component corresponding to the carrier, a filter for said channel for suppressing the carrier and frequencies in the neighborhood of the carrier and for suppressing frequencies lying within the range of one side band, means for generating an intermediate carrier frequency well within the ordinary telephone range, and means responsive to a ringing frequency below the ordinary telephone range to modulate said intermediate carrier frequency in accordance with said ringing frequency and to impress the modulated current upon said balanced modulator to produce side bands, at least one of which is well within the range of free transmission of the filter.

6. In a signaling system, a carrier channel, a source of carrier frequency therefor, a balanced modulator upon which said carrier frequency may be impressed and modulated in accordance with speech, the circuit of said modulator being so balanced as to substantially prevent the transmission of the modulated component corresponding to the carrier, a filter for said channel for suppressing the carrier and frequencies in the neighborhood of the carrier and for suppressing frequencies lying within the range of one side band, means for generating an intermediate carrier frequency well within the ordinary telephone range, means responsive to a ringing frequency below the ordinary telephone range to modulate said intermediate carrier frequency in accordance with said ringing frequency and to impress the modulated current upon said balanced modulator to produce side bands, at least one of which is well within the range of free transmission of the filter, a demodulator at a receiving station for detecting from the transmitted side band a component corresponding to the modulated intermediate frequency, means to translate said detected component into a ringing frequency, and means responsive to said ringing frequency for transmitting a ringing signal.

In testimony whereof, we have signed our names to this specification this 31st day of March, 1924.

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