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RINGING ARRANGEMENT FOR CARRIER CIRCUITS

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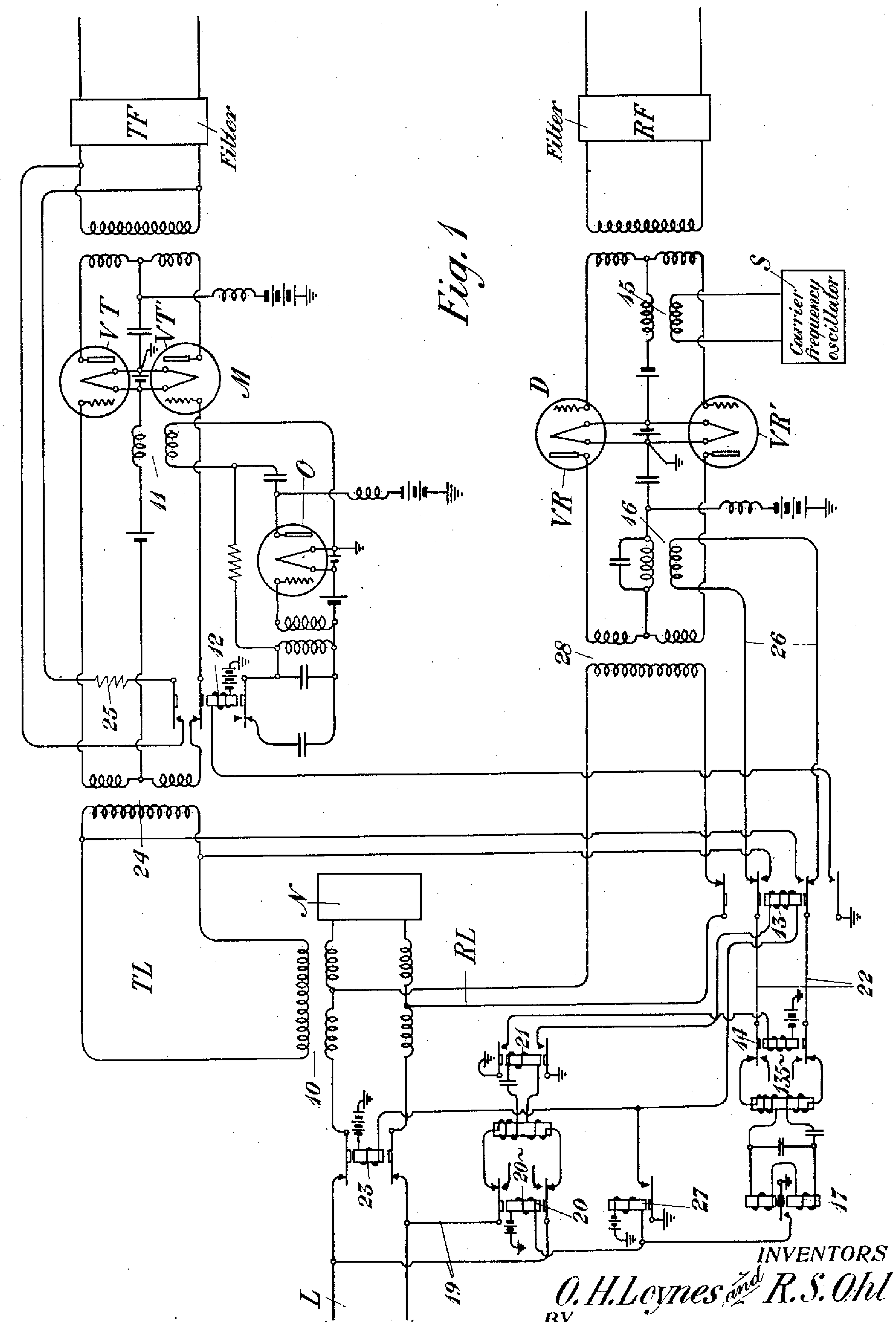

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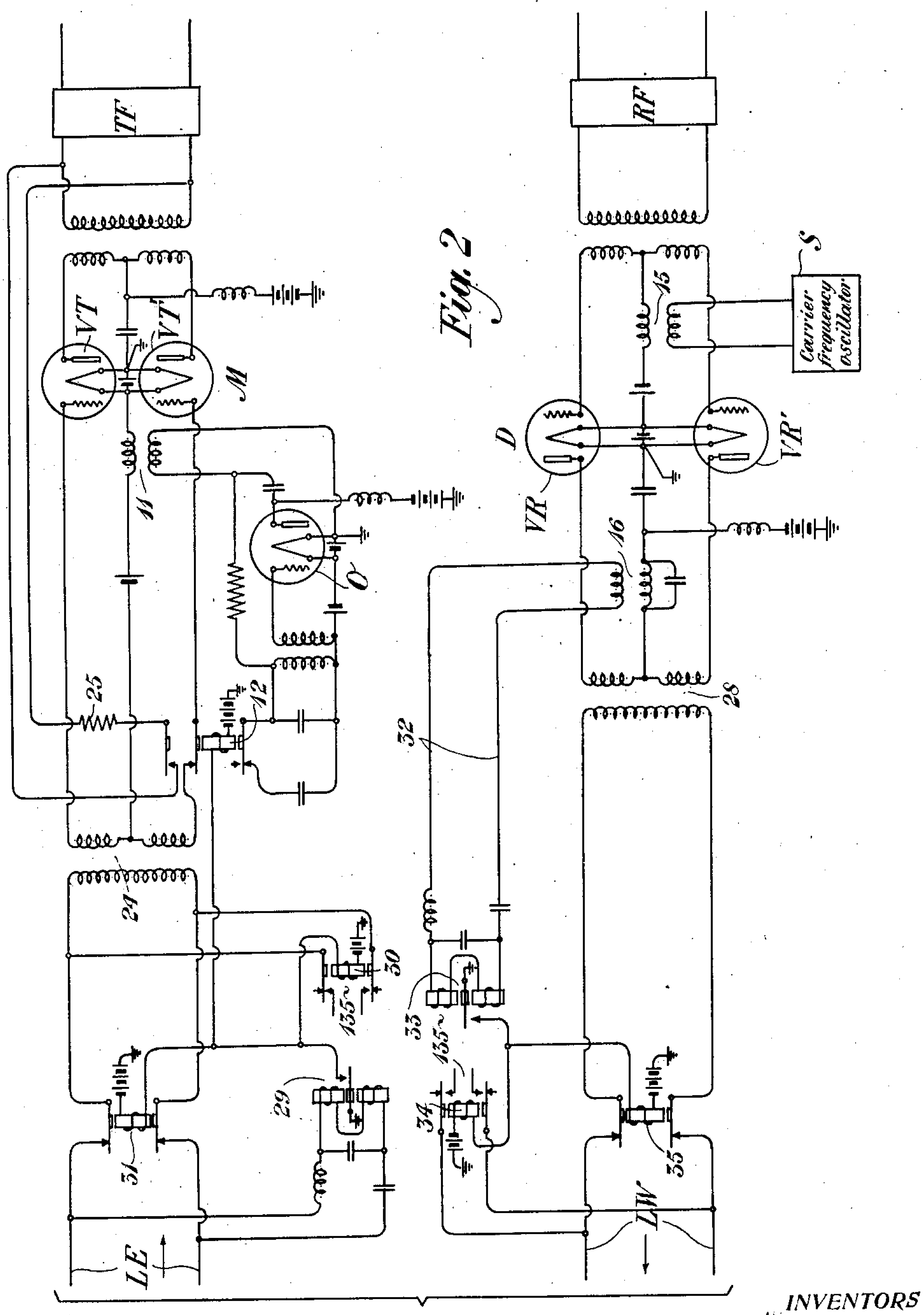

Fig. 2

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UNITED STATES PATENT OFFICE.

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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 tnat the carrier frequency is shifted in response to a ringing signal so that it will fall well within the transmission band of the filter. The carrier thus shifted in frequency is then modulated in accordance with the ringing frequency and the normally balanced circuit of the modulator is unbalanced so as to permit the carrier to be transmitted.

The invention may now be more fully understood from the following detailed description thereof when read in connection with the accompanying drawing, Figure 1 of which illustrates a circuit arrangement embodying the invention as applied to a two-wire low frequency telephone circuit, and Fig. 2 of which illustrates the invention as applied to a four-wire low frequency telephone circuit.

Referring to Fig. 1, L designates a low frequency transmission line which is connected to the transmitting channel TL and the receiving channel RL of a carrier circuit through the usual hybrid coil 10, the line being balanced by a network N. The transmitting channel includes the usual balanced modulator M, comprising vacuum tubes VT and VT′. An oscillating tube O is arranged to supply the carrier frequency to the modulator M through a transformer 11. The circuit is so arranged that in response to a ringing signal incoming from the line L, relay 12 is energized and by changing the capacity in the circuit of the oscillator O the carrier frequency supplied by the oscillator may be shifted about a thousand cycles from its normal position in the frequency spectrum. The relay 12 is also arranged to open the input circuit of one of the vacuum tubes of the modulator, for example, the tube VT′, thus unbalancing the modulator to enable the shifted carrier to be transmitted. The ringing signal also causes the energization of relays 13 and 14, whereby 135 cycle ringing current may be applied to the modulator to modulate the shifted carrier frequency.

The receiving channel includes the usual balanced demodulator D, comprising vacuum tubes VR and VR′. A suitable source of carrier current S having the same frequency as the carrier current normally supplied to the modulator is connected to the input circuit of the demodulator D through a transformer 15. The demodulator D detects the 135 cycle component from the incoming carrier and transmits it through a tuned transformer 16 to an alternating current relay 17, the circuit of which is tuned to the ringing frequency. Relay 17 in turn causes ringing current of 20 cycles, for example, to be applied to the low frequency 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 transmitted over the conductors 19 and over the back contacts of relay 20 to an alternating current relay 21, whose circuit is tuned to the ringing frequency. Relay 21, upon being energized, closes a circuit for the relay 14 at its upper contact so that the relay 14 applies ringing current to the conductors 22. At its lower contact, relay 21 closes a circuit through the windings of relays 13 and 23 in series. Relay 23 opens the circuit from the line L to the hybrid coil 10 and relay 13 connects the 135 cycle source over its inner front contacts to the input transformer 24 of the modulator M. At its upper contact relay 13 disables the output circuit of the demodulator D and at its lower front contact relay 13 closes a circuit for relay 12. Relay 12 changes the capacity of the oscillating circuit of the oscillator O to shift the frequency supplied by the oscillator, say, a thousand cycles. At its inner upper contact, relay 12 opens the circuit of the vacuum tube VT', thereby unbalancing the demodulator D so that the shifted carrier frequency is modulated by the ringing current of 135 cycles which is impressed through the transformer 24.

If we assume, for example, that the normal carrier current supplied by the oscillator O to the modulator has a frequency of 10,000 cycles and that this carrier and the lower side band are suppressed, the filter which is associated with the output circuit of the demodulator would be designed to have a band of free transmission ranging from about 10,200 cycles to 12,200 cycles. The operation of the relay 12 would then shift the carrier frequency to 11,000 cycles, which, it will be observed, is well within the free transmission range of the filter. The shifted carrier frequency, upon being modulated by the 135 cycle current, will cause frequencies of 11,000 cycles, 11,135 cycles and 10,865 cycles to be transmitted through the filter to the distant station. If desired, the relay 12 may be arranged to bridge a suitable resistance 25 across the outgoing circuit of the modulator to keep the transmitted frequencies within the desired amplitude.

The transmitting arrangement at the distant station will operate in the manner just described in response to a ringing current transmitted west, so that frequencies of 11,000 cycles, 11,135 cycles and 10,865 cycles will be transmitted through the band filter in the receiving channel and impressed upon the balanced demodulator D. These frequencies, by beating with each other, produce in the output circuit of the demodulator a component having a frequency of 135 cycles, which will be selected by the tuned transformer 16 and impressed upon the conductors 26. The detected 135 cycle current is then transmitted over the inner back contacts of relay 13 and over the back contacts of relay 14 to the relay 17, whose circuit is tuned to 135 cycles. The relay 17 then operates to close the circuits of relays 20 and 27. The latter closes a circuit of the relay 23 to disconnect the line L from the hybrid coil 10, while relay 20 connects the ringing frequency over the conductors 19 to the line L.

Fig. 2 shows the invention applied to a carrier circuit, the low frequency side of which is a four-wire circuit. LE designates the low frequency line transmitting from west to east, this line being connected to the modulator M and associated apparatus through a transformer 24. LW, on the other hand, designates a low frequency transmission line transmitting from east to west, this line being coupled with the demodulator D and associated apparatus through a transformer 28. Further details of the apparatus will be clear from the description of the operation.

Assuming that a ringing signal is transmitted over the line LE, the ringing current actuates the alternating current relay 29, which closes the circuits of relays 30 and 31. Relay 31, upon being energized, disconnects the line LE from the transformer 24 to prevent the transmission of the ringing current to the modulator. Relay 30, on the other hand, connects a source of 135 cycle current to the transformer 24, so that it may be impressed upon the modulator. The energization of relay 29 also closes a circuit of a relay 12, which functions exactly in the same manner as relay 12 of Fig. 1 to shift the carrier frequency well within the band of free transmission of the filter in the transmitting circuit, and unbalances the modulator M so that the shifted carrier will be modulated by the 135 cycle frequency and will then be transmitted to the distant station.

A similar ringing signal transmitted from the distant station, after passing through the band filter, is impressed upon the demodulator D, which functions in the same manner as the demodulator D of Fig. 1 to detect a component having a frequency of 135 cycles in its output circuit, this component being impressed through the tuned transformer 16 upon conductors 32, thereby actuating the alternating current relay 33. The latter relay closes the circuits of relays 34 and 35. The relay 35 disconnects the output circuit of the demodulator D from the line LW, and relay 34 at the same time connects a source of ringing current to the line LW.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. The method of transmitting a ringing frequency below the ordinary telephone range over a carrier system in which a carrier frequency is modulated in accordance with speech and the normal carrier and frequencies in the neighborhood of the normal carrier are suppressed, which consists in shifting the carrier frequency in response to a ringing signal to a point well within the range of free transmission of the carrier channel and then modulating the shifted carrier frequency in accordance with the ringing frequency.

2. The method of transmitting a ringing frequency below the ordinary telephone range over a carrier system in which a carrier frequency is modulated in accordance with speech and the normal carrier and frequencies in the neighborhood of the nor-

mal carrier and the frequencies lying within one side band are suppressed by means of a filter, which method consists in shifting the carrier frequency in response to a ringing signal to a point well within the range of free transmission of the filter, and then modulating the carrier frequency thus shifted in accordance with the sub-audible ringing frequency.

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 frequencies in the normal carrier and neighborhood of the carrier, means responsive to a ringing frequency below the ordinary telephone range for shifting the carrier to a point well within the range of free transmission of the circuit, and means to modulate the shifted carrier in accordance with the ringing frequency.

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 normal carrier and frequencies in the neighborhood of the carrier, means responsive to a ringing frequency below the ordinary telephone range for shifting the carrier to a point well within the range of free transmission of the circuit, means to modulate the shifted carrier in accordance with the ringing frequency, a demodulator at the receiving station for detecting from the shifted and modulated carrier a frequency component corresponding to the ringing frequency, and means responsive to the detected 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 a normal carrier frequency from said source 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 normal carrier frequency, a filter for such channel for suppressing the normal carrier frequencies in the neighborhood of the carrier and for suppressing frequencies lying within the range of one side band, means responsive to a ringing frequency below the ordinary telephone range for shifting the frequency of said carrier source to a point well within the range of free transmission of the filter, and means to modulate the shifted carrier frequency in accordance with the ringing frequency.

6. In a signaling system, a carrier channel, a source of carrier frequency therefor, a balanced modulator upon which a normal carrier frequency from said source may be impressed, the circuit of said modulator being so balanced as to substantially prevent the transmission of the modulated component corresponding to the normal carrier frequency, a filter for said channel for suppressing the normal carrier and frequencies in the neighborhood of the normal carrier and for suppressing frequencies lying within the range of one side band, means responsive to a ringing frequency below the ordinary telephone range for shifting the frequency of said carrier source to a point well within the range of free transmission of the filter, means to modulate the shifted carrier frequency in accordance with the ringing frequency, and means responsive to the ringing frequency to unbalance the modulator so that the shifted and modulated carrier may be transmitted.

7. In a signaling system, a carrier channel, a source of carrier frequency therefor, a balanced modulator upon which a normal carrier frequency from said source may be impressed, the circuit of said modulator being so balanced as to substantially prevent the transmission of the modulated component corresponding to the normal carrier frequency, a filter for such channel for suppressing the normal carrier and frequencies in the neighborhood of the carrier and for suppressing frequencies lying within the range of one side band, means responsive to a ringing frequency below the ordinary telephone range for shifting the frequency of said carrier source to a point well within the range of free transmission of the filter, means to modulate the shifted carrier frequency in accordance with the ringing frequency, a demodulator at a receiving station for detecting from the modulated and shifted carrier a frequency component corresponding to the ringing frequency, and means responsive to the detected ringing frequency for transmitting a ringing signal.

8. In a signaling system, a carrier channel, a source of carrier frequency therefor, a balanced modulator upon which a normal carrier frequency from said source may be impressed, the circuit of said modulator being so balanced as to substantially prevent the transmission of the modulated component corresponding to the normal carrier frequency, a filter for said channel for suppressing the normal carrier and frequencies in the neighborhood of the carrier and for suppressing frequencies lying within the range of one side band, means responsive to a ringing frequency below the ordinary telephone range for shifting the frequency of said carrier source to a point well within the range of free transmission of the filter, means to modulate the shifted carrier frequency in accordance with the ringing frequency, means responsive to the ringing frequency to unbalance the modulator so that the shifted and modulated carrier may be transmitted, a demodulator at a receiving

station for detecting from the modulated and shifted carrier a frequency component corresponding to the ringing frequency, and means responsive to the detected ringing frequency for transmitting a ringing signal.

9. In a carrier signaling system, the combination with a line of a carrier telephone circuit, a source of ringing current connected with the said line, a source of carrier current connected with the said carrier circuit to supply current of predetermined frequency thereto to be modulated by voice currents transmitted over the said line, and means controlled by the said source of ringing current to change the frequency of the said carrier current whenever ringing current is transmitted over the said line.

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

OWEN H. LOYNES.
RUSSELL S. OHL.