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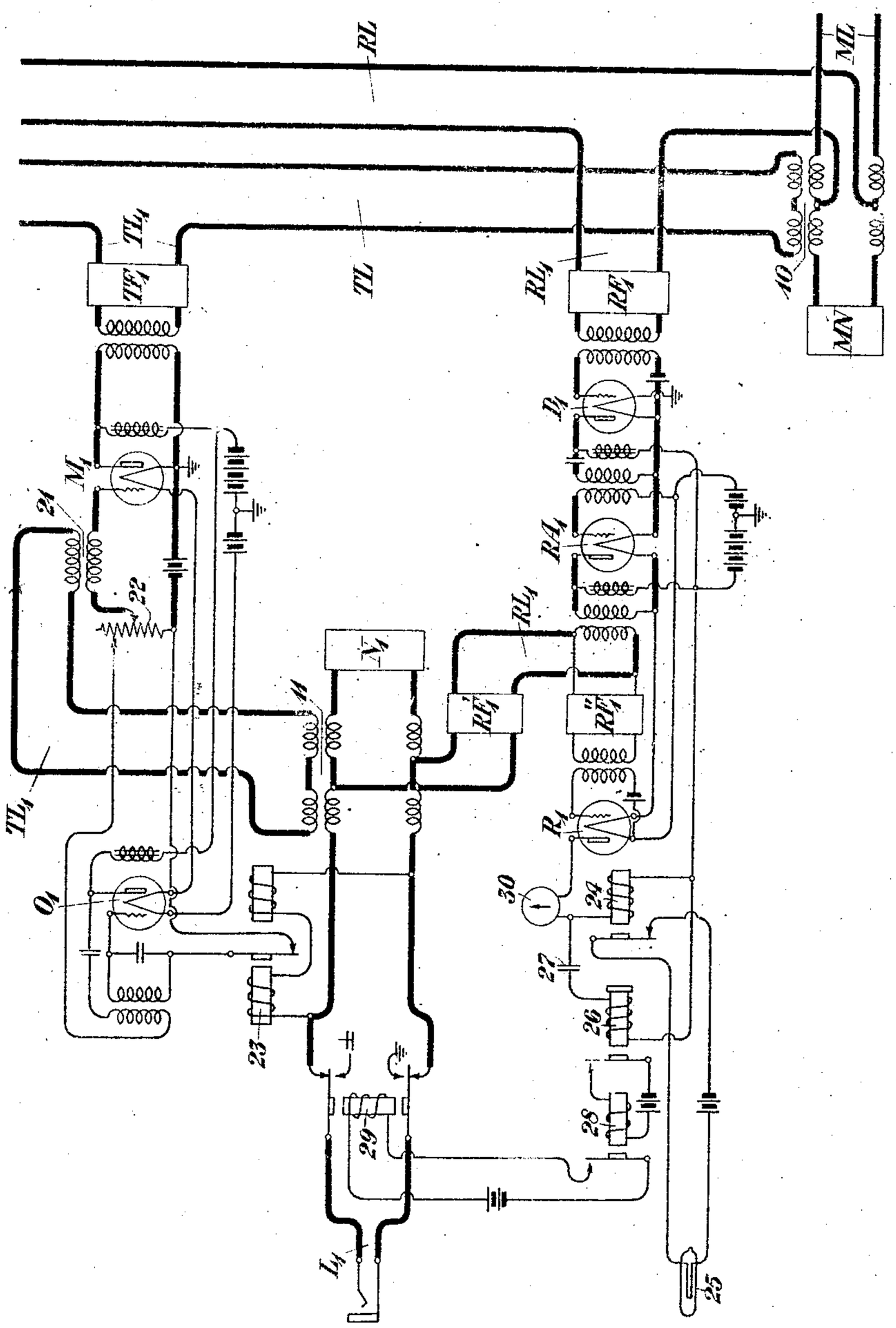


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By his Attorney

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# UNITED STATES PATENT OFFICE.

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## RINGING CIRCUITS FOR MULTIPLEX SIGNALING.

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*To all whom it may concern:*

Be it known that I, HERMAN A. AFFEL, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Ringing Circuits for Multiplex Signaling, of which the following is a specification.

This invention relates to the transmission of signals, and more particularly to the transmission of signals by means of so-called carrier currents.

One of the objects of this invention is to provide an arrangement for transmitting ringing or other supervisory signals over the channels of a carrier transmission system.

Another object of the invention is to provide ringing apparatus for a system of the character described, said ringing apparatus being arranged to function in response to the interruption of the unmodulated carrier component which may be transmitted along with the modulated side band for any particular channel.

Another object of the invention is to provide a ringing apparatus for a system of this character which will not respond to accidental or casual interruptions of the unmodulated carrier component, either of a temporary or permanent nature, thus preventing the transmission of a false ringing signal under these circumstances.

These objects, together with other objects of the invention more fully appearing hereafter, are accomplished in accordance with the present invention by providing means responding to a ringing signal for indirectly interrupting the unmodulated carrier component successively at a frequency which may be, for example, that of the ringing current. The receiving portion of the apparatus is so designed as to respond to interruptions of the carrier frequency repeated at the desired low frequency, said receiving apparatus being so organized, however, as to be unresponsive to a single interruption of the unmodulated carrier component, whether the interruption be temporary or continued for a long interval.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawing, the figure of which illustrates a circuit diagram embodying one form of the invention.

Referring to the drawing, $L_1$ designates a low frequency transmission line adapted to be associated with a carrier transmission line ML through a transmitting channel $TL_1$ and a receiving channel $RL_1$. The channels $TL_1$ and $RL_1$ are associated with the low frequency line $L_1$, through a balanced transformer arrangement 11 of well-known construction. The line $L_1$ is balanced by means of an artificial line or network $N_1$, in order to render the transmitting and receiving channels substantially conjugate at the low frequencies transmitted over the line $L_1$. The channels $TL_1$ and $RL_1$ are associated with common transmitting and receiving channels TL and RL respectively, to which transmitting and receiving channels individual to other low frequency lines may also be connected. The common transmitting and receiving circuits TL and RL are associated with line ML through a balanced transformer arrangement 10 similar to the balanced transformer arrangement 11, and an artificial line or network MN is provided for balancing the main line ML at carrier frequencies, so that the common transmitting and receiving circuits TL and RL will be substantially conjugate at those frequencies.

The transmitting channel $TL_1$, includes a modulator $M_1$ of the well-known vacuum tube type, the input circuit of said modulator being associated with the low frequency portion of the channel $TL_1$ through a transformer 21. An oscillator O′ which may be of well-known vacuum tube type is provided for the purpose of generating oscillations of carrier frequency, these oscillations being supplied to the input circuit of the modulator $M_1$ through potentiometer 22. A ringing responsive relay 23 is bridged across the low frequency line $L_1$ and this relay is so designed that its armature will vibrate at the frequency of the ringing current incoming from the line $L_1$. The armature of the relay 23 is arranged to interrupt the connection from the oscillator $O_1$ to the modulator $M_1$, thereby interrupting the transmission of the carrier frequency at the frequency of the ringing current.

The receiving channel $RL_1$ includes a demodulator or detector $D_1$ of the simple vacuum tube type. An amplifying tube RA may also be included in the output circuit of the demodulator or detector for amplifying currents appearing in the output circuit of the detector. The system is ar-

ranged so that the unmodulated carrier component is transmitted along with the modulated side band, and, as is well known, the unmodulated carrier component will appear in the output circuit of the detector $D_1$ and consequently the output circuit of the amplifier RA, along with the detected signal in accordance with which the side band was modulated. Two branches are associated with the output circuit of the amplifier RA, one branch including a low pass filter $RF_1$, for transmitting the detected low frequency currents while suppressing the unmodulated carrier component. The other branch includes a high pass filter $RF_1''$ for transmitting the unmodulated carrier component while suppressing the detected low frequency currents. The detected currents passed by the first mentioned filter are transmitted over the line $L_1$. The carrier frequency component passed by the filter $RF_1''$ is impressed upon a rectifying tube $R_1$ associated with the corresponding branch circuit. This rectifying tube includes a milliammeter 30 in its output circuit for indicating the amplitude of the transmitted carrier. The rectified current passes through a direct current relay 24 in the output circuit, which relay is arranged to control the circuit of a signal lamp 25 which normally glows but is extinguished when the carrier is interrupted. A relay 26 is also included in the output circuit of the rectifier, a condenser 27 being in circuit with said relay so that only the low frequency pulses corresponding to the repeated interruption of the carrier frequency will be transmitted through the relay 26. Owing to the presence of the condenser 27, the rectified current appearing in the output circuit of the rectifier when the carrier is not interrupted does not pass through the relay 26 and said relay is therefore normally deenergized. When the carrier is repeatedly interrupted at a rate corresponding to the frequency of the ringing current, pulsations of current flow through the relay 26 at the same rate and said relay is energized to open the circuit of the auxiliary relay 28, which in turn closes the circuit of a relay 29 for applying ringing current to the low frequency line $L_1$. If the carrier frequency is interrupted but once, whether the interruption be momentary or continued for a long period, but a single pulse of current flows through the relay 26, and, as this relay or relay 28 may be adjusted to be slow acting, it will not respond to a single pulse and hence only transmits a ringing signal to the line $L_1$ when the pulses are repeated at a rate determined by the frequency of the ringing current.

The operation is as follows: Voice currents incoming from the line $L_1$ pass through the transformer 11 to the circuit $TL_1$ and are impressed through the transformer 21 upon the input circuit of the modulator $M_1$. The modulator $M_1$ is also supplied with oscillations of carrier frequency from the oscillator $O_1$ through the potentiometer 22. The carrier frequency is modulated by the voice currents, and the unmodulated carrier component and one side band are transmitted through the filter $TF_2$ to the common transmitting circuit TL, the other side band being suppressed. The transmitted side band and carrier frequency component pass through the transformer 10 into the line ML, over which they are transmitted to the distant station. A modulated side band received from the distant station is transmitted, together with the unmodulated carrier component, into the common receiving circuit RL, and is selected by the filter $RF_1$ into the receiving channel $RL_1$. The unmodulated carrier and the side band are impressed upon the detector $D_1$, as a result of which the unmodulated carrier frequency and the signaling currents represented by the side band appear in the output circuit of the detector and are amplified by the amplifier RA. The detected low frequency voice currents pass through the low pass filter $RF_1''$ to the line $L_1$, while the unmodulated carrier frequency component passes through the high pass filter $RF_1''$ into the rectifier $R_1$. The resultant rectified current maintains the relay 24 energized and produces a proper indication of the milliammeter 30.

A ringing signal incoming from the line $L_1$ actuates the relay 23 to interrupt the circuit of the oscillator $O_1$ at a rate corresponding to the ringing frequency and the interrupted carrier frequency is transmitted through the modulator $M_1$ and over the circuit TL to the main line ML. A ringing signal incoming from the distant station appears as an interruption of the carrier frequency normally transmitted into the channel $RL_1$. This carrier frequency is transmitted through the detector $D_1$ and the amplifier RA as already described, and each time the carrier frequency is interrupted the rectified current appearing in the output circuit of the rectifier $R_1$ is likewise interrupted. Each interruption of the rectified current causes a pulse of current to flow through the condenser 27 and the winding of the relay 26, and the cessation of pulses of current thus flowing energizes a circuit of the relay 28, which relay in turn closes the circuit of the relay 29 to apply ringing current to the line $L_1$. Should the carrier frequency be interrupted for a continued period due to a defect of the line ML, or should a transient interruption occur due to any momentary condition, but a single pulse will flow through the relay 26, and, as this relay is arranged not to respond to

single pulsations of current, no ringing current is transmitted to the line $L_1$. The interruption of the carrier, however, results in the deenergization of the relay 24, which opens the circuit of the lamp 24 at the switchboard, thereby apprising the attendant of the fact that there is some defect upon the line which needs correction. Any continued decrease in the amplitude of the carrier current will be registered on the milliammeter 30, thereby apprising the attendant that some adjustment should be made to increase the amplitude of the carrier.

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 of the invention as defined in the following claims.

What is claimed is:

1. In a carrier signaling system, means to transmit the unmodulated carrier compoent along with the modulated side band, means responsive to ringing current to pulsatingly interrupt the unmodulated carrier, a detector and a relay in circuit therewith at the receiving station, means to prevent said relay from receiving energy from the detector when continuous carrier oscillations are received, and means controlled by said relay for transmitting a ringing signal, said means being responsive only to the repeated interruption of the carrier.

2. In a carrier signaling system, means to transmit the unmodulated carrier component along with the modulated side band, means responsive to ringing current to pulsatingly interrupt the unmodulated carrier, a detector and a relay in circuit therewith at the receiving station, means to prevent said relay from receiving energy from the detector when continuous oscillations are received, and means controlled by said relay in response to the repeated interruption of the carrier for transmitting a ringing signal, said means being unresponsive to a single interruption of the carrier frequency.

3. In a carrier signaling system, means for transmitting the unmodulated carrier component along with the modulated side band, means responsive to ringing current for interrupting the carrier frequency at the frequency of the ringing current, a detector and a relay in circuit therewith at the receiving station, means to prevent said relay from receiving energy from the detector when continuous carrier oscillations are received, and means controlled by said relay for transmitting a ringing signal, said means being responsive only to the repeated interruption of the carrier at the ringing frequency.

4. In a carrier signaling system, means for transmitting the unmodulated carrier component along with the modulated side band, means responsive to ringing current for interrupting the carrier frequency at the frequency of the ringing current, a detector and a relay in circuit therewith at the receiving station, means to prevent said relay from receiving energy from the detector when continuous oscillations are being received, and means controlled by said relay in response to the interruption of the carrier at the ringing frequency for transmitting a ringing signal, said last mentioned means being unresponsive to a single interruption of the carrier frequency.

5. In a carrier signaling system, a main transmission line over which carrier frequencies may be transmitted, a low frequency line, a receiving channel for interconnecting said lines, means at a transmitting station for transmitting the unmodulated carrier component along with the modulated side band over said main transmission line, means at said transmitting station to pulsatingly interrupt the carrier frequency in response to ringing current, a detector and a relay in circuit therewith associated with said receiving channel, means to prevent said relay from receiving energy from the detector when continuous oscillations are received, and means operating under the control of said relay in response only to repeated pulsating interruptions for transmitting ringing current to said low frequency line.

6. In a carrier signaling system, a main transmission line over which carrier frequencies may be transmitted, a low frequency line, a receiving channel for interconnecting said line, means at a transmitting station for transmitting the unmodulated carrier component along with the modulated side band over said main transmission line, means at said transmitting station to pulsatingly interrupt the carrier frequency in response to a ringing current, a detector and a relay in circuit therewith associated with said receiving channel, means to prevent said relay from receiving energy from the detector when continuous carrier oscillations are received, means controlled by said relay in response to pulsating interruptions for transmitting ringing current to said low frequency line, said last mentioned means being unresponsive to single interruptions of the carrier frequency.

7. In a carrier signaling system, a main transmission line over which carrier currents may be transmitted, a low frequency line, a receiving channel for interconnecting said lines, means at a transmitting station for transmitting the unmodulated carrier component over said main line along with the modulated side band, means at said transmitting station responsive to ringing current for interrupting said carrier fre-

quency at the frequency of said ringing current, a detector and a relay in circuit therewith associated with said receiving channel, means to prevent said relay from receiving energy from said detector when continuous carrier oscillations are received, and means controlled by said relay responsive only to repeated interruptions of the unmodulated carrier at the ringing frequency to transmit ringing current to said low frequency line.

8. In a carrier signaling system, a main transmission line over which carrier frequencies may be transmitted, a low frequency line, a receiving channel for interconnecting said lines, means at a transmitting station for transmitting the unmodulated carrier component over said main line along with the modulated side band, means at said transmitting station responsive to ringing current for interrupting said carrier frequency at the frequency of said ringing current, a detector and a relay in circuit therewith associated with said receiving channel, means to prevent said relay from receiving energy from said detector when continuous oscillations are received, means controlled by said relay in response to interruptions of the unmodulated carrier at the ringing frequency to transmit ringing current to said low frequency line, said last mentioned means being unresponsive to single interruptions of the carrier frequency.

In testimony whereof I have signed my name to this specification this 30th day of December, 1920.

HERMAN A. AFFEL.