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RINGING ARRANGEMENT FOR MULTIPLEX CIRCUITS

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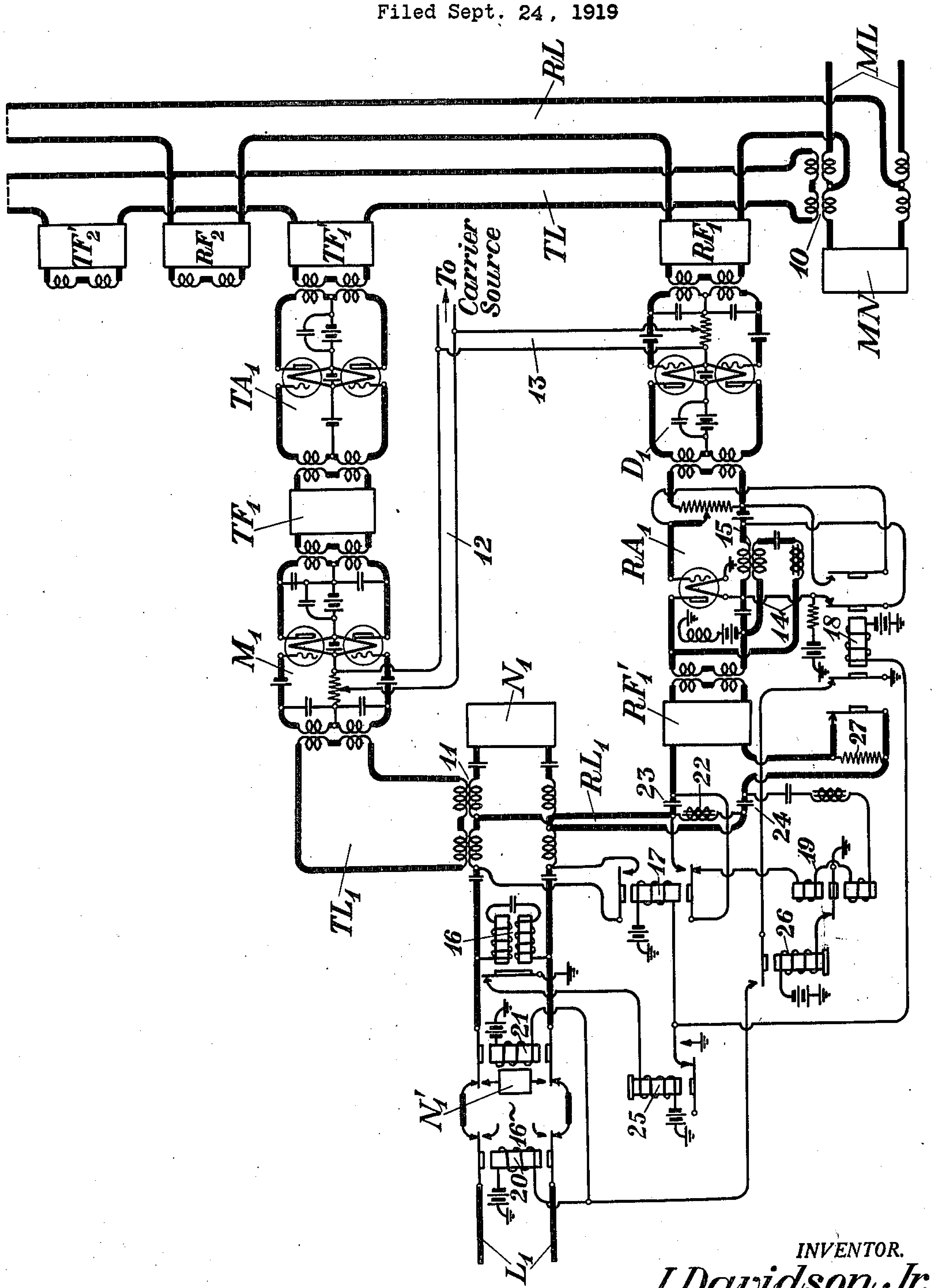

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BY

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RINGING ARRANGEMENT FOR MULTIPLEX CIRCUITS.

Application filed September 24, 1919. Serial No. 325,823.

To all whom it may concern:

Be it known that I, JOHN DAVIDSON, Jr., residing at Montclair, in the county of Essex and State of New Jersey, have invented certain Improvements in Ringing Arrangements for Multiplex Circuits, of which the following is a specification.

This invention relates to multiplex systems employing carrier currents and more particularly to arrangements whereby ringing or other signaling currents may be transmitted over the channels of such a system.

One of the features of the invention resides in the provision of a system of relays for controlling the transmission of ringing current in either direction at the junction point of a low frequency signaling line with the carrier system, said relays being so interlocked that when one relay is actuated to control the transmission of ringing current in one direction the transmission of ringing current in the opposite direction will be prevented.

A further feature of the invention relates to the provision of a system of relays for controlling the transmission of ringing current in either direction at the junction point of a low frequency signaling line and the carrier system, one of said relays being arranged to control some element of the carrier system, such as an amplifier, in such a manner that it will function as a source of relayed ringing current for transmission over the carrier system, and another relay being arranged to control the application of ringing current to the low frequency signaling line, the relays being so interlocked that transmission of ringing current over the carrier system and over the low frequency signaling line cannot take place simultaneously.

These features, together with other features of the invention, which will more fully appear hereinafter, may be realized in accordance with the detailed arrangements set forth in the following description and illustrated in the accompanaying drawing, the figure of which illustrates a circuit diagram embodying one form of the invention.

In the figure, ML designates a main line or circuit for the transmission of carrier currents. Common transmitting and receiving circuits TL and RL are associated with the main line ML through a balanced transformer 10. In order that the circuits TL and RL may be rendered conjugate so that electrical disturbances in the one will be without effect upon the other, the main line ML is balanced by an artificial line or network MN.

L_1 designates a low frequency signaling line or circuit, which, in common with a plurality of other lines, is adapted to transmit signals over the main line ML. In the case illustrated, the line L_1 is an ordinary low frequency telephone circuit. The line L_1 is associated through the transformer 11, with an outgoing carrier transmission channel TL_1 and an incoming carrier receiving channel RL_1. These two channels are rendered substantially conjugate by providing an artificial line or network N_1 for balancing the line L_1. The channels TL_1 and RL_1 are associated with the common circuits TL and RL through filters TF_1' and RF_1 respectively. Similar channels corresponding to other low frequency signaling circuits may be associated with the circuits TL and RL through filters TF_2' and RF_2 respectively.

These filters are preferably of the broad band type disclosed in the U. S. patents of George A. Campbell, Nos. 1,227,113 and 1,227,114, dated May 22, 1917. Said filters are designed in accordance with the principles of the Campbell patents above referred to, in such a manner that they will transmit bands of frequencies in the neighborhood of the carrier frequency assigned to the channel, the bands being of sufficient width to accommodate the frequency variation due to the modulation of the basic carrier frequency by the signaling frequencies. The bands transmitted by the filters TF_1' and RF_1 may in practice be the same. The bands transmitted by other filters, such as TF_2' and RF_2 should be sufficiently remote from the bands transmitted by the filters TF_1' and RF_1 to allow for frequency separation between the channels.

The transmitting channel TL_1 includes a modulator M_1, a band filter TF_1 and an amplifier TA_1. The modulator M_1 may be of any well-known type, but is illustrated as a duplex vacuum tube modulator of the type illustrated and described in the U. S. application of John R. Carson, Serial No. 157,413, filed March 26, 1917. The modulator is supplied with carrier currents of the frequency assigned to the channel, over a circuit 12. The arrangement is such that carrier currents are not transmitted by the modulator unless the circuit is unbalanced, due to the application of signaling current thereto.

The filter TF_1 is of the general type disclosed in the Campbell patent above mentioned and is designed to suppress voice frequencies and freely pass carrier frequencies. The amplifier TA_1 may be of any well-known character, but is preferably a duplex vacuum tube amplifier, which, as is well known, provides a minimum degree of distortion at high frequencies and hence is well adapted for the amplification of carrier currents.

The receiving or incoming channel RL_1 includes a detector or demodulator D_1. This demodulator may be of any well-known type, but is preferably a duplex vacuum tube modulator of the general character illustrated and described in the U. S. application of John R. Carson, Serial No. 157,414, filed March 26, 1917. The duplex demodulator described in the said Carson application operates upon the so-called homodyne method of receiving and consequently is supplied from the circuit 13 with oscillations of the carrier frequency assigned to the channel. The oscillations supplied from the circuit 13 react in a well-known manner with the received modulated currents, to detect the low frequency signaling currents.

The channel RL_1 also includes an amplifier RA_1. This amplifier is preferably a vacuum tube amplifier, as illustrated, and serves to amplify the detected signaling currents. It is also provided with a feed-back connection 14, which is coupled to the input circuit through a transformer 15. In the normal operation of the amplifier the transformer 15 is short-circuited, but the apparatus is so arranged that when ringing current comes in over the line L_1 the short circuit from the secondary winding of the transformer 15 is opened and the feed-back connection 14 becomes operative, so that the amplifier now functions as a source of oscillations of ringing frequency which are transmitted from the circuit RL_1 to the channel TL_1, in which they modulate the carrier frequency for transmission to a distant station. The incoming circuit RL_1 also includes a filter RF_1'. This filter may likewise be of the general type illustrated in the above mentioned patents to George A. Campbell, and is preferably so designed as to transmit a range of frequencies extending from zero up to the highest frequency employed in ordinary telephonic transmission.

Since it is generally customary to ring over lines such as L_1 at relatively low frequencies, such, for instance, as 16 cycles per second, it is desirable that some apparatus should be provided at the junction between the low frequency line and the carrier system, to translate these ringing currents into ringing currents of some higher frequency which is more suitable for the modulation of carrier currents. It has generally been found that ringing current having the frequency of 133 cycles is adapted for this purpose, although it will be understood that other frequencies may be used if preferred. In order to produce the translation in ringing frequency above referred to, the line L_1 is provided with a ringing responsive relay 16, which indirectly controls relays 17 and 18; the latter serves to convert the amplifier RA_1 into a generator of oscillations having a frequency of 133 cycles. The relay 17 connects a short circuit across the line L_1 at the point where it is connected to the transformer 11, so that the transformer arrangement is unbalanced and the oscillations generated by the amplifier RA_1 may be transmitted over the circuit RL_1 to the outgoing channel TL_1, where they modulate the carrier oscillations and are then transmitted to the distant station.

A ringing responsive relay 19 is bridged across the channel RL_1, as indicated, and this relay is adapted to respond to detected 133 cycle ringing current and control the action of relays 20 and 21. The relay 20 is arranged to apply 16 cycle ringing current to the line L_1, the relay 21 at the same time connecting an artificial line N_1' in place of the line L_1, so as to prevent singing in the channels RL_1 and TL_1. The circuit of the relay 19 is so arranged that when the relay 16 is operated in response to ringing current the relay 19 cannot be operated. The circuits of the relays 20 and 21 which are controlled by the relay 19 are also arranged to prevent the operation of these relays when the relay 16 is operated. This prevents the possibility of a ring-back or a false operation of the relay 20, when the relay 16 responds to ringing current incoming from the line L_1.

In order to prevent the relay 16 from being operated when 133 cycle ringing current is impressed upon the relay 19, a filter comprising shunt inductance 22 and series capacity 23 and 24 is provided in the circuit RL_1, beyond the connection of the relay 19. This filter serves to prevent the transmission of 133 cycle ringing current over the circuit RL_1, beyond the relay 19, so that the relay 16 will not respond thereto. The circuit of the relay 16 is furthermore tuned to respond to 16 cycle current, thereby further preventing the possibility of a false operation of this relay, in response to a ringing signal received from the line ML. Since the presence of the filter 22, 23, 24 in the circuit RL_1 would prevent the transmission of 133 cycle ringing current from the amplifier RA_1 to the circuit TL_1 in response to the action of relay 16, relay 17, which is controlled by the relay 16, is so arranged as to short-circuit condenser 23, so that the filter is no longer effective to prevent the transmission of 133 cycle ringing current.

Further details of the invention may be understood from a detailed description of the operation. Talking currents incoming from the line L_1 are transmitted through the transformer 11 to the circuit TL_1 and are impressed upon the modulator M_1. High frequency carrier currents from the circuit 12 are now modulated by the modulator M_1 in accordance with the talking currents and the modulated high frequency currents are transmitted through the filter TF_1, amplified by the amplifier TA_1 and then transmitted through the filter TF_1' to the common circuit TL. These modulated carrier frequencies, together with modulated carrier frequencies from other channels simultaneously impressed upon the circuit TL, are transmitted through the transformer 10 to the main line ML. Modulated carrier currents incoming from the line ML, having the proper frequency, are selected by the filter RF_1 from the circuit RL and impressed upon the detector D_1. As a result of the reaction of the received carrier currents and the unmodulated carrier currents from the circuit 13 in the detector D_1, the low frequency talking currents appear in the output circuit of said detector, and are impressed upon the amplifier RA_1. After being amplified the low frequency currents are transmitted through the filter RF_1' to the main line L_1. The filter 22, 23, 24 and the bridged connection through the relay 19, being tuned to 133 cycles frequency, are not effective to substantially reduce the transmission of talking currents over the circuit RL_1.

Sixteen cycle ringing current incoming from the line L_1 actuates the relay 16, which opens the normally closed circuit of the relay 25. The latter relay releases its armature, thereby connecting ground to the circuits of relay 17 and 18, both of which are energized. Relay 18, at its extreme right hand front contact, short circuits the potentiometer in the input circuit of the amplifier RA_1 and at its inner right hand contact opens a short circuit about the secondary winding of transformer 15, so that the feedback 14 of the amplifier RA_1 becomes effective and the amplifier RA_1 now functions as a generator of 133 cycle currents, which are transmitted through the filter RF_1'. At its outer left hand contact relay 18 removes a short circuit from about the resistance 27, which is now included in the circuit RL_1. At its inner left hand contact relay 18 holds open the circuits of relays 20 and 21, to prevent any possibility of the false action of these relays, due to the response of the relay 19 to 133 cycle current, which might occur owing to some defect in the circuit. Relay 17 at its lower contact opens the circuit of relay 19 and short-circuits the condenser 23, so that 133 cycle current from the amplifier RA_1 may be freely transmitted over the circuit RL_1. Relay 17, at its upper front contact, connects a short circuit across the line L_1, thereby unbalancing the transformer 11, so that 133 cycle current is transmitted through said transformer to the outgoing circuit TL_1. The modulator M_1 now modulates the carrier frequency in accordance with 133 cycle current, and the modulated carrier currents are then transmitted through the filter TF_1, amplifier TA_1, filter TF_1', etc. to the main line ML.

Incoming carrier current modulated in accordance with 133 cycle ringing current is transmitted from the main line ML into the circuit RL and is selected through the filter RF_1 and impressed upon the detector D_1. As a result of the action of the detector, 133 cycle current appears in the output circuit thereof and is impressed upon the amplifier RA_1. After amplification by the amplifier RA_1, the 133 cycle current is transmitted through the low frequency filter RF_1' and flows through the circuit of relay 19, being substantially prevented from passing beyond the junction point of this relay with the circuit RL_1, by means of the filter 22, 23, 24. Relay 19, in response to 133 cycle ringing current, opens the circuit of relay 26, so that a circuit is completed from ground over the inner left hand back contact of relay 18, back contact of relay 26 and through the windings of relays 20 and 21 to battery. Relay 20 disconnects the line L_1 from the transformer 11 and applies 16 cycle ringing current over its front contacts to said line. Relay 21, at the same time, connects the artificial line or network N_1 to the transformer 11, to maintain the balance of the circuit, while the line L_1 is disconnected.

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 multiplex carrier system, a low frequency signaling circuit, a circuit for the transmission of alternating carrier currents, outgoing and incoming carrier channels for interconnecting said circuits, said channels including means for translating signaling currents into carrier currents, and vice versa, a relay responsive to ringing current incoming from the signaling circuit for applying signaling currents to the outgoing carrier channel associated with said circuit, a relay responsive to signaling currents transmitted from the carrier transmission circuit to the incoming carrier channel associated with said signaling circuit for aplying ring-

ing current to said signaling circuit, and means whereby when one of said relays is operated the other relay is prevented from operation.

2. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, outgoing and incoming carrier channels interconnecting said circuits, said channels including means for translating signaling currents into carrier currents, and vice versa, a relay responsive to ringing current incoming from said signaling circuit, means controlled by said relay for applying ringing currents to the outgoing carrier channel associated therewith, a relay responsive to ringing currents transmitted from said carrier transmission circuit to the incoming carrier channel associated with said signaling circuit, means controlled by said relay for applying ringing currents to said signaling circuit, and means whereby when one of said relays is operated the means to apply ringing current controlled by the other relay is rendered inoperative.

3. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, outgoing and incoming carrier channels for interconnecting said circuits, said channels including means for translating signaling currents into carrier currents, and vice versa, a relay associated with said signaling circuit for controlling the application of ringing current to the outgoing carrier channel associated with said signaling circuit, a relay associated with the incoming carrier channel interconnecting said signaling circuit and carrier transmission circuit, said relay controlling the application of ringing current to said signaling circuit, and means whereby when one of said relays is operated the operation of the other relay is prevented.

4. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, outgoing and incoming carrier channels for interconnecting said circuits, said channels including means for translating signaling currents into carrier currents, and vice versa, a relay associated with said signaling circuit, means controlled by said relay for applying ringing current to the outgoing carrier channel associated therewith, a relay associated with the incoming carrier channel interconnecting said signaling circuit and carrier transmission circuit, means controlled by said relay for applying ringing current to said signaling circuit, and means whereby when one of said relays is operated the application of ringing current under the control of the other relay is prevented.

5. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, outgoing and incoming carrier channels for interconnecting said circuits, said channels including means for translating signaling currents into carrier currents, and vice versa, a ringing responsive relay associated with said signaling circuit, a second relay controlled by said ringing responsive relay for applying ringing current to the outgoing carrier channel associated with said signaling circuit, a ringing responsive relay associated with the incoming carrier channel interconnecting said signaling circuit and carrier transmission circuit, a fourth relay controlled thereby for applying ringing current to the signaling circuit, and interlocking connections between said second and fourth relays whereby when one is actuated the operation of the other is prevented.

6. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, outgoing and incoming carrier channels for interconnecting said circuits said channel including means for translating signaling currents into carrier currents, and vice versa, a ringing responsive relay associated with said signaling circuit, a second relay controlled by said ringing responsive relay for applying ringing current to the outgoing channel associated with said signaling circuit, a ringing responsive relay associated with the incoming carrier channel interconnecting said signaling circuit and said carrier transmission circuit, a fourth relay controlled thereby, means whereby when said first-mentioned ringing relay is operated the operation of said second-mentioned ringing relay is prevented, and interlocking connections between said second and fourth relays whereby when one of said relays is actuated the operation of the other is prevented.

7. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, outgoing and incoming carrier channels for interconnecting said circuits, said channels including means for translating signaling currents into carrier currents, and vice versa, a ringing responsive relay associated with said signaling circuit for controlling the application of ringing current to the outgoing channel associated therewith, a ringing responsive relay associated with the incoming carrier channel interconnecting said signaling circuit and carrier transmission circuit, and means whereby when said first-mentioned ringing responsive relay is operated said second-mentioned ringing responsive relay is rendered inoperative.

8. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, outgoing and incoming carrier channels for interconnecting said circuits, said channels including means for translating signaling currents into

carrier currents, and vice versa, one of said channels including an amplifier, a relay responsive to ringing current incoming from said signaling line, means under the control of said relay whereby said amplifier is caused to supply ringing current to the carrier transmission circuit, a relay responsive to ringing current outgoing from the carrier transmission circuit said relay controlling the application of ringing current to the signaling circuit, and means whereby one of said relays is rendered ineffective when the other relay is operated.

In testimony whereof, I have signed my name to this specification this 23rd day of September, 1919.

JOHN DAVIDSON, JR.