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RINGING ARRANGEMENT FOR MULTIPLEX CIRCUITS.

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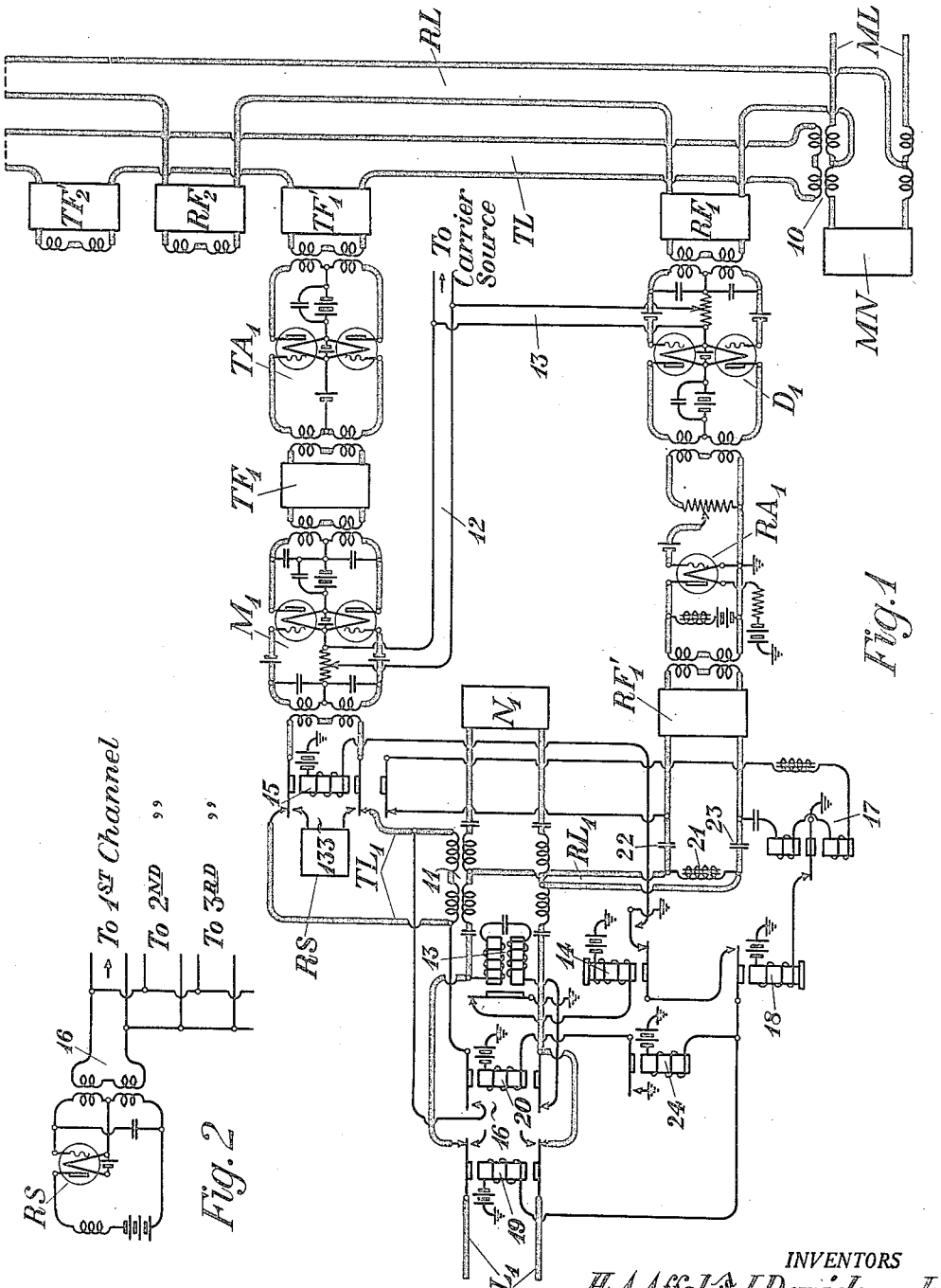

Fig. 1

Fig. 2

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RINGING ARRANGEMENT FOR MULTIPLEX CIRCUITS.

1,402,202. Specification of Letters Patent. Patented Jan. 3, 1922.

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To all whom it may concern:

Be it known that we, HERMAN A. AFFEL and JOHN DAVIDSON, Jr., residing at Brooklyn and Montclair, in the counties of Kings and Essex and States of New York and New Jersey, respectively, have invented certain Improvements in Ringing Arrangements for Multiplex Circuits, of which the following is a specification.

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

One of the features of the invention resides in the provision of a source of ringing current common to a plurality of outgoing carrier channels adapted to superpose the signals from a plurality of signaling circuits upon a common transmission circuit, said source of ringing current being so arranged that in response to a ringing signal transmitted over any signaling circuit, ringing current from said source will be applied to the corresponding outgoing channel.

A further feature 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 and a carrier system, said system of relays including a relay responsive to ringing current transmitted over the signaling circuit, and a second relay responsive to ringing current transmitted over the carrier transmission circuit, said ringing responsive relays being so arranged that when either one is operated the operation of the other will be prevented.

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 accompanying drawing, Figure 1 of which illustrates a circuit diagram embodying one form of the invention and Figure 2 of which illustrates the circuit arrangement of a form of oscillator which may be employed for supplying ringing current to the carrier system.

Referring to Figure 1, ML designates a main line or a 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.

patent to John R. Carson, No. 1343307, issued June 15, 1920. 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 patents above referred to and is designed to suppress voice frequencies and pass only 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 wall 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. patent to John R. Carson, No. 1343308, issued June 15, 1920. 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. 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 a 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 13, which through a slow acting relay 14 controls the relay 15 whereby 133 cycle ringing current from a source RS may be applied to the input circuit of the modulator M_1. The ringing source RS may be of any suitable source of ringing current, but is preferably a vacuum tube oscillator of a well known type such as is illustrated in Figure 2. This oscillator should be so arranged that it will supply 133 cycle oscillations to any one of a plurality of channels and consequently its output circuit 16 is provided with parallel connections leading to the several channels so that upon the operation of a relay such as 15 at any channel, the oscillations from the oscillator will be supplied to such channel.

In order to provide the necessary translation when ringing current is transmitted from the line ML to the line L_1 a relay 17 responsive to 133 cycle ringing current is bridged across the incoming channel or circuit RL_1, so that the detected ringing current from the detector D_1 will actuate said relay. Relay 17, through a slow acting relay 18, controls relays 19 and 20. Relay 19 controls the application of 16 cycle ringing current to the line L_1, while relay 20 opens the circuit of the ringing responsive relay 13 to prevent a false operation of said relay and short circuits the secondary winding of the transformer 11 to prevent 133 cycle ringing current transmitted over the incoming circuit RL_1 from being impressed upon the outgoing circuit TL_1. A filter comprising shunt inductance 21 and capacities 22 and 23 is established in the circuit RL_1 beyond the relay 17, this filter offering a high impedance to 133 cycle ringing current, so that the transmission of such ringing current to the transformer 11 is reduced and the major portion of the energy of the ringing current passes through the relay 17. The relay 15 is so arranged that when it is operated in response to ringing current flowing through the windings of the relay 13 the circuit of relay 17 is held open to prevent the false operation thereof. The relay 14, which is released at the same time, prevents the operation of relays 19 and 20.

Further details of the invention may be understood from a description of the operation which is as follows: 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 17, which is tuned to 133 cycles frequencies, 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 ringing responsive relay 13 which opens the circuit of the slow acting relay 14. Upon the armature of relay 14 falling off, ground is disconnected from back contact of relay 18 thereby preventing the false operation of said relays 19 and 24 if relay 18 should release. Ground is also connected to the windings of relay 15 which is operated. Relay 15, over its front contacts, applies ringing current from the oscillator RS to the input of the modulator M_1. At its lower contact relay 15 opens the circuit of ringing responsive relay 17 to prevent the false operation of said relay. The ringing current from the source RS applied to the modulator M_1 modulates the carrier current from the source 12 and the modulated carrier currents are then transmitted through the filter TF_1, amplified by the amplifier TA_1 and transmitted through filter TF'_1 and over the circuit TL to the main line ML. Carrier frequencies modulated in accordance with ringing current incoming from the line ML are transmitted into the common circuit RL and are selected by the filters such as RF_1, RF_2, etc., into the receiving channels. The modulated carrier currents transmitted through the filter RF_1 are impressed upon the input circuit of the detector D_1, where they react with unmodulated carrier currents of the circuit 13, so that 133 cycle ringing current is detected in the output circuit of the detector D_1. This ringing current is amplified by the amplifier RA_1 and transmitted through the filter RF'_1. Owing to the impedence of the filter 21, 22, 23, the 133 cycle ringing currents flow through the low impedance bridge including the ringing responsive relay 17, thereby actuating said relay. Relay 17 opens the circuit of the slow acting relay 18, which at its upper back contact completes the circuits of relays 19 and 24. Relay 19 over its front contacts applies 16 cycle ringing current to the line L_1, while relay 24 completes the circuit of relay 20. Relay 20 at its lower contact holds open the circuit of a ringing responsive relay 13 to prevent the false operation thereof and short circuits the secondary winding of the transformer 11 to prevent 133 cycle energy from the circuit RL_1 from being impressed upon the outgoing channel TL_1. Relay 24 is a slow release relay and is employed in the circuit to keep relay 20 operated sufficiently long after the release of relay 19 to prevent any capacity discharge from the line, due to ringing, from operating relay 13 and causing a false signaling.

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 plurality of signaling circuits, a circuit for the transmission of carrier currents, a plurality of outgoing carrier channels for simultaneously interconnecting said signaling circuits with said carrier transmission circuit, a source of ringing current common to said channels, and means responsive to ringing current incoming from any of said signaling circuits to apply ringing current from said source to the corresponding outgoing channel.

2. In a multiplex carrier system, a plurality of signaling circuits, a circuit for the transmission of carrier currents, a plurality of outgoing carrier channels for simultaneously interconnecting said signaling circuits with said carrier transmission circuit, a ringing responsive relay associated with each signaling circuit, a source of ringing current common to said carrier channels, and means responsive to the action of any of said ringing relays for applying ringing current from said source to the corresponding carrier channel.

3. In a multiplex carrier system, a plurality of signaling circuits, a circuit for the transmission of carrier currents, a plurality of outgoing carrier channels for simultaneously interconnecting said signaling circuits with said carrier transmission circuit, an oscillator common to said carrier channels and adapted to generate oscillations of ringing frequency, and means responsive to ringing current incoming from any one of said signaling circuits for applying ringing current from said oscillating source to the corresponding carrier channel.

4. In a multiplex carrier system, a signaling circuit, a circuit for the transmission

of carrier currents, outgoing and incoming carrier channels for interconnecting said circuits, a ringing responsive relay associated with said signaling circuit for controlling the application of ringing current to the outgoing carrier channel associated with said signaling circuit, a ringing responsive relay assocated 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 either one of said relays is operated the operation of the other relay is prevented.

5. In a multiplex carrier system, a plurality of signaling circuits, a circuit for the transmission of carrier currents, an outgoing and incoming carrier channel individual to each signaling circuit for interconnecting each signaling circuit with the carrier transmission circuit, a source of ringing current common to said outgoing channels, a source of ringing current common to said signaling circuits, a ringing responsive relay associated with each signaling circuit, a ringing relay associated with each incoming channel, means responsive to the operation of any one of said first mentioned relays for applying ringing current from said first mentioned common source to the outgoing carrier channel corresponding to the operated relay, means responsive to the operation of any one of said second mentioned relays for applying ringing current from said second mentioned source to the corresponding signaling circuit, and means whereby when either of the relays associated with a given signaling circuit and its corresponding incoming carrier channel is operated, the operation of the other relay is prevented.

6. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of carrier currents, outgoing and incoming carrier channels for interconnecting said circuits, a relay associated with said signaling circuit, a relay associated with the incoming carrier channel, means controlled by said first mentioned relay for applying ringing current to the outgoing carrier channel and opening the circuit of said second mentioned relay, and means controlled by said second mentioned relay for applying ringing current to the signaling circuit and for opening the circuit of said first mentioned relay.

7. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of carrier currents, an outgoing carrier channel having its input associated with said signaling circuit and its output associated with said carrier transmission circuit, an incoming carrier channel having its input associated with said carrier transmission circuit and its output associated with said signaling circuit, a ringing responsive relay associated with said signaling circuit, a ringing responsive relay associated with said incoming channel, a third relay controlled by said first mentioned ringing responsive relay for applying ringing current to the outgoing carrier channel, a fourth relay controlled by said second mentioned ringing responsive relay for applying ringing current to the signaling circuit, and means whereby, when said first mentioned ringing responsive relay is operated, said second mentioned ringing responsive relay and said fourth relay are prevented from operation, and said third relay is operated to apply ringing current to the outgoing channel, and means whereby when said second mentioned ringing responsive relay is operated said first mentioned ringing responsive relay and said third relay are prevented from operation and said fourth relay is actuated to apply ringing current to the signaling circuit.

8. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of carrier currents, an outgoing carrier channel having its input associated with said signaling circuit and its output associated with said carrier transmission circuit, an incoming carrier channel having its input associated with said carrier transmission circuit and its output associated with said signaling circuit, a ringing responsive relay associated with said signaling circuit, a ringing responsive relay associated with said incoming channel, a third relay controlled by said first mentioned ringing responsive relay for applying ringing current to the outgoing carrier channel, a fourth relay controlled by said second mentioned ringing responsive relay for applying ringing current to the signaling circuit, and means whereby when said first mentioned ringing responsive relay is operated said second mentioned ringing responsive relay and said fourth relay are prevented from operation and said third relay is operated to apply ringing current to the outgoing channel, and means whereby when said second mentioned ringing responsive relay is operated said first mentioned ringing responsive relay and said third relay are prevented from operation, the input of said outgoing channel is short circuited and said fourth mentioned relay is operated to apply ringing current to said signaling circuit.

9. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of carrier currents, outgoing and incoming carrier channels for interconnecting said circuits, said outgoing channel being associated with said signaling circuit through a balanced transformer and said incoming channel being connected to the midpoints of the windings of said transformer, a ringing responsive relay associated with said signaling circuit, a second ringing responsive

relay associated with said incoming carrier channel, means responsive to said first mentioned ringing responsive relay to apply ringing current to said outgoing channel at a point beyond said balanced transformer and means responsive to the operation of said second mentioned ringing responsive relay for applying ringing current to the signaling circuit at a point in said signaling circuit beyond said balanced transformer.

In testimony whereof we have signed our names to this specification this 24th day of September, 1919.

HERMAN A. AFFEL.
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