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J. DAVIDSON, JR

RINGING ARRANGEMENT FOR MULTIPLEX CIRCUITS

Filed Sept. 24, 1919

2 Sheets-Sheet 1

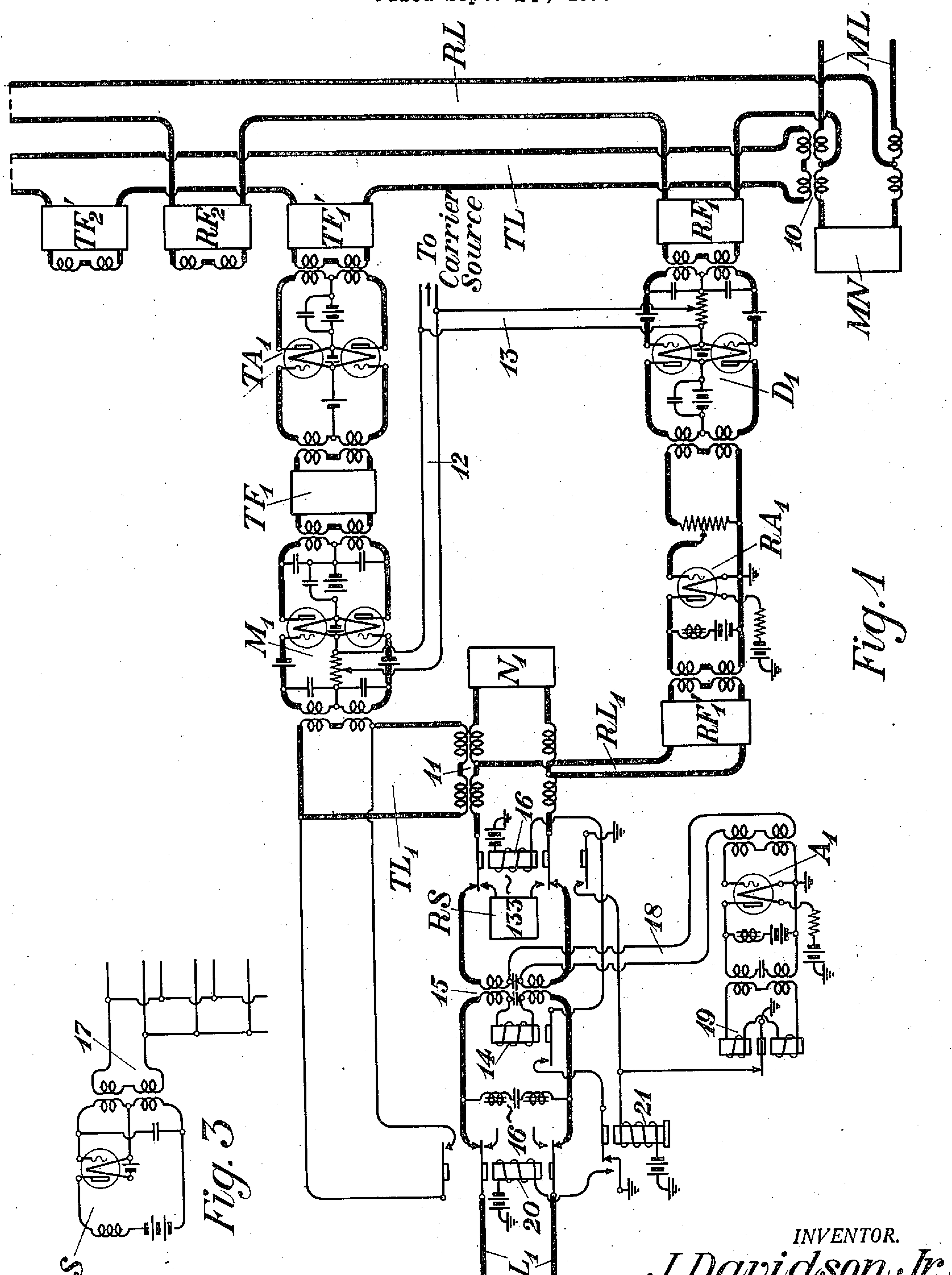

Fig. 1

Fig. 3

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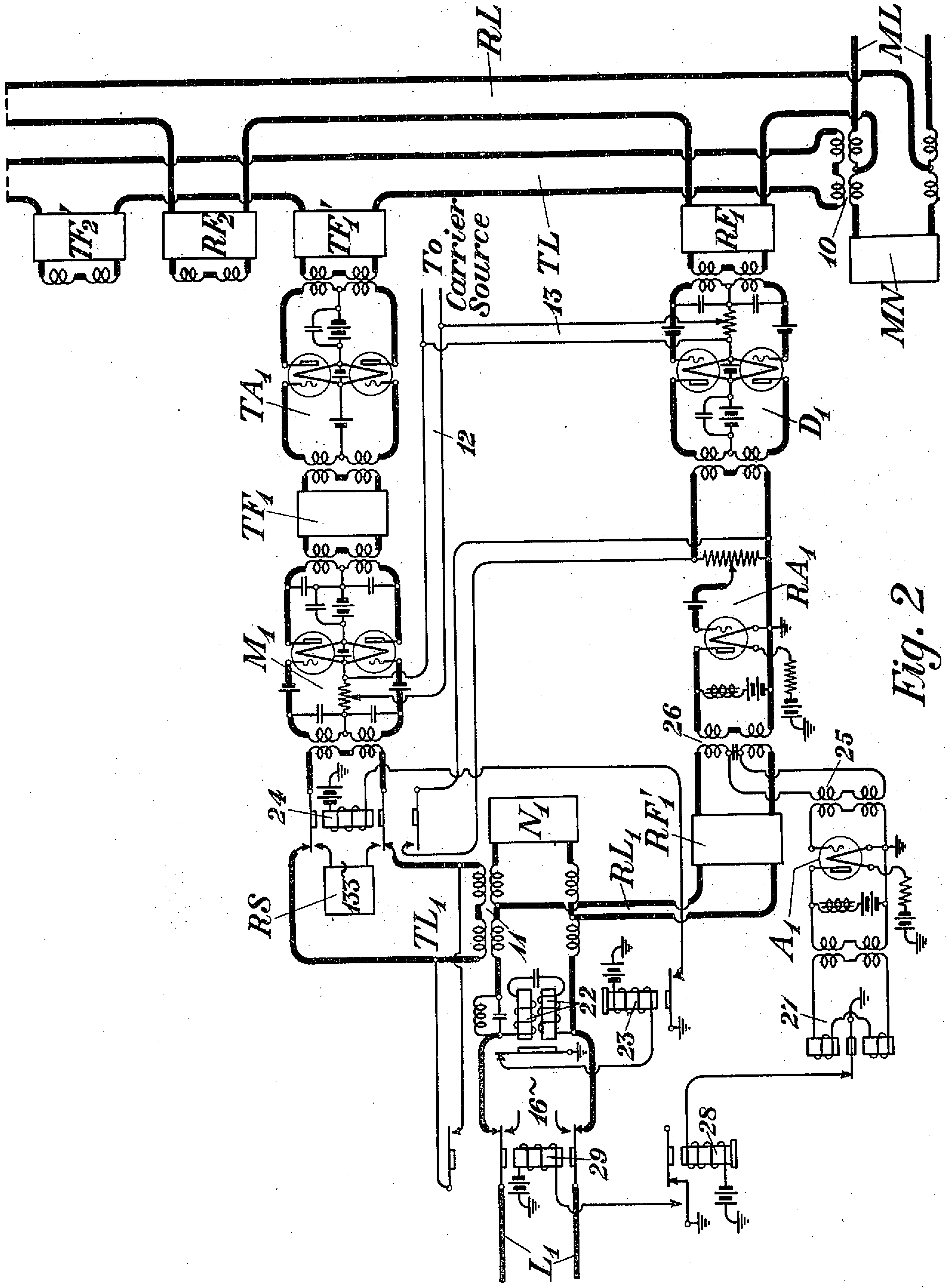

Fig. 2

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UNITED STATES PATENT OFFICE.

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RINGING ARRANGEMENT FOR MULTIPLEX CIRCUITS.

Application filed September 24, 1919. Serial No. 325,824.

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 this invention resides in the provision in a carrier system of a special amplifier for amplifying ringing currents received from the carrier transmission circuit, so that the amplification of said ringing currents may be adjusted to any desired degree independent of the amplification desired for telephonic or other signaling currents.

Another feature of the invention resides in the provision of an arrangement in the low frequency line or circuit for controlling the relaying of ringing currents in either direction at the junction point of the low frequency line or circuit with the carrier system.

These features, together with other features of the invention, which will more fully appear hereinafter, may be realized in accordance with the detailed arrangement set forth in the following description and illustrated in the accompanying drawing, Figures 1 and 2 of which constitute circuit diagrams of two embodiments of the invention and Figure 3 of which illustrates a circuit arrangement of a form of oscillator which may be employed for supplying ringing current.

In Figure 1 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 25, 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 a band filter of the type disclosed in the Campbell patents above referred to and is designed to suppress low frequencies and pass the 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 and a filter RF'_1. The amplifier RA_1 is preferably a vacuum tube amplifier as illustrated, and serves to amplify the detected signaling currents. The filter RF'_1 may 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 currents having a frequency of 133 cycles is adapted to 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 14 associated with the left hand winding of a transformer 15. Said relay 14 controls a relay 16, whereby ringing current from a source RS may be applied to the junction point of the line L_1 with the transformer 11, so that ringing current is transmitted through said transformer to the outgoing carrier channel TL_1. The 133 cycle ringing source RS may be of any well-known character, but is preferably an oscillating vacuum tube arrangement such as illustrated in Figure 3. For reasons of economy it is desirable that this ringing source should supply ringing current for a plurality of signaling circuits and consequently its outgoing circuit 17 is provided with parallel connections leading to the contacts of relays such as 16 for a number of different circuits.

In order to provide for relaying ringing currents incoming from the main line ML to the line L_1 a circuit 18 leading to the input of an amplifier A_1 is connected to the right hand winding of the transformer 15. The circuit 18 is turned by means of the condenser to respond to 133 cycles. A ringing responsive relay 19 is associated with the output circuit of the amplifier A_1 and controls the circuit of a relay 20 which applies 16 cycle ringing current to the line L_1 over its front contacts and simultaneously short circuits the outgoing channel TL_1 in order to prevent the transmission thereto of 133 cycle ringing current incoming from the channel RL_1. The relay 19 controls the relay 20 through a slow acting relay 21 which, when it functions to close the circuit of the relay 20, simultaneously opens the circuit of the relay 16 to prevent a false operation of said relay. The relay 16 is also so arranged that when actuated to apply ringing current to the channel TL_1 it prevents the de-energization of the slow acting relay 21, so that it is impossible to complete a circuit over the relay 20.

The operation of the arrangement of Figure 1 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.

Sixteen cycle ringing current incoming from the line L_1 actuates the ringing responsive relay 14 which at its lower front contact completes the circuit from ground over the normally closed contact of relay 21, front contact of relay 14 and through the winding of relay 16 to battery. Relay 16, at its front contacts connects 133 cycle ringing current to the right winding of the transformer 11 and said ringing current is transmitted through the transformer 11 to the outgoing carrier channel TL_1. The relay 16 at its lower front contact also connects ground to the winding of the slow acting relay 21, thereby preventing the said slow acting relay from being de-energized, due to the chattering of the contacts of the ringing responsive relay 19. Relay 21 is therefore held actuated and prevents false operation of the relay 20. The 133 cycle ringing current transmitted to the channel TL_1 is impressed upon the input of the modulator M_1 and modulates carrier current from the circuit 12. The modulated carrier current is then transmitted through the filter TF_1, amplified by the amplifier TA_1 and passed through the filter TF'_1 to the common circuit TL, from which it is transmitted through the transformer 10 to the main line ML.

Carrier currents modulated in accordance with ringing currents and transmitted over the line ML from a distant station, are impressed upon the common circuit RL and are selected through the filter RF_1 and impressed upon the input circuit of the demodulator D_1. The modulated carrier frequencies react with carrier currents from the circuit 13, so that 133 cycle ringing currents appear in the output circuit of the demodulator D_1. These 133 cycle ringing currents are amplified by the amplifier RA_1 and transmitted through the filter RF'_1 and over the contacts of the relay 16 to the circuit 18. From the circuit 18 the 133 cycle ringing currents are passed to the amplifier A_1 which amplifies the ringing currents so that the amplified currents actuate the ringing responsive relay 19. The actuation of this relay causes the de-energization of the slow acting relay 21 which disconnects ground from the circuit of the relay 16 to prevent a false operation and connects ground to the circuit of relay 20. Relay 20 is therefore energized and applies 16 cycle ringing currents over its front contacts to the line L_1. At the same time it short circuits the channel TL_1 at its upper front contact to prevent the transmission of 133 cycle ringing current from the circuit RL^1 to the circuit TL_1.

In the arrangement which is described it will be noted that the means for relaying the ringing currents in both directions is associated with the low frequency line L_1. A modification of the invention is illustrated in Figure 2, in which the 133 cycle ringing current is applied to and taken off from the carrier channels. In this figure a relay 22 responsive to 16 cycle ringing current is bridged across the line L_1 and controls, through a slow acting relay 23, a relay 24 which applies ringing current to the input connection of the modulator M_1 from the 133 cycle ringing source RS. The relay 24 is also arranged to short circuit the input winding of the amplifier RA_1 to prevent the transmission of 133 cycle ringing current from the detector D_1.

In order to provide for relaying ringing currents incoming from the main line ML, the circuit 25 leading to the input of the amplifier A_1 is associated with the secondary winding of a transformer 26. The amplifier A_1 is arranged to amplify 133 cycle ringing current coming from the detector D_1 and controls, through its output circuit, a relay 27 responsive to 133 cycle ringing current. Relay 27, through a slow acting relay 28, controls a relay 29, whereby 16 cycle ringing current is impressed upon the line L_1. Relay 29 also functions to short circuit the channel TL_1 to prevent 133 cycle ringing current from being impresed thereon from the incoming channel RL_1.

The operation of the arrangement of Figure 2 with respect to the transmission of telephone currents is similar to that described for Figure 1. Ringing current incoming from the line L_1, however, actuates the ringing responsive relay 22, thereby opening the circuit of the slow acting relay 23. The slow acting relay 23 thereby energizes relay 24 which connects 133 cycle ringing current from a source RS to the input connection of the modulator M_1. Ringing current applied to the modulator modulates the carrier current from the source 12 and the modulated currents are then transmitted through a filter TF_1, amplified by the amplifier TA_1 and transmitted through the filter TF'_1 to the common transmitting circuit TL, from which they are impressed upon the line ML through the transformer 10.

Carrier frequencies modulated by 133 cycle ringing currents at the distant station, after being transmitted over the line ML, are impressed upon the common receiving circuit RL and passed through the filter RF_1 to the input circuit of the demodulator D_1. Detected 133 cycle ringing currents now appear in the output circuit of said demodulator and after being amplified by the amplifier RA_1 are impressed through the circuit 25 upon the amplifier A_1, which is adjusted to secure proper amplification for 133 cycle currents to operate the relay 27. The operation of relay 27 opens the circuit of the slow acting relay 28, which in turn closes the circuit of the relay 29. Relay 29, over its front contacts, applies 16 cycle ringing current to the line L_1 and simultaneously short circuits the channel TL_1 over its upper front contact, thereby preventing 133 cycle ringing current from being transmitted through the channel RL_1 to the channel TL_1. It will be noted that when the relay 24 was actuated to apply 133 cycle current to the outgoing channel, said relay at its lower front contact closed a short circuit connection across the input of the amplifier RA_1 in the receiving channel RL_1. This prevented the possibility of the transmission of 133 cycle current over the channel TL_1 into the common circuit TL through the transformer 10 back into the common receiving circuit RL and through the receiving channel RL_1 to the relay 27, consequently no false operation of this relay can result.

By the provision of a supplemental amplifier for the ringing current received over the carrier transmission circuit, the received ringing current may be amplified to any desired degree suitable for operation of ringing responsive apparatus. The amplifier RA_1 is not satisfactory for this purpose, since when this amplifier is adjusted to secure the proper amplification for telephone currents it does not sufficiently amplify the received ringing currents.

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 signaling circuit, a circuit for the transmission of alternately carrier currents, an incoming carrier channel for interconnecting said circuits, said channel including means for translating carrier currents into signaling currents, an amplifier in said channel for amplifying signaling currents, another amplifier associated with said channel for amplifying ringing currents incoming from said carrier transmission circuit, and means responsive to ringing currents amplified by said second mentioned amplifier for applying ringing currents to said signaling circuit.

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, means responsive to ringing current incoming from said signaling circuit for applying ringing current to said outgoing channel, an amplifier in said incoming channel for amplifying signaling current, a second amplifier associated with said channel for amplifying ringing currents, and means responsive to amplified ringing currents incoming from said carrier transmission circuit for applying ringing currents to said signaling circuit.

3. 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, means associated with said signaling circuit and responsive to ringing current transmitted thereover for applying ringing current to said outgoing carrier channel, and means associated with said signaling circuit and responsive to ringing current incoming from said incoming carrier channel to apply ringing current to said signaling circuit.

4. 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, means associated with said signaling circuit and responsive to ringing currents incoming from said circuit to apply ringing currents to said outgoing carrier channel, means associated with said signaling circuit for amplifying ringing currents incoming from said incoming carrier channel, and means responsive to such amplified ringing currents for applying ringing current to said signaling circuit.

5. 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 associated with said signaling circuit and responsive to ringing current incoming from said signaling circuit to control the application of ringing current to said outgoing carrier channel, means associated with said signaling circuit to amplify ringing current incoming from said incoming carrier channel and a ringing responsive relay associated with said amplifying means for controlling the application of ringing current to said signaling circuit.

6. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, an incoming carrier channel interconnecting said circuits, said channel including means for translating carrier currents into signaling currents, and an amplifier associated with said signaling circuit for amplifying ringing currents incoming from said carrier channel.

7. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, an incoming carrier channel interconnecting said cir-

cuits, said channel including means for translating carrier currents into signaling currents, an amplifier for amplifying signaling currents incoming from said carrier channel and a second amplifier for amplifying ringing currents incoming from said channel.

8. In a multiplex carrier system, a signaling circuit, a circuit for the transmission of alternating carrier currents, an incoming carrier channel interconnecting said circuits, said channel including means for translating carrier currents into signaling currents, an amplifier for amplifying signaling currents incoming from said carrier channel, a second amplifier for amplifying ringing currents incoming from said carrier channel, and means controlled by said second mentioned amplifier for applying ringing currents to said signaling circuit.

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

JOHN DAVIDSON, Jr.