Oct. 2, 1923.

1,469,253

R. W. DEARDORFF

CARRIER TELEGRAPH CIRCUITS

Filed Oct. 21, 1920

3 Sheets-Sheet 1

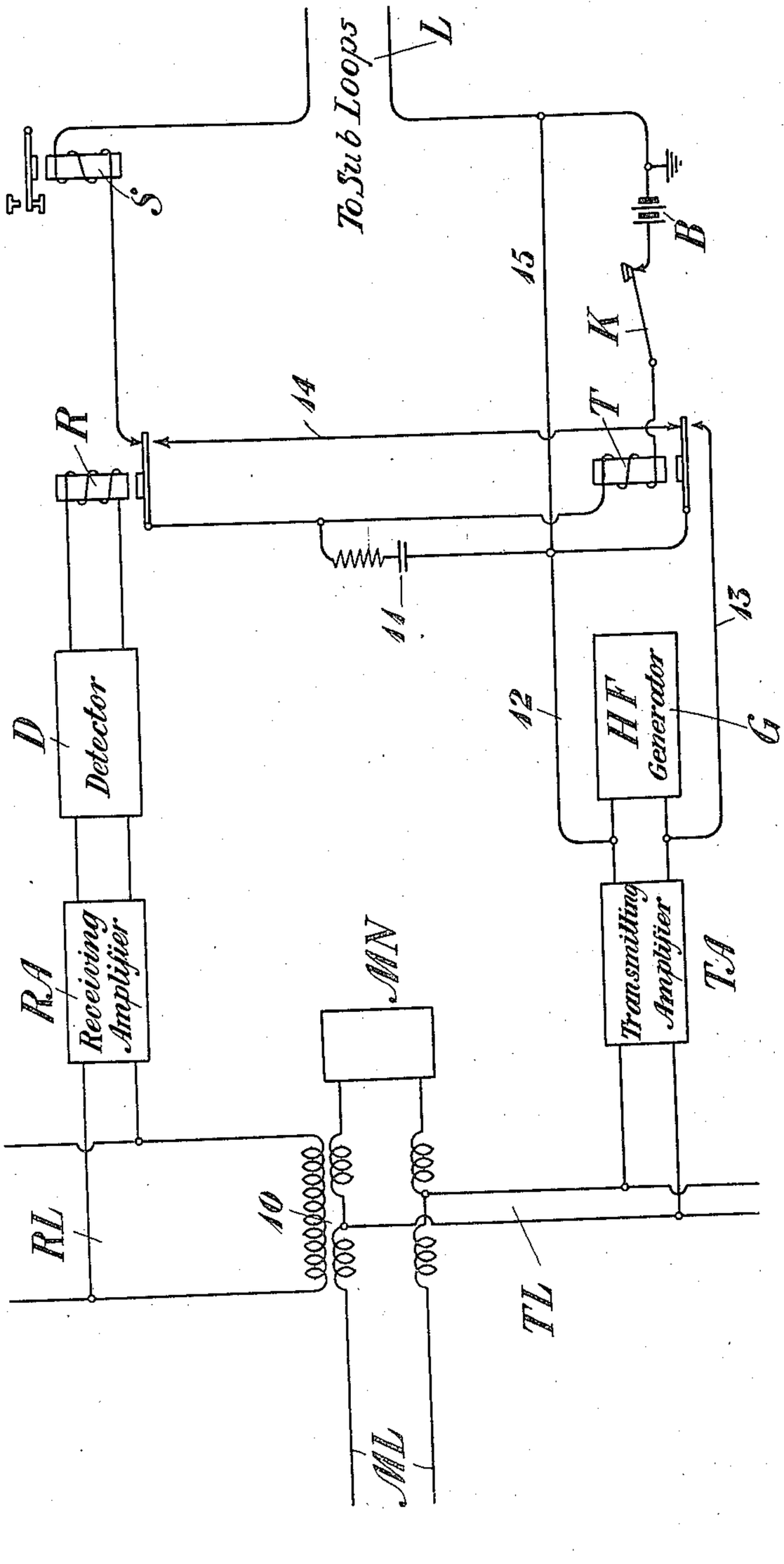

Fig. 1

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3 Sheets-Sheet 2

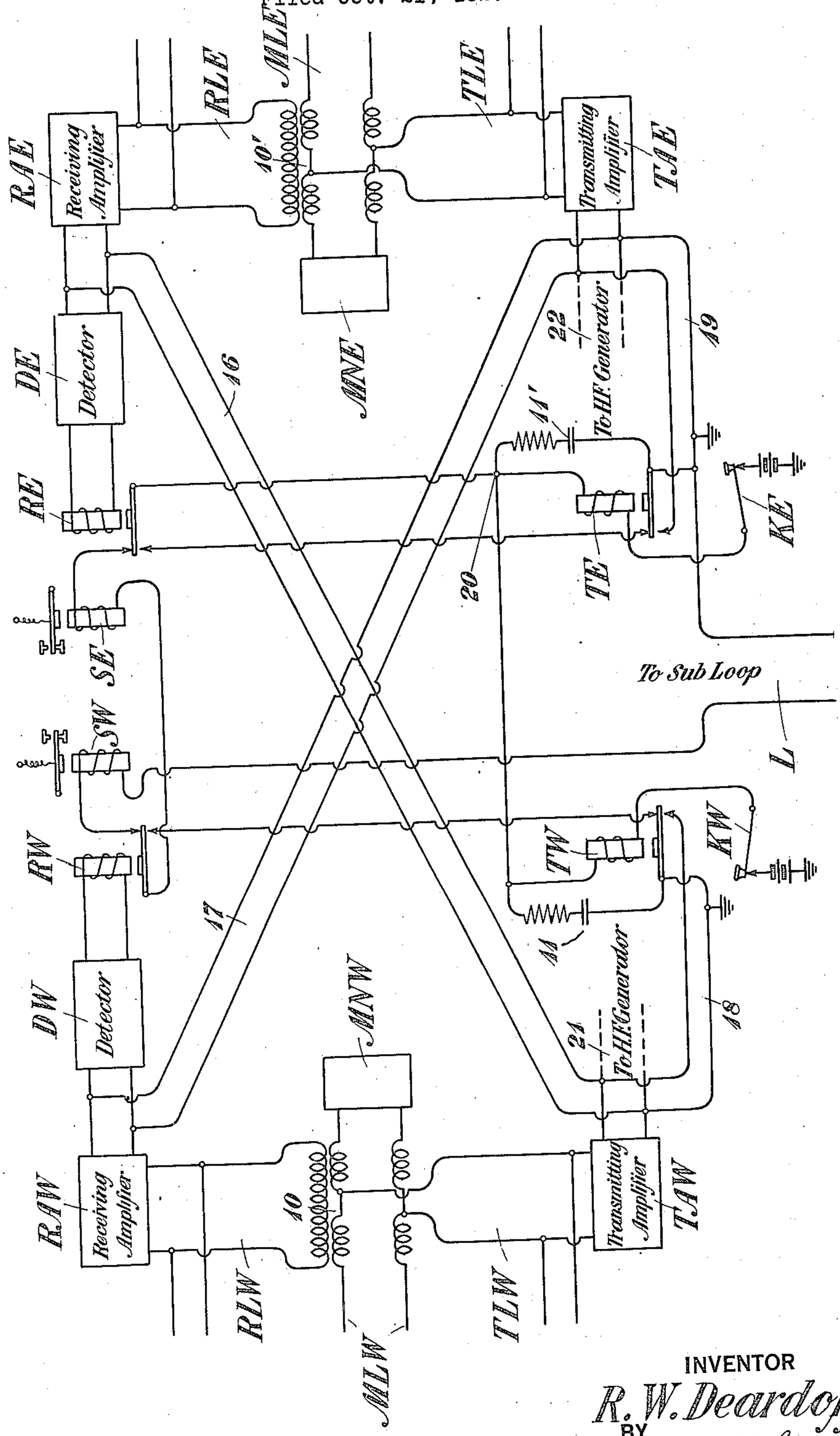

Fig. 2

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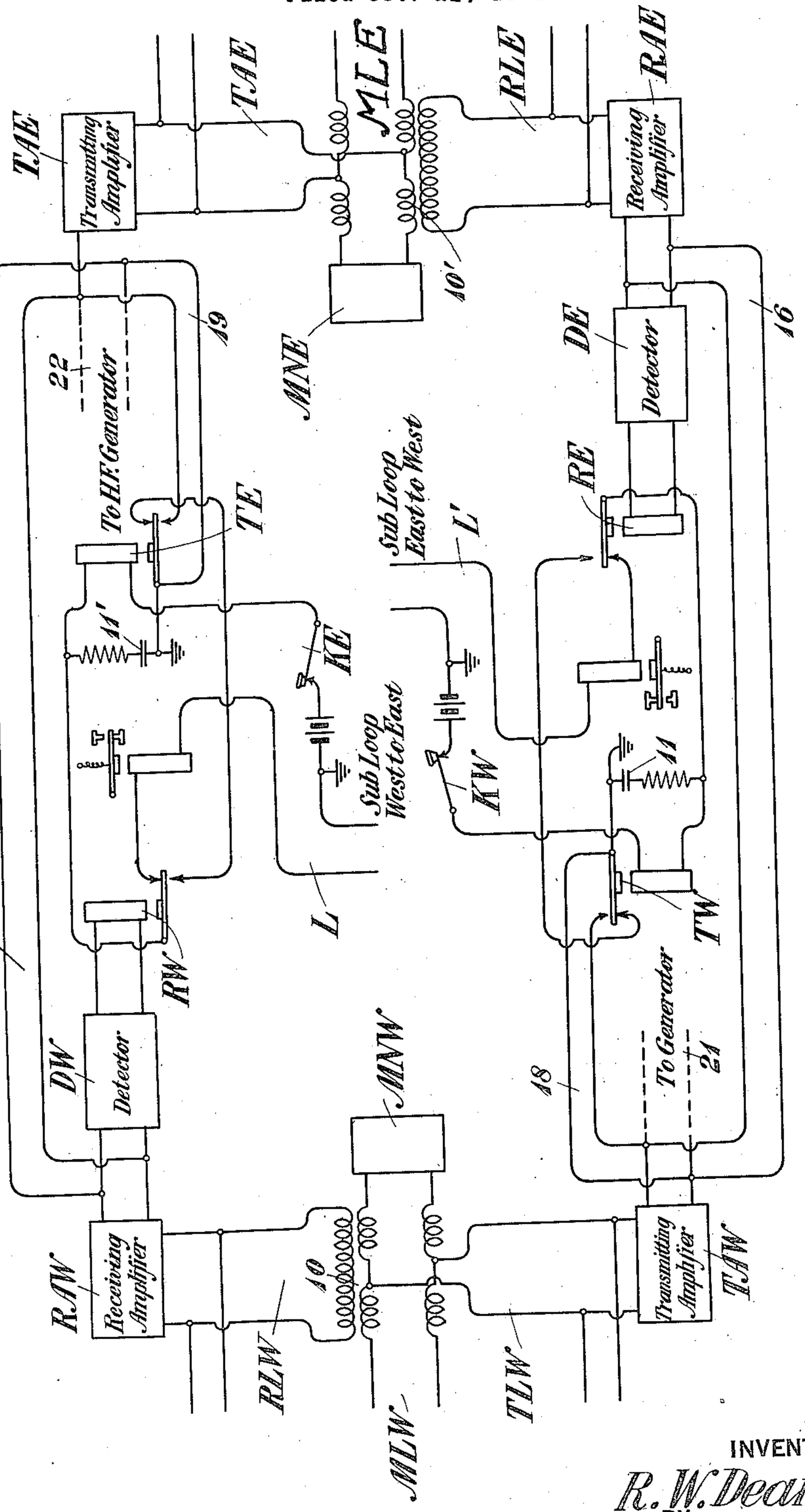
3 Sheets-Sheet 3

Fig. 3



INVENTOR

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ATTORNEY

Patented Oct. 2, 1923. 1,469,253

UNITED STATES PATENT OFFICE.

RALPH WARNER DEARDORFF, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

CARRIER TELEGRAPH CIRCUITS.

Application filed October 21, 1920. Serial No. 418,478.

To all whom it may concern:

Be it known that I, RALPH W. DEARDORFF, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Carrier Telegraph Circuits, of which the following is a specification.

This invention relates to signaling systems and more particularly to signaling systems in which telegraph signals are transmitted by means of carrier currents.

One of the objects of the invention is to produce a system in which an ordinary telegraph subscriber's circuit or loop may be associated with the channels of a carrier system. Another object of the invention is to provide an arrangement by which an ordinary telegraph subscriber's circuit or loop may be associated with the channels of a carrier repeater so that the telegraph subscriber may transmit messages over the carrier line sections interconnected by the repeater or may monitor the messages transmitted through the carrier repeater.

Other and further objects of the invention will be clear from the following description when read in connection with the accompanying drawing, Fig. 1 of which illustrates a simple circuit arrangement for interconnecting a telegraph subscriber's loop with the channels of the carrier system, Fig. 2 of which illustrates the subscriber's loop associated with a carrier repeater apparatus upon a half duplex basis, and Fig. 3 of which illustrates a similar arrangement adapted to be operated upon a full duplex basis.

Referring to Fig. 1, ML designates a main transmission line adapted for the transmission of carrier currents, said main line being associated by the carrier transmission channel TL and the carrier receiving channel RL. In order that the channels TL and RL may be substantially conjugate, the channel RL is associated with the line ML through a balanced transformer arrangement 10 of well known construction, the artificial line or network MN being provided for the purpose of balancing the main line ML. The carrier transmission channel TL includes an amplifier TA which may be of any well known construction such, for example, as a vacuum tube amplifier. A high frequency generator G is connected to the input circuit of the amplifier, said generator being any known means for producing oscillations of carrier frequency such, for example, as a vacuum tube oscillator. The carrier receiving channel includes a receiving amplifier RA which may be of any well known construction such as, for example, a vacuum tube amplifier, some known form of detecting arrangement D being associated with the output circuit of the amplifier. The detector D may, for example, be a vacuum tube detector having a receiving relay R associated with its output circuit.

L designates the usual form of subscriber's loop extending to a telegraph subscriber's station where it may be provided with a receiving sounder and sending key (not shown). Serially included in the loop is a sounder S, a contact of the receiving relay R, a transmitting relay T, a sending key K and a battery B. A circuit including a condenser 11 is arranged in shunt with the loop and in series with the transmitting relay T and the battery B, the purpose of this condenser being to provide a temporary holding current for the transmitting relay T during the operation of the receiving relay R as will be more fully described hereinafter. The contacts of the transmitting relay T are so arranged that the generator G may be short circuited over conductors 12 and 13 so that signals may be sent by interrupting the transmission of the carrier frequency. A conductor 14 extends from the normal contact of the transmitting relay T to the operating contact of the receiving relay R to provide a holding circuit for the transmitting relay T when the armature of the receiving relay R has been shifted in response to received signals thereby preventing the received signals from being transmitted back to the carrier circuit from which they originated.

The operation is as follows: a circuit is normally closed from battery B over the key K through the winding of the transmitting relay T, normal contact of the receiving relay R, sounder S and over the subscriber's loop back to battery B. The subscriber may signal by interrupting the loop through the manipulation of the key (not shown) at the subscriber's station or signals may be transmitted by interrupting the loop through the key K at the central office. The interruption of the loop causes the sounder S to respond to the transmitted signal by releas-

ing its armature and also causes the deenergization of the transmitting relay T. The interruption of the loop by removing the shunt to the condenser 11 changes the potential across said condenser so that a brief impulse of current flows through the winding of the transmitting relay T thereby preventing the transmitting relay from releasing for an instant. As soon as this brief impulse of current ceases the armature of the relay T is shifted to complete the short circuit of generator G over conductors 12 and 13. The carrier frequency which is normally transmitted over the main line ML to the distant station is therefore interruped and causes the response of the receiving apparatus thereat.

Signals may be transmitted from the distant station by interrupting the normal frequency transmitted to the receiving channel RL in a similar manner. The interruption of the carrier frequency causes the detector D to actuate the receiving relay R in a well known manner. The receiving relay R in shifting its armature opens the loop circuit L thereby causing response of the sounder S and the similar sounder at the subscriber's station. As soon as the armature of the receiving relay R leaves its normal contact the opening of the shunt to the condenser 11 changes the potential across the terminals of said condenser so that a temporary holding current flows through the winding of the relay T. This current is of sufficient duration to maintain relay T energized until the armature of the receiving relay rests upon the other contact when a holding circuit of the relay T will be completed from battery B over key K, winding of relay T, contact of relay R, conductor 14, normal contact of transmitting relay T and thence over the conductor 15 back to battery B. The response of the transmitting relay T to received signals is thereby prevented as the received signals will not be repeated back over the channels TL to the main line. At the end of the interruption of the carrier frequency the relay R is again deenergized and the circuit is restored to normal.

If while signals are being received as above described it is desired to interrupt the distant sending operator in transmitting a message to such operator for any reason the operator at the subscriber's station or an operator at the central station may hold the loop open for a considerable period by means of a key such as the key K thereby causing the transmitting relay T to short circuit the generator G in the manner already described, so long as the key is held open. The interruption of the loop prevents the relay R from transmitting signals to the loop during the break period.

The effect of the break signal at the distant station may be understood from a consideration of the result produced by a break signal transmitted from a distant station to the station illustrated. The interruption of the carrier frequency transmitted from the channel RT at the distant station causes the relay R to shift its armature as before. Should the loop at this moment be open during the operation of transmitting a space signal, the transmitting relay T will be deenergized and the holding circuit for said relay over the conductor 14 can not be closed. Upon the sending operator again closing the key the loop will still be open at the contact of the receiving relay R and the transmitting relay T will still remain deenergized. The sounders in the loop circuit will also remain deenergized and the sending operator either at the subscriber's station or at the central station will be informed that a break signal is being sent from the distant receiving station by the fact that the sounders do not respond to the transmitting key.

Fig. 2 illustrates an arrangement embodying the principles of Fig. 1 for associating a subscriber's loop with the carrier repeater apparatus of a carrier telegraph system upon a half duplex basis. In this figure MLE and MLW designate main line sections over which carrier current may be transmitted. Transmitting and receiving channels TLW and RLW are associated with main line MLW through a balanced transformer arrangement 10. Transmitting and receiving channels TLE and RLE are associated with the main line MLE through a balanced transformed 10', artificial balancing networks MNW and MME being provided for balancing the main line sections. Amplifiers TAW and TAE are included in the transmitting channels, these amplifiers being similar to the amplifiers described in Fig. 1. Similar amplifiers RAW and RAE are included in the receiving channels. In order to provide two-way transmission at the carrier frequency the output circuit of the amplifier RAE is directly connected over a circuit 16 with the input of the transmitting amplifier TAW thereby providing for carrier transmission from east to west. A similar circuit 17 connects the output of the amplifier RAW with the input of the amplifier TAE for providing carrier transmission from west to east.

Since the carrier is normally transmitted when signals are not being sent signals may be transmitted over the line section MLW by interrupting the carrier frequency, this being accomplished by short circuiting the conductor 16 over which the carrier is normally transmitted from the line MLE by the conductors 18. In a similar manner signals may be transmitted to the line section MLE by short circuiting the conductors 17 through the conductors 19. Transmitting

relays TE and TW are provided for controlling the short circuiting connections, these relays being connected in parallel in the subscriber's loop L.

In order that the signals transmitted in either direction over the main line sections may be received in the subscriber's loop detectors DE and DW are connected to the output circuit of the amplifiers RAE and RAW in parallel with the connections 16 and 17, respectively. These detectors may be of the type described in Fig. 1 and are provided with receiving relays RE and RW in their output circuits. The contacts of these receiving relays are serially included in the loop circuit and main line sounders SE and SW as well as transmitting keys KE and KW are associated with the loop for transmitting and receiving at the repeater station. The loop itself will extend to a subscriber's station where a transmitting key and receiving sounder (not shown) will be provided. Condensers 11 and 11′ are connected in shunt with the loop and in series with the transmitting relays TW and TE, respectively, for the purpose of providing temporary holding currents as described in connection with Fig. 1.

The operation is as follows: since the system is intended to operate on a half duplex basis, carrier signal transmission will only take place in one direction at a time. If transmission is taking place from east to west an incoming carrier current from the main line MLE will be transmitted to the amplifier RAE, then transmitted over conductors 16 to the amplifier TAW from which point, after being amplified, it will be transmitted over the channel TLW to the main line MLW. The detector DE is bridged across the transmission circuit just described at the output of the amplifier RAE and each time the carrier frequency is interrupted during the transmission of signals the receiving relay RE will be operated by the detector. The relay RE by shifting its armature opens the loop circuit which may be traced from battery in parallel over the keys KE and KW through the windings of the transmitting relays TE and TW to the junction point 20 and thence over the normal contact of receiving relay RE through the sounder SE, over the normal contact of receiving relay RW through the sounder SW and over the loop L to ground. The interruption of the loop causes the sounders SE and SW as well as the sounder at the subscriber's station to respond. Since the interruption of the loop changes the potential across the condensers 11 and 11′, however, a temporary holding current flows through the windings of the transmitting relays TE and TW so that these relays are not deenergized. As soon as the armature of the relay RE is shifted to its alternate contact the holding circuit is completed from ground over the normal contact of the transmitting relay TE over the alternate contact of receiving relay RE to the point 20 and thence in parallel through the windings of the relays TE and TW to battery. The transmitting relays are thereby prevented from responding to the received impulses.

Carrier transmission from west to east takes place in a similar manner, in this instance, however, passing through the amplifier RAW over the circuit 17 and through the amplifier TAE. The detector DW responds to the interruption of the carrier frequency so that for each interruption the receiving relay RW interrupts the loop circuit which will be bridged across the condensers 11 and 11′ and passes through the contacts of the receiving relays RE and RW in series. The sounders in the loop will respond as before but the interruption of the loop causes a temporary holding current to flow through the transmitting relays TE and TW from the condensers 11 and 11′. As soon as the armature of receiving relay RW is shifted to its alternate contact a holding circuit is provided from ground over the normal contact of the transmitting relay TW, over the alternate contact of receiving relay RW through the sounder SE, over the normal contact of receiving relay RE to point 20 and thence in parallel through the relays TE and TW to battery. If the operator at the subscriber's station desires to transmit, the loop circuit will be opened by means of the key at the subscriber's station. The opening of the loop causes the deenergization of the transmitting relays TE and TW thereby closing the short circuits over the conductors 18 and 19. If no signals are being transmitted in either direction over the main line sections, the carrier frequency will be transmitted continuously in both directions over the circuits 16 and 17. By closing the short circuits over the conductors 18 and 19, the carrier frequency to amplifiers TAW and TAE will be interrupted thereby causing the response of the receiving apparatus along either line.

Signals may be transmitted from the repeater station west only, by opening the key KW which deenergizes the transmitting relay TW only, since relays TE and TW are in parallel. Similarly signals may be transmitted east only by interrupting key KE. These operations do not open the loop and has no effect therein. If, while signals are being received at the repeater station, for example from east to west, it is desired to break in for any purpose, this may be done by opening the loop by means of the sending key at the subscriber's station. Transmitting relays TE and TW will be deenergized as before and relay TE, by short circuiting

the continuous carrier frequency which is transmitted through amplifiers RAW and TRE in series to the main line section MLE, while signals are being transmitted from east to west, will interrupt said frequency, thereby causing the receiving relay at the sending station to interrupt the loop at said station and prevent the sounders in said loop from responding to the operation of the key. After holding open the transmitting key at the repeating station, illustrated, for a sufficient interval to apprise the sending operator that it is desired to break in, signals may be transmitted from the repeater station both east and west in the usual manner, it being assumed that the distant sending operator has in the meantime ceased to manipulate the sending key.

If, while the operator of the loop L is transmitting, a break signal should be received from a station on the line MLE, for example, the receiving relay RE will shift its armature and hold it against its alternate contact during the continued interruption of the carrier frequency. Should the transmitting relays TE and TW be deenergized at this moment due to the transmission of a space signal, they cannot be again energized during the continuance of the break for the reason that the loop is open. Should they be energized at the time the break is received, they will be locked up over the alternate contact of the receiving relay RE due to the holding circuit already described. In either case the interruption of the loop prevents further response of the sounders to the manipulation of the sending key thereby apprising the sending operator that a distant station desires to break in.

If it is desired to operate the station illustrated in Fig. 2 as a terminal station for transmitting to and receiving from either line MLE or MLW, the repeater connection 16 and 17 may be opened and sources of carrier frequencies such as vacuum tube oscillators my be connected to the dotted line leads indicated at 21 and 22. The operation of receiving will then be the same as already described. The transmitting operation will also take place in a very similar manner to that already described the only difference being that the carrier frequencies supplied by the oscillators will be short circuited by connections 18 and 19, instead of the frequencies transmitted over the repeater connections 16 and 17.

Fig. 3 illustrates a similar arrangement except that the apparatus operates upon a full duplex basis. The repeater connections are the same as in Fig. 2, the essential difference being in the loop connections. Two loops L and L′ are provided, loop L being so arranged as to receive signals transmitted from west to east and to transmit signals from the loop east. The loop L′ is arranged to receive signals transmitted from east to west and to transmit signals from the loop west. The loop L includes a transmitting relay TE associated with the transmitting channel TAE of the repeater and the loop also passes through the normal contact of the receiving relay RW associated with the receiving channel RAW of the repeater. A condenser 11′ is connected in series with the transmitting relay TE and in shunt with the loop L to provide a temporary holding current for the transmitting relay to prevent it from responding to the receiving relay RW. Similarly the loop L′ includes the transmitting relay TW associated with the transmitting channel TAW of the repeater and a normal contact of the receiving relay RE associated with the receiving channel RLE of the repeater. A condenser 11 is connected in series with the winding of the transmitting relay TW and in shunt with the loop L′ to assist in preventing the transmitting relay TW from responding to the transmitting relay RE.

The operation is as follows: signals may be sent from the loop L to the east over the line MLE by interrupting the loop by means of the key KE or a similar key at the subscriber's station. The deenergization of the transmitting relay TE shifts its armature and closes a short circuit connection over conductors 19 so that the carrier frequency which is normally transmitted to the amplifier TAE over the circuit 17 will be interrupted thereby causing the response of the receiving apparatus associated with the line section MLE. When signals are being transmitted from line section LMW to line section LME through the repeater, the detector DW responds to the interruption of the carrier frequency so that the relay RW shifts its armature to its alternate contact thereby interrupting the loop and causing the sounders in the loop to respond. The interruption of the loop by changing the potential across the condenser 11′ causes a temporary holding current to flow through the transmitting relay TE until a locking circuit is provided for said relay when the armature of the transmitting relay RW rests upon its alternate contact, the locking circuit being from ground over the normal contact of transmitting relays TE and RW through the winding of the transmitting relay TE to battery.

In a similar manner signals may be transmitted from the loop L′ over the line section MLW while signals transmitted from the line section MLE to the line section MLW may be received in said loop. If desired the repeater connections 16 and 17 may be opened and carrier sources connected to the conductors 21 and 22 in each case. The repeater station may be used as a terminal

station for the line MLE, the loop L being used for transmission to the line MLE and the loop L′ being used for receiving said line simultaneously. The arrangement may also function as a terminal station for the line MLW in which case the loop L will be used for receiving from the line and the loop L′ for transmitting.

In all of the figures it will be understood that for multiplex operation additional carrier channels may be provided as indicated by the parallel leads associated with the illustrated channels. In this case the amplifiers will include tuned circuits to separate the frequencies assigned to the channels.

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 signaling system a carrier transmitting channel, a carrier receiving channel, a transmitting relay for controlling said carrier transmitting channel, a receiving relay associated with said carrier receiving channel and a telegraph circuit including said transmitting relay and the contacts of said receiving relay directly in series, and means to prevent the actuation of said transmitting relay when said receiving relay is operated in response to signals received in said receiving channel.

2. In a signaling system a carrier transmitting channel, a carrier receiving channel, a transmitting relay for controlling said transmitting channel, a receiving relay associated with said receiving channel, a telegraph circuit including the winding of said transmitting relay and the contacts of said receiving relay directly in series, a condenser associated with said transmitting relay and means whereby, when said telegraph circuit is opened by said receiving relay in response to signals received in said receiving channel the potential across said condenser is changed so that a temporary current flow occurs through the winding of said transmitting relay to prevent it from responding to the action of said receiving relay.

3. In a signaling system a carrier transmitting channel, a carrier receiving channel, a transmitting relay for controlling said transmitting channel, a receiving relay associated with said receiving channel, a telegraph circuit including the winding of said transmitting relay and the contacts of said receiving relay directly in series, a condenser in circuit with said transmitting relay, said condenser being shunted by a portion of said telegraph circuit including the contacts of said receiving relay and means whereby when said receiving relay opens said telegraph circuit in response to signals received in said receiving channel a holding circuit is closed through said transmitting relay, the opening of the telegraph circuit by said receiving relay producing a change in potential across the terminals of said condenser for providing a momentary holding current for said transmitting relay until its holding circuit is closed.

4. In a signaling system transmission line sections for the transmission of carrier currents, a repeater apparatus interconnecting said line sections comprising a receiving carrier channel associated with one line section, a transmitting carrier channel associated with the other line section, each channel including amplifying means, and said receiving channel including means for translating carrier currents into low frequency signaling current, a direct connection between the amplifying arrangements in said transmitting and receiving channels, a transmitting relay for controlling said transmitting channel, a receiving relay associated with said receiving channel, a low frequency telegraph circuit including the windings of said transmitting relay and contacts of said receiving relay directly in series, whereby carrier signals received in said receiving channel may be translated into low frequency signals and transmitted to said telegraph circuit and at the same time be transmitted as high frequency carrier currents to said transmitting channel, and whereby low frequency signals transmitted over said telegraph circuit may be translated into high frequency carrier currents transmitted over said transmitting channel, and means comprising a condenser for preventing said transmitting relay from responding to changes in the current condition of said telegraph circuit produced by said receiving relay.

5. In a signaling system transmission line sections for the transmission of carrier currents, a repeater apparatus interconnecting said line sections comprising a receiving carrier channel associated with one line section, a transmitting carrier channel associated with the other line section, each channel including amplifying means, and said receiving channel including means for translating carrier currents in a low frequency signaling current, a direct connection between the amplifying arrangements in said transmitting and receiving channels, a transmitting relay for controlling said transmitting channel, a receiving relay associated with said receiving channel, a low frequency telegraph circuit including the windings of said transmitting relay and contacts of said receiving relay directly in series, whereby carrier signals received in said receiving channel may be translated into low frequency signals and transmitted to said telegraph circuit and at the same time be trans-

mitted as high frequency carrier currents to said transmitting channel, and whereby low frequency signals transmitted over said telegraph circuit may be translated into high frequency carrier currents transmitted over said transmitting channel, and means comprising a condenser shunted by a portion of said telegraph circuit which includes the contacts of said receiving relay for preventing said transmitting relay from responding to the actuation of said receiving relay.

6. In a signaling system a pair of transmission line sections for transmitting carrier currents a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels associated with each line section and carrier transmitting channels associated with each line section, amplifying apparatus in each channel, means in each receiving channel for translating carrier currents into low frequency signaling currents, a direct connection between the amplifying means in the receiving channel associated with each line section and the amplifying means included in the corresponding transmitting channel associated with the other line section, transmitting relays for controlling said transmitting channels, receiving relays associated with said receiving channels and a telegraph circuit associated with said transmitting relays in such a manner that the contacts of both receiving relays will be directly in series with each other in said circuit.

7. In a signaling system a pair of transmission line sections for transmitting carrier currents, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels associated with each line section and carrier transmitting channels associated with each line section, amplifying apparatus in each channel, means in each receiving channel for translating carrier currents into low frequency signaling currents, a direct connection between the amplifying means in the receiving channel associated with each line section and the amplifying means included in the corresponding transmitting channel associated with the other line section, transmitting relays for controlling said transmitting channels, receiving relays associated with said receiving channels, and a telegraph circuit associated with said transmitting and receiving relays in such a manner that the contacts of said receiving relays will be directly in series with each other and in series with the windings of said transmitting relays.

8. In a signaling system a pair of transmission line sections for transmitting carrier currents, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels associated with each line section and carrier transmitting channels associated with each line section, amplifying apparatus in each channel, means in each receiving channel for translating carrier currents into low frequency signaling currents, a direct connection between the amplifying means in the receiving channel associated with each line section and the amplifying means included in the corresponding transmitting channel associated with the other line section, transmitting relays for controlling said transmitting channels, receiving relays associated with said receiving channels and a telegraph circuit associated with said transmitting and receiving relays in such a manner that the windings of said transmitting relays will be in parallel with each other.

9. In a signaling system a pair of transmission line sections for transmitting carrier currents, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels associated with each line section and carrier transmitting channels associated with each line section, amplifying apparatus in each channel, means in each receiving channel for translating carrier currents into low frequency signaling currents, a direct connection between the amplifying means in the receiving channel associated with each line section and the amplifying means included in the corresponding transmitting channel associated with the other line section, transmitting relays for controlling said transmitting channels, receiving relays associated with said receiving channels, and a telegraph circuit associated with said transmitting and receiving relays in such a manner that the windings of said transmitting relays will be in parallel with each other and the contacts of said receiving relays will be in series with each other and in series with the windings of said transmitting relays.

10. In a signaling system a pair of transmission line sections for transmitting carrier currents, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels associated with each line section and carrier transmitting channels associated with each line section, amplifying apparatus in each channel, means in each receiving channel for translating carrier currents into low frequency signaling currents, a direct connection between the amplifying means in the receiving channel associated with each line section and the amplifying means included in the corresponding transmitting channel associated with the other line section, transmitting relays for controlling said transmitting channels, receiving relays associated with said receiving channels, and a

telegraph circuit associated with said transmitting and receiving relays in such a manner that the windings of said transmitting relays will be in series with the contacts of said receiving relays.

11. In a signaling system a pair of transmission line sections for transmitting carrier currents, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels associated with each line section and carrier transmitting channels associated with each line section, amplifying apparatus in each channel, means in each receiving channel for translating carrier currents into low frequency signaling currents, a direct connection between the amplifying means in the receiving channel associated with each line section and the amplifying means included in the corresponding transmitting channel associated with the other line section, transmitting relays for controlling said transmitting channels, receiving relays associated with said receiving channels, a telegraph circuit associated with said transmitting and receiving relays in such a manner that the windings of said transmitting relays will be in series with the contacts of said receiving relays, and condensers associated with the windings of said transmitting relays in such a manner that a temporary holding current will be provided for said windings when the telegraph circuit is opened by the contacts of said receiving relays.

12. In a signaling system a pair of transmission line sections for transmitting carrier currents, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels associated with each line section and carrier transmitting channels associated with each line section, amplifying apparatus in each channel, means in each receiving channel for translating carrier currents into low frequency signaling currents, a direct connection between the amplifying means in the receiving channel associated with each line section and the amplifying means included in the corresponding transmitting channel associated with the other line section, transmitting relays for controlling said transmitting channels, receiving relays associated with said receiving channels, a telegraph circuit associated with said transmitting and receiving relays in such a manner that the windings of said transmitting relays will be in series with the contacts of said receiving relays, and condensers associated with the windings of said transmitting relays in such a manner that said condensers will be shunted by a portion of said telegraph circuit including the contacts of said receiving relays whereby a temporary holding current for said transmitting relays will be provided when the telegraph circuit is opened by the contacts of the receiving relays.

In testimony whereof, I have signed my name to this specification this 19th day of October 1920.

RALPH WARNER DEARDORFF.