April 15 , 1924. 1,490,166

L. ESPENSCHIED

CARRIER TELEGRAPH CIRCUITS

Filed Oct. 21, 1920 3 Sheets-Sheet 1

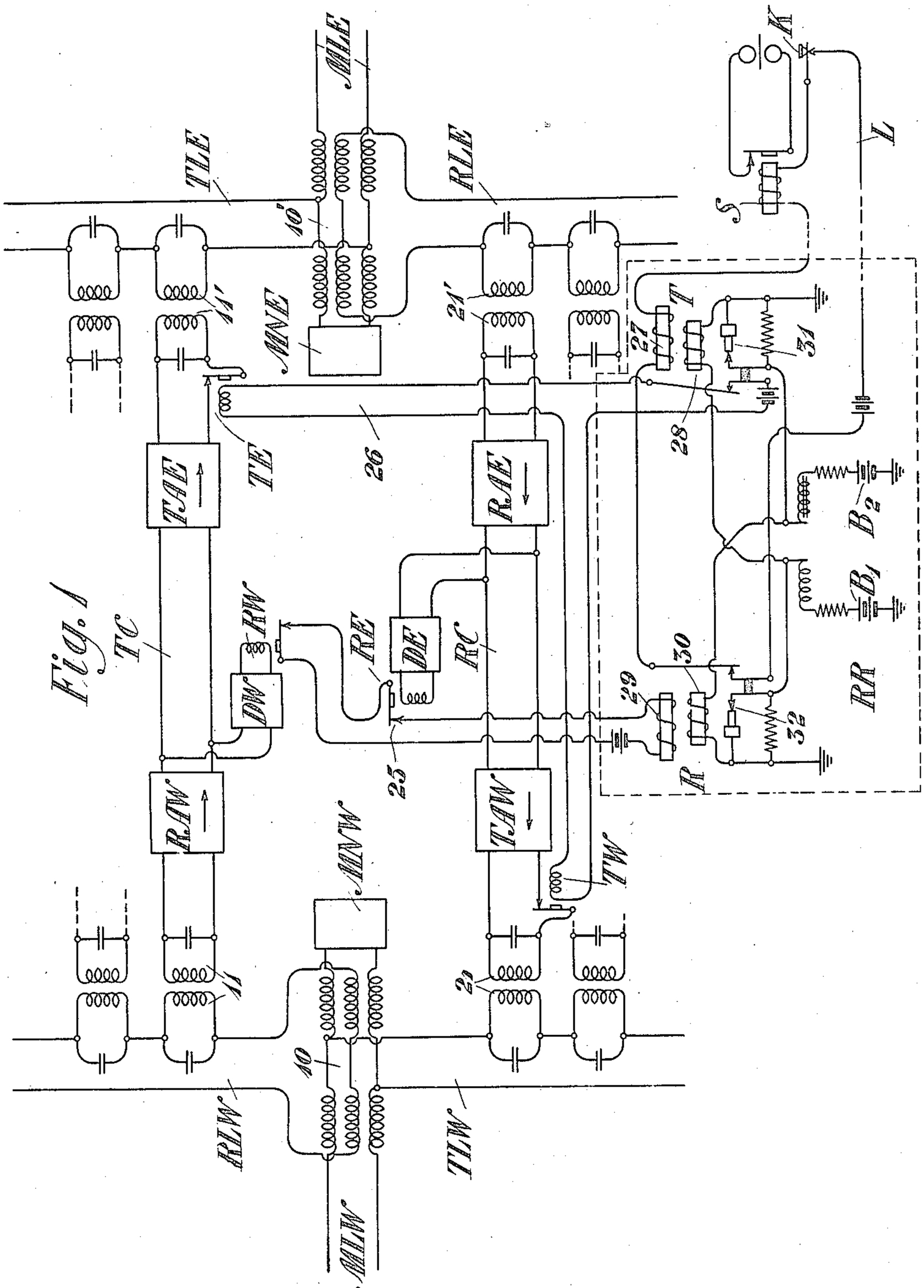

Fig. 1

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CARRIER-TELEGRAPH CIRCUITS

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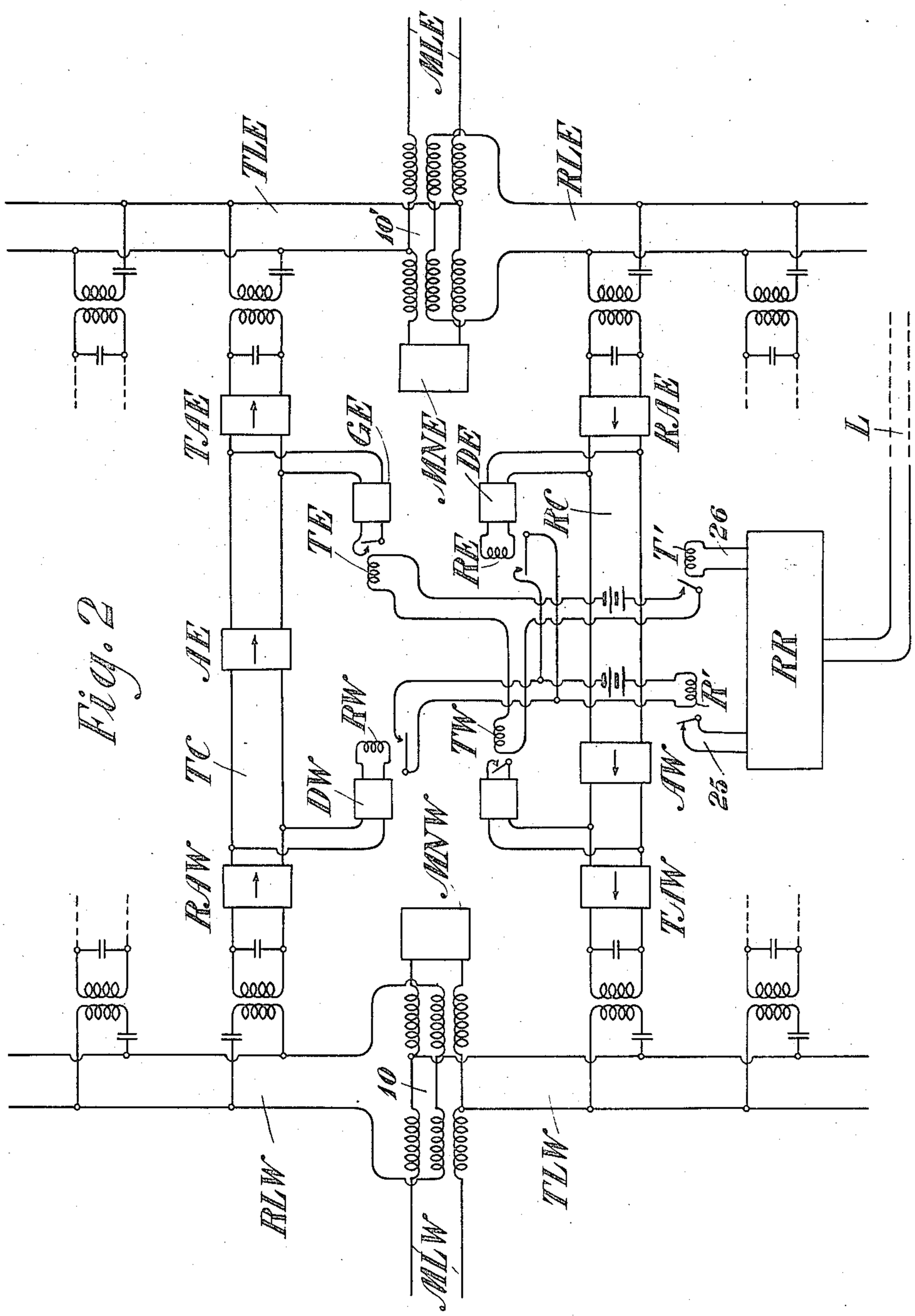

Fig. 2

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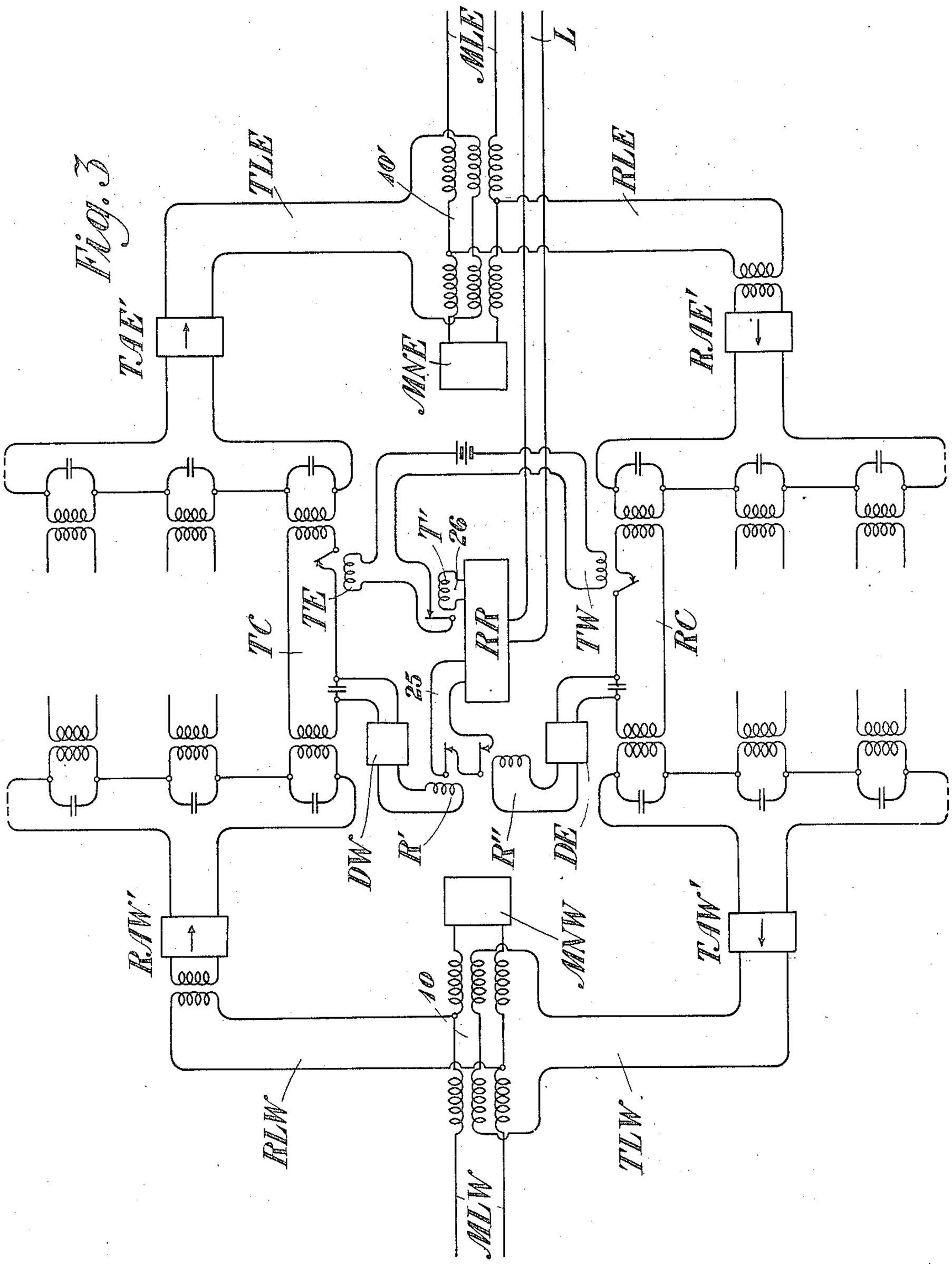
Fig. 3



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Patented Apr. 15, 1924. 1,490,166

UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF QUEENS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

CARRIER TELEGRAPH CIRCUITS.

Application filed October 21, 1920. Serial No. 418,481.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at Queens, in the county of Queens 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 systems in which telegraph signals are transmitted by means of carrier lines.

One of the objects of this invention is to provide means whereby a telegraph subscriber's circuit or loop may be associated with the channels of a carrier transmission circuit.

Another object of the invention is to provide means for interconnecting a telegraph subscriber's circuit or loop with a carrier transmission system in such a manner that signals may be transmitted from the loop to the carrier system, and from the carrier system to the loop, the loop being a low frequency circuit.

Another object of the invention is to provide means for associating a telegraph subscriber's circuit or loop with the transmitting and receiving channels of a carrier transmission system, said means being so arranged that signals transmitted to the loop will not be repeated from the loop back to the carrier transmitting channel associated with the circuit from which the signals originated.

Another object of the invention is to provide means for associating a local telegraph subscriber's circuit or loop with the carrier channels of a through telegraph repeater arrangement associating two carrier transmission line sections.

Another object of the invention is to provide an arrangement for associating a telegraph subscriber's circuit or loop with the oppositely directed carrier channels of a telegraph repeater arrangement interconnecting two carrier transmission line circuits, said means being so arranged that signals received by the loop will not be repeated back in the direction from which they came.

Other and further objects of the invention will be clear from the following description when read in connection with the accompanying drawing, Figures 1, 2 and 3 of which constitute circuit diagrams of the different embodiments of the invention.

Referring to Fig. 1, which shows a subscriber's loop associated with the channels of a carrier telegraph repeater in such a manner as to be operated on a half duplex basis, MLE and MLW respectively designate two line sections of a carrier transmission circuit. These line sections are interconnected by a repeater arrangement, in which each telegraph channel in a given direction is provided with separate amplifying means. The repeater apparatus comprises common transmitting and receiving circuits TLE and RLE, associated with the carrier line section MLE, and common transmitting and receiving circuits TLW and RLW associated with the transmission line MLW. In order to render the transmitting and receiving circuits conjugate with respect to each other, the receiving channels are associated with the main line sections MLW and MLE through balanced transformers 10 and 10′ of well-known construction, and the main line sections are balanced by artificial lines or networks MNW and MNE. Several repeater channels for transmitting from west to east may interconnect the receiving circuit RLW and the transmitting circuit TLE, the several repeating channels being associated with said circuits through selective devices such as sharply tuned circuits. But one channel TC transmitting from west to east is illustrated, said channel being associated with the receiving circuit RLW and the transmitting circuit TLE through tuned circuits 11 and 11′ respectively. Channel TC includes a transmitting amplifying arrangement TAE, and a receiving amplifying arrangement RAW, said amplifying arrangements being connected to operate in tandem with respect to through transmission. Each of these amplifying arrangements may be of any well-known character, such, for example, as a vacuum tube amplifier. Similarly, repeater channels for transmitting from east to west are associated by means of tuned circuits with the circuits RLE and TLW; but one such channel RC is illustrated, the channel RC being associated with the circuits TLW and RLE respectively by means of sharply tuned elements 21 and 21′. Transmitting and receiving amplifiers TAW and TAE are included

in the channel RC, and are arranged to operate in tandem for through transmission.

While it is not inherent in the system thus far described that transmission should not take place simultaneously in opposite directions as regards a given pair of channels, where the system is to be operated upon a half duplex basis it will be understood that, in practice, transmission takes place in a given direction in the one channel of a pair at one time; that is, if transmission is taking place from east to west signals will be transmitted only over the channel from east to west, the corresponding channel from west to east being idle so far as the transmission of signals is concerned. When the system is operated in this manner, it is possible to associate a subscriber's loop, such as the loop L, with the transmitting and receiving channels, so that the subscriber's loop will operate upon a half duplex basis to transmit and receive signals to and from the carrier repeater channels. In order that signals may be received by the loop L from either the channel TC or channel RC, detecting devices DW and DE are associated in bridges connected across the channels TC and RC respectively, between the receiving and transmitting amplifiers of each channel. These detecting devices may be of any well-known character, such, for example, as vacuum tube detectors. Relays RE and RW are connected in the output circuits of the detectors to control the local circuit 25 of the repeating apparatus RR, included within the dotted lines, said repeating apparatus functioning to repeat signals from the loop to the carrier channels and vice versa.

In order that signals may be transmitted from the loop to the carrier channels, a local circuit 26 is associated with the mechanical repeater RR, said circuit including transmitting relays TE and TW for opening and closing the output circuits of the transmitting amplifiers TAE and TAW respectively, or otherwise interrupting the transmission of carrier oscillations from the transmitting oscillators to the corresponding carrier line section. Since in practice, when a channel is idle, the carrier frequency is continuously transmitted, it will be seen that signals may be transmitted from the repeater point by merely interrupting the carrier frequency normally transmitted through the repeater in the manner indicated. The mechanical repeating apparatus RR comprises a transmitting relay T and a receiving relay R. The transmitting relay T controls the circuit 26 and includes a main coil 27 arranged in the loop circuit and an auxiliary or locking coil 28 controlled by the receiving relay R. The receiving relay R, upon the other hand, controls the continuity of the loop L and includes a main coil 29 in the circuit 25 and an auxiliary or locking coil 30 controlled by the transmitting relay T. The loop L may include a key K and a sounder S for transmitting and receiving signals from a subscriber's station.

Further details of the apparatus will be understood from the description of the operation, which is as follows: Normally, a carrier frequency is transmitted from east to west from the main line MLE through the transformer 10′ into the circuit RLE, and from thence through the tuned circuits 21′, amplifiers RAE and TAW, tuned circuits 21, and transmitting circuit TLW, to the line section MLW. Similarly, a carrier current is transmitted from west to east from the line section MLW, through the transformer 10, tuned circuits 11, amplifiers RAW and TAE, tuned circuits 11′, and transmitting circuit TLE, to the main line MLE. Signals may be transmitted over either of these channels in the appropriate direction by interrupting the carrier frequency in any well-known manner. If signals are being transmitted from west to east, the interruptions in the carrier frequency transmitted over the channel RC act through the detector DE to cause the detector RE to open the circuit 25, thereby deenergizing the coil 29 of the receiving receiving relay R of the mechanical repeater. The coil 30 of said relay has its winding short-circuited over the normally closed contact 31 of the transmitting relay T. Consequently, each time the coil 29 is deenergized, the armature of the relay R falls off and opens the loop circuit, deenergizing the sounder S in the loop and the coil 27 of the transmitting relay T. The sounder S, by responding to the interruptions of the loop, records or makes known the signals transmitted through repeater channel RC at the subscriber's station. At the same time that the coil 27 was deenergized, the normally closed contacts 32 of the relay R are opened, thereby removing a shortcircuit from about the coil 28 of the relay T, so that said coil is energized at the same time that the coil 27 is deenergized, thus preventing the armatures from falling off and transmitting the signal from the circuit 26 to the carrier channels. In a similar manner, if signals are transmitted from west to east, the detector DW responds to the interruptions of the carrier frequency, and causes the repeating apparatus RR to repeat the signals to the loop L.

Signals may be transmitted from the loop L in opposite directions to the line sections MLE and MLW respectively, by opening and closing the loop by means of the key K. Each time the loop is opened, the coil 27 of the transmitting relay T is deener-

gized, and, as the coil 28 of said relay is normally shortcircuited by the contact 32 of the receiving relay R, the armature of the transmitting relay T falls off each time the loop is interrupted and opens the circuit 26, causing the transmitting relays TE and TW to open the output circuits of the transmitting amplifiers TAE and TAW, thereby interrupting the continuous carrier frequency normally transmitted in opposite directions.

If, while carrier signals are being transmitted through the carrier repeater in either direction, the operator having control of the loop circuit desires to break in or interrupt for the purpose of transmitting, the operator may transmit a break signal by holding open the key K for an interval, thereby causing the armature of the transmitting relay to fall off during the continuance of the break. As a consequence, the transmitting relays TE and TW interrupt the carrier frequency normally transmitted to each line section from the channel TC and RC respectively. The continued interruption of the carrier frequency transmitted over the main line sections apprises the operators associated with the line sections that another operator desires to break in. The falling off of the armature of the transmitting relay T by interrupting contact 31 removes the shortcircuit from about the winding 30, and therefore prevents the armature of the receiving relay R from responding to interruptions of the circuit through the coil 29, due to receiving signals. If, while the operator associated with the loop L is transmitting, an operator at a distant point desires to break in, the break signal will be evidenced by an interruption of the carrier frequency; for example, if an operator associated with the line section MLW desires to break in, the carrier frequency transmitted through the channel TC will be interrupted, and the detector DW, acting through the relay RW, opens the circuit 25, thereby causing the armature of the relay R to fall off and hold open the loop circuit during the continuance of the break. The operator who is sending by opening and closing the loop circuit, becomes aware that a break signal is being received, by the fact that the sounder S no longer responds to the interruption of the loop.

Fig. 2 shows an arrangement somewhat similar to that of Fig. 1, except that the system operates as an open circuit system as distinguished from the closed circuit system shown in Fig. 1; that is, the signals are transmitted not by interrupting a normally transmitted carrier frequency, but by transmitting groups or trains of carrier oscillations. The loop itself will be operated, as before, upon a closed circuit basis, so that signals from the loop will be transmitted by opening the loop. The carrier apparatus is, therefore, arranged so that when the loop is open, the carrier frequency will be transmitted. Similarly, the apparatus is so arranged that when the carrier frequency is received, the loop is interrupted.

A mechanical repeater apparatus RR is merely indicated schematically in Fig. 2, but will be identical with that shown in Fig. 1. The circuit 25 leading to the receiving relay of the repeater RR is normally closed under the control of a relay R′, which is deenergized during periods when the carrier current is not being received. The circuit of the relay R′ is jointly controlled by the receiving relays RE and RW associated with the detectors DE and DW. These receiving relays, when deenergized, maintain the circuit of the relay R′ open, but if either relay is energized by a detected train of carrier oscillations, the circuit of the relay R′ will be closed.

Since the carrier frequency is not normally transmitted through the carrier repeater channels, it is not possible to control the transmission of signals from the loop by interrupting the continuity of the repeater channels. Consequently, in the system of Fig. 2, the repeater channels remain intact, but sources of carrier frequency, such as GE and GW, are bridged across the channels TC and RC respectively on the input sides of the transmitting amplifiers TAE and TAW. These sources may be of any well-known character, but are preferably vacuum tube oscillators. The oscillators are normally inoperative, but are arranged to generate oscillations when their circuits are closed, by means of the normally deenergized transmitting relays TE and TW, which are included serially in a local circuit, which is held open by the normally energized relay T′ in the circuit 26 controlled by the transmitting relay T of the mechanical repeater RR. Additional amplifiers AE and AW may be provided in the carrier channels, if desired, for the purpose of securing additional amplification for through transmission.

The operation is as follows: Each time the loop L is opened in transmitting signals, the relay T′ will be deenergized by means of the transmitting relay T of the repeating apparatus RR, thereby closing the circuit of the transmitting relays TE and TW. These relays maintain closed the circuits of the oscillators GE and GW to transmit trains of oscillations corresponding to the interruptions of the loop L, through the amplifiers TAE and EAW to the line sections MLE and MLW respectively. If signals are being transmitted from west to east through the carrier channel TC, each time a train of oscillations passes through the channel TC the detector DW operates to en-

ergize the relay RW, which in turn closes the circuit of the relay R'. The relay R', by opening the circuit 25, causes the receiving relay R to repeat the signal to the loop L by opening the loop. In a similar manner, signals transmitted from east to west through the channel RC cause the relay RE to close the circuit of the relay R', which in turn operates through the receiving relay of the repeater RR to open the loop L.

Fig. 3 illustrates a closed circuit system, somewhat similar to that of Fig. 1, except that the frequencies of the several carrier channels transmitted in a given direction are amplified by a common amplifier. For this purpose common amplifiers RAW' and RAE' are associated with common receiving circuits RLW and RLE and common transmitting amplifiers TAE' and TAW' are associated with the common transmitting circuits TLE and TLW. The carriers frequencies assigned to the channels are separated into the proper channels, such as TC and RC, through tuned circuits arranged in the output sides of the receiving amplifiers and the input sides of the transmitting amplifiers. The circuit 25 of the mechanical repeater RR is maintained normally closed by relays R' and R'' controlled by the detectors DW and DE respectively. The relays R and R' are normally energized when carrier currents are being transmitted through the channels TC and RC respectively, but, upon the interruption of transmission of the carrier frequency through either channel, the corresponding relay is deenergized and opens the circuit 25 to in turn transmit the signal to the loop L by opening the loop. The relay T' in the circuit 26 of the mechanical repeater RR is normally energized, and maintains the circuit of the transmitting relays TE and TW normally closed. When the loop is interrupted, however, in transmitting signals, the relay T' is deenergized through the action of the mechanical repeater, so that the transmitting relays TE and TW open the channels TC and RC to interrupt the transmission of the normally transmitted carrier frequency to the line sections MLE and MLW respectively.

It will be obvious that the general principles herein described 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, two transmission line sections over which carrier currents may be transmitted, a carrier repeater arrangement for interconnecting the ends of said line sections, said repeater arrangement comprising carrier transmitting and carrier receiving channels associated with each line section, arrangements for interconnecting the carrier transmitting channel associated with each line section with the carrier receiving channel associated with the opposite line section, said arrangements including means for repeating carrier frequencies incoming from one line section through the interconnected channels to the other line section at the same frequency, means associated with at least one of said receiving channels for translating carrier currents into low frequency signals, a low frequency telegraph circuit, and a mechanical telegraph repeater for associating said telegraph circuit with said translating means, whereby carrier signals transmitted from one line section to the other through said carrier repeater arrangement may be repeated to said low frequency telegraph circuit as low frequency signals.

2. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a carrier repeater arrangement for interconnecting the ends of said line sections, said repeater arrangement comprising carrier transmitting and carrier receiving channels associated with each line section, arrangements for interconnecting the carrier transmitting channel associated with each line section with the carrier receiving channel associated with the opposite line section, said arrangements including means for repeating carrier frequencies incoming from one line section through the interconnected channels to the other line section at the same frequency, means associated with each of said receiving channels for translating carrier currents into low frequency signals, a low frequency telegraph circuit, and a mechanical repeating arrangement for associating said telegraph circuit with said translating means whereby carrier signals transmitted from one line section to the other through said carrier repeater ararrangement may be repeated to said low frequency telegraph circuit as low frequency signals.

3. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a carrier repeater for interconnecting the ends of said line sections, said repeater arrangement comprising transmitting carrier channels and receiving carrier channels associated with each line section, arrangements for interconnecting the carrier transmitting channel associated with each line section with the carrier receiving channel associated with the opposite line section, said arrangements including means for repeating carrier frequencies incoming from one line section through the interconnected channels to the other line section at the same frequency, means associated with at least one of said transmitting channels for translating low frequency signals into carrier currents, a

low frequency telegraph circuit and a mechanical telegraph repeater for interconnecting said telegraph circuit and said transmitting channel whereby the telegraph signals from said low frequency circuit may be transmitted over said carrier channel.

4. In a signaling system, two transmission line sections, over which carrier currents may be transmitted, a carrier repeater for interconnecting the ends of said line sections, said repeater arrangement comprising transmitting carrier channels and receiving carrier channels associated with each line section, arrangements for interconnecting the carrier transmitting channel associated with each line section with the carrier receiving channel associated with the opposite line section, said arrangements including means for repeating carrier frequencies incoming from one line section through the interconnected channels to the other line section at the same frequency, means associated with at least one of said transmitting channels for translating low frequency signals into carrier currents, a low frequency telegraph circuit and a mechanical telegraph repeater for interconnecting said circuit with said transmitting channels whereby signals transmitted over said telegraph circuit may be repeated to said carrier channels.

5. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a carrier repeater arrangement for interconnecting the ends of said line sections, said repeater arrangement comprising carrier transmitting channels and carrier receiving channels associated with each line section, arrangements for interconnecting the carrier transmitting channel associated with each line section with the carrier receiving channel associated with the opposite line section, said arrangements including means for repeating carrier frequencies incoming from one line section through the interconnected channels to the other line section at the same frequency, means associated with at least one of said receiving channels for translating carrier currents into low frequency signals, means associated with at least one of said transmitting channels for translating low frequency signals into carrier currents, a low frequency telegraph circuit and a two-way mechanical telegraph repeater for interconnecting said telegraph circuit with said translating means whereby carrier signals transmitted from one line section to the other through said carrier repeater arrangement may be repeated to said telegraph circuit as low frequency signals, and whereby low frequency signals transmitted over said telegraph circuit may be repeated to said transmission line section as carrier currents.

6. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a carrier repeater arrangement for interconnecting the ends of said line sections, said repeater arrangement comprising carrier transmitting channels and carrier receiving channels associated with each line section, means for interconnecting the carrier receiving channel of each line section with the carrier transmitting channel of the opposite line section, means associated with at least one of said receiving channels for translating carrier currents into low frequency signals, means associated with at least one of said transmitting channels for translating low frequency signals into carrier currents, a low frequency telegraph circuit and a two-way mechanical telegraph repeater for interconnecting said telegraph circuit with said translating means, whereby carrier signals transmitted from one line section to the other through said carrier repeater arrangement may be repeated to said telegraph circuit as low frequency signals, and whereby low frequency signals transmitted over said telegraph circuit may be repeated to said transmission line sections as carrier currents, and means associated with said mechanical telegraph repeater for preventing received signals repeated thereby from actuating the transmitting element of the repeater to repeat the signals back in the direction from which they originated.

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

LLOYD ESPENSCHIED.