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R. W. DEARDORFF

CARRIER TELEGRAPH CIRCUITS

Filed Oct. 21, 1920 2 Sheets-Sheet 1

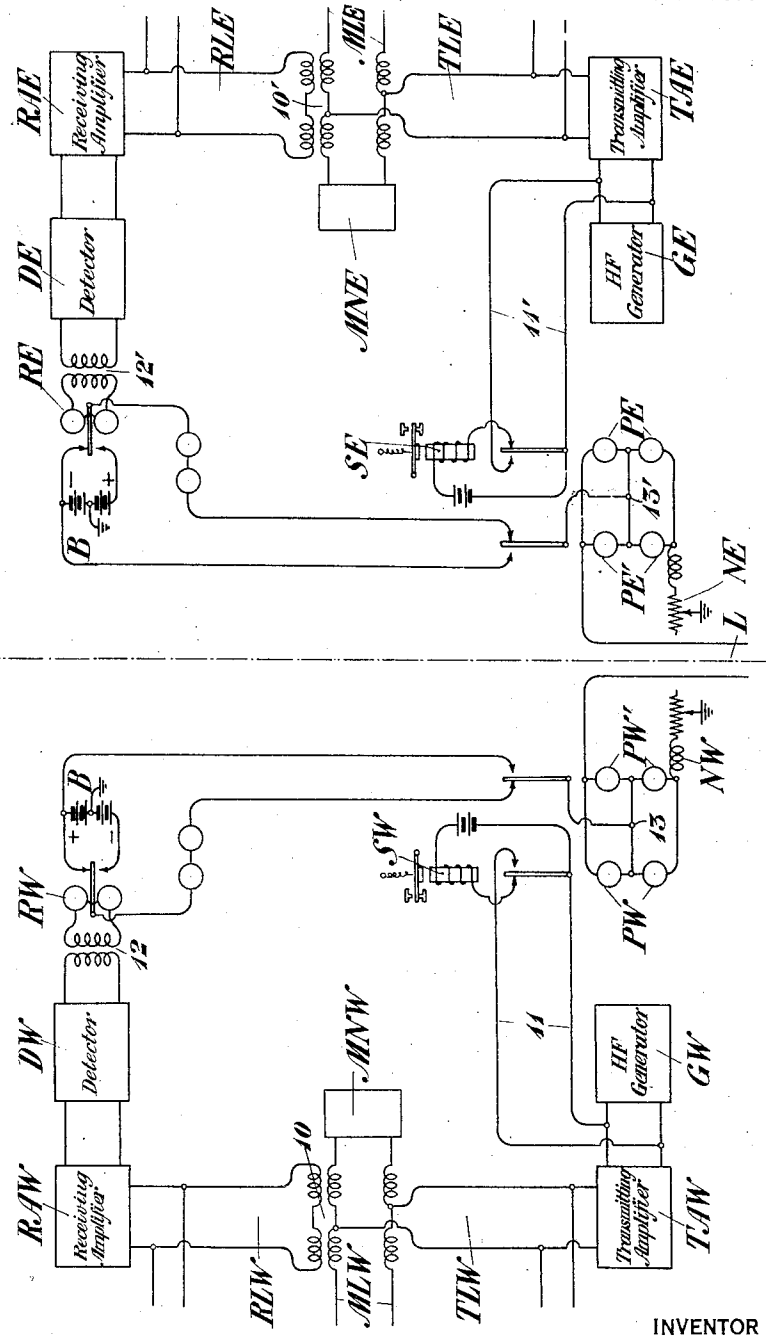


Fig. 1

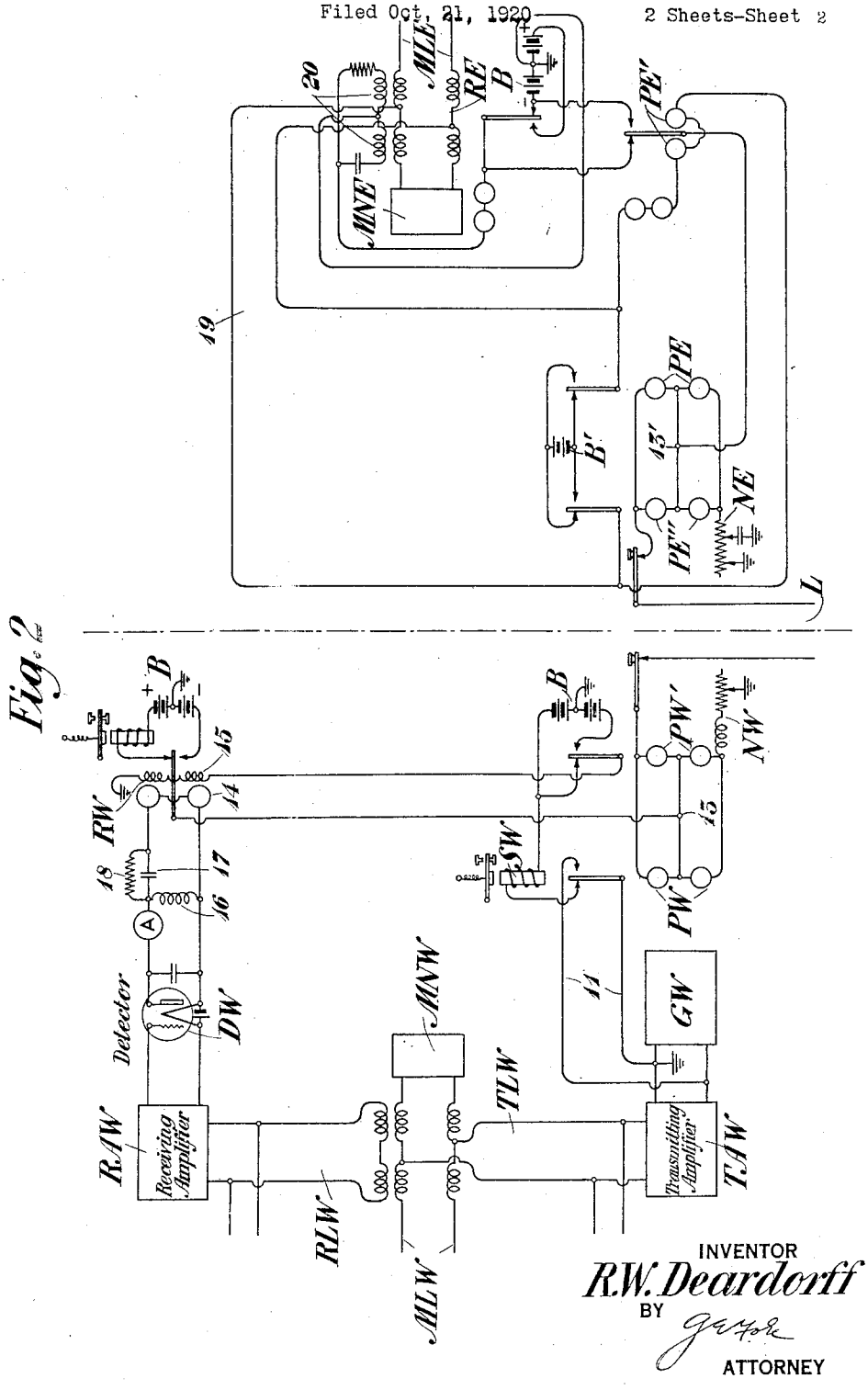
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Filed Oct. 21, 1920 2 Sheets-Sheet 2



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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. 418,480.

To all whom it may concern:

Be it known that I, RALPH W. DEARDORFF, a citizen of the United States, 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 systems in which telegraph signals are transmitted by means of carrier currents.

One of the objects of the invention is to provide a mechanical telegraph repeater for repeating telegraph signals transmitted over a carrier circuit to a low frequency telegraph line.

Another object of the invention is to provide a repeater apparatus for a carrier telegraph system, so arranged that the telegraph signals will be repeated mechanically by translating the carrier frequencies into low frequency signals, repeating the low frequency signals, and then translating the signals back into carrier frequencies.

Another object of the invention is to provide a repeater apparatus of the character just described and to associate therewith an ordinary subscriber's circuit or loop so that repeated signals may be received in the loop or transmitted from the loop to the carrier system through the repeater apparatus.

Another object of the invention is to provide a system of the character just described in which a local subscriber's circuit or loop will be arranged for half-duplex operation.

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

Referring to Figure 1, MLE and MLW designate transmission line sections adapted for the transmission of carrier currents. A transmitting channel TLE and a receiving channel RLE are associated with the main line section MLE through the balanced transformer arrangement 10′, a balancing network NME being provided in order to render the circuits TLE and RLE substantially conjugate. Similarly, a transmitting circuit TLW and a receiving circuit RLW are associated with the main line section MLW through the balanced transformer 10, and the main line section MLW is balanced by an artificial line or network MNW. The transmitting circuits or channels, TLE and TLW, include transmitting amplifiers TAE and TAW, while the receiving circuits or channels, RLE and RLW, include similar receiving amplifiers, RAE and RAW. These amplifiers may be of any well known construction, as, for example, vacuum tube amplifiers. Sources of current, GE and GW, adapted to generate current of carrier frequency, are provided for the transmitting of carrier frequency, are provided for the transmitting channels, TLE and TLW, respectively. These sources may be of any known character, but are preferably vacuum tube oscillators. Detectors DE and DW are associated with the output circuit of the amplifiers RAE and RAW, respectively. These detectors may be of any well known form, such, for example, as the vacuum tube detectors. Polar receiving relays RE and RW are associated with the output circuits of the detectors through the transformers 12′ and 12, so that the polar relays will respond to the alternating current component of the detected low frequency telegraph signal.

A subscriber's loop L is provided for interconnecting the transmitting and receiving channels so that signals received from one line section may be repeated over the loop to the other line section, at the same time actuating signal-responsive means associated with the loop. Signals may also be transmitted from the loop to the line sections. For this purpose, balancing networks NE and NW are associated with opposite ends of the loop, and polar transmitting relay arrangements are included in the loop and balancing circuits. One of the polar relay arrangements comprises polar relays PE and PE′, each having a winding included in the loop circuit and another winding included in the balancing circuit. The armature of the polar relay PE′ is adapted to control a connection from the junction point 13′ of the windings of the polar relays to the terminals of a divided battery B, said connection also extending

over the contacts of the polar receiving relay RE. The armature of the polar relay PE controls a circuit of a sounder SE and is adapted to open and close the short-circuit connections 11′, whereby the generator GE may be short-circuited to interrupt the transmission of the carrier frequency to the main line section MLE. The polar relay arrangement at the opposite end of the loop comprises two polar relays PW and PW′, each having one winding in the loop circuit and a winding in the balancing circuit NW. The armature of the polar relay PW′ controls a connection extending from the junction point 13 to the pole of the divided battery B, said connection extending also over the contact of the receiving relay RW. The armature of the polar relay PW controls a circuit of a sounder SE and also opens and closes the short-circuiting conductors 11, whereby the generator GW may be short-circuited to interrupt the transmission of the carrier frequency to the line section MLW.

Further details of the apparatus may be understood from the description of the operation, which is as follows:

Normally, when signals are not being transmitted, the carrier frequency is applied to the main line section MLE at a distant station, and is transmitted at the station illustrated into the channel RLE, through the receiving amplifier RAE to the detector DE. While this frequency is being transmitted, the armature of the receiving relay RE will rest against its upper contact. At the same time, the carrier frequency will be applied to the line section MLW at a distant station, and will be transmitted into the channel RLW through the amplifier RAW, to the detector DW. During the transmission of this frequency, the armature of the receiving relay RW will rest against its upper contact. Under these circumstances, it will be seen that positive battery is connected to the junction point 13 and negative battery to the junction point 13′ so that the two batteries are series-aiding with respect to the loop L. Consequently, a greater current flows through the loop windings of the several polar transmitting relays than flows through the balancing windings thereof. The armatures of these relays are held against their contacts as illustrated in the drawing. Consequently, the short-circuit connections 11 and 11′ are held open and carrier frequencies from the generators GE and GW are transmitted through the amplifiers TAE and TAW to the line sections MLE and MLW, respectively, these frequencies being transmitted in the opposite direction from the frequencies applied at the other ends of the main line sections. It will, therefore, be seen that when signals are not being transmitted, a carries frequency is in effect transmitted from one line section to the other through the repeater in each direction.

As the circuit is to operate upon a half-duplex basis, signals will be transmitted in only one direction at a time and the signals may be transmitted by interrupting the carrier frequency. If, for example, the carrier frequency incoming over the line MLE is interrupted, each time the carrier frequency is interrupted, the detector DE causes the polar relay RE to shift its armature from negative to positive battery. When positive battery is connected over the armature of the relay RE to the junction point 13′, it will be seen that the battery connections at opposite ends of the loop are mutually opposed, and no current flows through the loop. The sounders in the loop, therefore, release their armatures and the upper windings of the polar relays are de-energized. The current flow through the lower windings of the polar relays PE and PE′ is in a direction opposite to the normal current flow, so that these windings tend to hold the armatures of the relays against their normal contacts, thereby preventing the signal from being transmitted back to the line section MLE. The current flow through the lower windings of the polar relays PW and PW′, however, is in the normal direction. Consequently, the armatures of the said relays are shifted to their alternate contacts. The armature of the relay PW opens the circuit of the sounder SW and closes the short-circuit connection 11′, thereby interrupting the transmission of the carrier frequency from the generator GW to the line section MLW. The armature of the polar relay PW′ opens the connection extending from the junction point 13 over the contacts of the receiving relay RW and directly connects the point 13 to the positive side of the divided battery B independently of the receiving relay RW, so that the condition of the loop can not be affected by a signal received by the receiving relay RW while signals are being transmitted from the line section MLE.

If signals are transmitted in the opposite direction through the other channel, the carrier frequency incoming from the line section MLW will be interrupted and for each interruption, the detector DW will become effective to cause the polar relay RW to shift its armature to its alternate contact so that negative battery will be connected to the junction point 13. The battery connections at both ends of the loop L are now negative so that no current flows through the loop and the sounders in the loop (not shown) release their armatures. The current flow through the lower windings PW and PW′ is now of such a direction as to hold their armatures against their normal

contacts, thereby preventing the received signal from being repeated back to the line section MLW. The current through the lower windings of the polar relays PE and PE′, on the other hand, is in such a direction that the armatures of said relays are shifted to their alternate contacts. The armature of the polar relay PE, upon being shifted, short-circuits the generator GE, thereby interrupting the transmission of the carrier frequency to the line section MLE, and the armature of the polar relay PE′ renders the circuit connections controlled by the receiving relay RE ineffective so that signals can not be received in the loop circuit from said polar relay, while signals are being transmitted to the loop from the receiving polar relay RW.

Signals may be transmitted from the loop L to the line sections MLE and MLW by interrupting the loop by means of the sending key (not illustrated). Each time the loop is interrupted, the current flow through the upper windings of the polar transmitting relays is interrupted and the current flow through the lower windings of both sets of polar relays is in such a direction as to cause their armatures to be shifted to their alternate contacts. The polar relay PE, therefore, short-circuits the generator GE and interrupts the carrier frequency transmitted to the main line section MLE and the polar relay PE′ renders the receiving relay RE ineffective to change the condition of the loop. Similarly, the polar relay PW short-circuits the generator GW and interrupts the transmission of the carrier frequency to the main line section MLW, while the polar relay PW′ renders the receiving polar relay RW ineffective to transmit signals to the loop.

If, while signals are sent from the loop L, a "break" signal should be received, for example from the line section MLE, the carrier frequency which normally is transmitted over said line section to the detector DE will be interrupted during the continuance of the "break," and the armature of the polar relay RE will be shifted to make contact with positive battery, and will remain in this condition during the continuance of the "break." Positive battery will now be connected at both ends of the loop and no current flow through the loop can take place. Consequently, the sounders in the loop will not follow the transmitting key which interrupts the loop and the operator will thus be informed that a "break" signal is being received. When the loop is not being used for sending but is receiving signals transmitted from either main line section, a "break" signal may be transmitted by opening the loop by means of the sending key, and holding it open for a considerable interval. When the loop is open, the two sets of polar transmitting relays at each end of the loop will shift their armatures to their alternate contacts, where they will remain during the continuance of the "break." Consequently, the carrier frequency transmitted to each line section from the generators GE and GW respectively, will be interrupted and will remain interrupted so long as the "break" continues.

Fig. 2 illustrates an arrangement for mechanically repeating telegraph signals between a carrier telegraph line and a metallic low frequency telegraph line. In this figure, MLW designates a carrier transmission line and MLE a low frequency metallic telegraph circuit. The transmitting and receiving channels associated with the carrier line MLW are in general similar to those illustrated in Fig. 1. In this instance, however, the polar receiving relay RW is provided with a main winding 14 in the output circuit of the detector DW and an auxiliary winding 15 controlled by the armature of the polar relay PW′. An inductance 16 is bridged across the output circuit of detector DW to by-pass a portion of the direct current component of the detected telegraph signals, the alternating current component passing through a condenser 17 to the winding 14. If a portion of the direct current component is desired to pass through the winding 14, a resistance 18 may be bridged about the condenser 17. The armature of the polar relay PW′ is so arranged that when it rests against its normal contact, a connection is extended to one pole of the divided battery B so current flows through the auxiliary winding 15 in such a direction as to produce a pull tending to shift the armature of the receiving relay RW to its alternate contact. So long as the carrier frequency is applied to the detector DW, a sufficient direct current flows through the resistance 18 to the main winding 14, so that a pull, due to the main winding is exerted on the armature in the opposite direction from that due to the auxiliary winding 15, the pull due to the winding 14 being sufficiently greater than that due to the winding 15 to hold the armature against its normal contact. With this arrangement, each time the carrier frequency is interrupted, the main winding 14 is de-energized and the winding 15 becomes effective to shift the armature to its alternate contact. At the beginning and end of each interruption, a kick, due to the alternating current component, passes through the condenser 17 to assist in shifting the armature in the desired direction. When the armature of the polar relay PW′ is shifted to its alternate contact, the connection is extended from the opposite pole of the battery B through the auxiliary winding 15 to the receiving relay RW. With the

circuit in this condition, the current flow through the winding 15 is in the opposite direction from that previously described, and tends to hold the armature of the receiving relay RW against its normal contact. This prevents the receiving relay from responding to received signals when signals are being transmitted by the polar relay arrangement PW—PW′.

The metallic telegraph line MLE is balanced by an artificial line or network MNE and a polar receiving relay RE of well known construction, is provided, having windings in the metallic line MLE and in the balancing circuit MNE. The armature of the receiving relay RE controls the connection from the negative pole of the divided battery B to the junction point 13′ of the windings of two polar relays PE and PE″, having windings included in the loop circuit L and the balancing circuit NE of the loop. The two polar relays PE and PE′ are provided so that the two armatures will be available which are necessary to change the polarity of the current transmitted from the battery B to a transmitting circuit 19, which is bridged across neutral points of the polar receiving relay RE. The polar relay PE′ is bridged across the transmitting circuit 19 so that said polar relay will respond to the currents of opposite signs transmitted over the transmitting circuit 19 to the metallic line MLE. The armature of the polar relay PE′ is arranged so that when a signal is transmitted by the transmitting polar relays PE and PE″, the circuit extending to the junction point 13′ over the armature of the receiving relay RE will be opened and will be independently established over the armature of the relay PE′ to prevent received signals from interfering with the signal being transmitted. Auxiliary or vibrating windings 20 are associated with the polar receiving relay RE, the circuit of these windings being controlled by the armature of said receiving relay in a well known manner, so that when impulses of opposite sign are received by the polar relay RE, a kick or surge of current will flow through the vibrating windings in such a direction as to assist in moving the armature of the relay in the desired direction.

Further details of the apparatus may be fully understood from a description of the operation. When signals are not being transmitted over the line MLE, current of one polarity is continuously applied to the line, and this current is of such a direction as to hold the armature of the polar receiving relay RE against its normal contact, which is connected to the negative pole of the divided battery B. With the armature of the receiving relay RE thus resting against its normal contact, it will be seen that negative battery is connected over said armature and the armature of the polar relay PE′ to the junction point 13′. Positive battery is also connected over the normal contact of the receiving relay RW to the junction point 13′. Consequently, the battery connections at the two ends of the loop L are series-aiding and greater current flows through the windings of the polar relays associated with the loop than flows through the windings included in the balancing circuits NE and NW.

Signals are transmitted from the main line section MLE by changing the polarity of the current normally transmitted. Each time an impulse of opposite sign occurs, the armature of the polar relay RE is shifted to its alternate contact. As the armature leaves its normal contact, the battery connection extending to the vibrating windings 20 of the receiving relay is opened and an impulse flows on said windings to assist in shifting the armature to its alternate contact. When the armature of the receiving relay RE is shifted, negative battery is disconnected from the junction point 13′ and positive battery is connected thereto over the alternate contact of the receiving relay. Positive battery is now connected to both ends of the loop L and no current flows in the loop so that the sounders therein respond. The upper windings of the relays PE and PE′ are de-energized and the current flow through the lower windings is in the opposite direction from that normally flowing so that these windings are energized to hold the armatures of the relays PE and PE″ against their normal contacts. No change is, therefore, produced in the polarity of the battery supplied to the transmitting circuit 19 and the repeated signal can not be repeated back to the metallic line MLE.

The cessation of the current flow through the loop results in de-energizing the windings of the polar relays PW and PW′ so that the lower windings become effective to shift the armatures of said relays. The armature of the relay PW opens the circuit of the sounder SW and closes the short-circuit connections 11, thereby short-circuiting the generator GW to interrupt the transmission of the carrier frequency to the carrier line MLW. At the same time, the armature of the polar relay PW′, upon being shifted, changes the direction of the current flow through the auxiliary winding 15 of the receiving relay RW and prevents said relay from responding to received signals. As soon as the impulse of opposite sign transmitted over the metallic line MLE ceases, a current of normal polarity flows thereover and the armature of the receiving relay RE is shifted to its normal contact. As said armature leaves its alternate

contact, an impulse of current flows through the vibrating winding 20 in such a direction as to assist in moving the armature to its normal contact. As soon as the armature is restored to normal, normal current flows through the loop circuit and the armatures of the polar relays PE and PW′ are restored to their normal contacts so that the carrier frequency in the generator GW is again transmitted to the carrier line MLW.

Signals may be transmitted over the carrier line MLW by interrupting the carrier frequency. Each time the carrier frequency is interrupted, the detector DW responds by interrupting the direct current flowing through its output circuit. As no direct current now flows through the main winding 14 of the receiving relay RW, the winding 15 shifts the armature of the relay to connect negative battery to the junction point 13. Negative battery is now connected to both ends of the loop and the current flow through the loop ceases so that the sounders in the loop respond. The relays PW and PW′ hold their armatures against their normal contacts, but the relays PE and PE″ shift their armatures to their alternate contacts, thereby changing the direction of current flow to the circuit 19 and the polar relay PE′. This change in the polarity of the current flowing to the transmitting circuit 19 does not effect the receiving relay RE which is balanced, but current of opposite sign is transmitted to the metallic line MLE. The polar relay PE′ responds to the change in polarity of the current to open the connection over the armature of the receiving relay RE to the junction point 13, and independently connects said junction point to negative battery so that signals received by the polar relay RE are ineffective to produce any change in the current condition of the loop L.

Signals may be transmitted from the loop L to both the carrier line MLE and the metallic line MLW by opening and closing the loop through the transmitting key, (not illustrated). When the loop is opened, the upper windings of the polar relays PE—PE″ and PW—PW′ are de-energized and the lower windings become effective to shift the armatures of said relays so that the carrier frequency normally transmitted to the main line MLW is interrupted and the polarity of the current flowing to the transmitting circuit 19 is changed in the manner already described. The receiving relays RW and RE will also be rendered ineffective in an obvious manner while the signal is transmitted from the loop. The effect of "break" signals transmitted to or from the loop will be similar, to that described in connection with Fig. 1 and need not be further considered.

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, two transmission line sections over which carrier currents may be transmitted, each line section extending from one station to a distant station, a carrier repeater arrangement for interconnecting the lines, comprising a carrier receiving channel associated with one line section, a carrier transmitting channel associated with the other line section, means associated with said first channel for translating carrier currents into low frequency telegraph signals, means associated with the transmitting carrier channel for translating telegraph signals into carrier currents of the same frequency as those received in said first channel, and a low frequency telegraph circuit for interconnecting said translating means.

2. In a signaling system, two transmission line sections, each line section extending from one station to a distant station, a repeater apparatus for interconnecting said sections, said repeater apparatus comprising carrier transmitting channels and carrier receiving channels associated with each section, means associated with each carrier receiving channel for translating carrier currents into low frequency telegraph signals, means associated with each carrier transmitting channel for translating telegraph signals into carrier currents, and a circuit arrangement for interconnecting the receiving translating means and the transmitting translating means for the transmission of telegraph signals.

3. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting the said sections, said repeater apparatus comprising carrier transmitting channels and carrier receiving channels associated with each line section, means associated with each carrier receiving channel for translating carrier currents into low frequency telegraph signals, means associated with each carrier transmitting channel for translating low frequency telegraph signals into carrier currents, and a low frequency telegraph loop interconnecting the several translating means so that telegraphic signals incoming over either line section may be repeated to the loop as low frequency signals and repeated from the loop to the other line section as carrier frequency signals.

4. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting said sections, said repeater apparatus comprising carrier

transmitting channels and carrier receiving channels associated with each line section, means associated with each carrier receiving channel for translating carrier currents into low frequency telegraph signals, means associated with each carrier transmitting channel for translating low frequency telegraph signals into carrier currents, and a low frequency telegraph loop interconnecting the several translating means so that telegraphic signals incoming over either line section may be repeated to the loop as low frequency signals and repeated from the loop to the other line section as carrier frequency signals, and means associated with said loop whereby low frequency telegraph signals may be transmitted through either carrier transmission channel to the line section.

5. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting said sections, said repeater apparatus comprising carrier transmitting channels and carrier receiving channels asssociated with each line section, means associated with each carrier receiving channel for translating carrier currents into low frequency telegraph signals, means associated with each carrier transmitting channel for translating low frequency telegraph signals into carrier currents, a low frequency telegraph loop interconnecting the several translating means so that telegraphic signals incoming over either line section may be repeated to the loop as low frequency signals and repeated from the loop to the other line section as carrier frequency signals, means associated with said loop whereby low frequency telegraph signals may be transmitted through either carrier transmission channel to the line section, and means associated with the telegraph loop whereby signals transmitted from one line section to the other will be recorded while being transmitted over the loop as low frequency signals.

6. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels and carrier transmitting channels associated with each line section, a low frequency telegraph loop, a balancing circuit at each end thereof, polar transmitting relays at each end of the loop having windings in the loop and balancing circuits, said polar relays controlling the transmission of carrier currents from said transmitting channels to the line sections, means associated with each carrier transmitting channel for translating carrier currents into low frequency signals, receiving relays associated with each carrier receiving channel, means for connecting oppositely poled sources over certain contacts of the receiving relays to the junction point of the windings of said polar transmitting relays, means for connecting sources oppositely poled in the reverse direction to other contacts of said receiving relays whereby upon the actuation of either receiving relay, mutually opposed sources will be connected to the loop.

7. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels and carrier transmitting channels associated with each line section, a low frequency telegraph loop, a balancing circuit at each end thereof, polar transmitting relays at each end of the loop having windings in the loop and balancing circuit, said polar relays controlling the transmission of carrier currents from said transmitting channels to the line sections, means associated with each carrier transmitting channel for translating carrier currents into low frequency signals, receiving relays associated with each carrier receiving channel, means for connecting oppositely poled sources over certain contacts of the receiving relays to the junction point of the windings of said polar transmitting relays, means for connecting sources oppositely poled in the reverse direction to other contacts of said receiving relays whereby upon the actuation of either receiving relay, mutually opposed sources will be connected to the loop, and means controlled by said polar transmitting relays for preventing said receiving relays from transmitting signals to the loop when signals are being transmitted over the loop to either polar transmitting relay.

8. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels and carrier transmitting channels associated with each line section, a low frequency telegraph loop, a balancing circuit at each end thereof, polar transmitting relays at each end of the loop having windings in the loop and balancing circuit, said polar relays controlling the transmission of carrier currents from said transmitting channels to the line sections, means associated with each carrier transmitting channel for translating carrier currents into low frequency signals, receiving relays associated with each carrier receiving channel, means for connecting oppositely poled sources over certain contacts of the receiving relays to the junction point of the windings of said polar transmitting relays, means for connecting sources oppositely poled in the re-

verse direction to other contacts of said receiving relays, whereby upon the actuation of either receiving relay, mutually opposed sources will be connected to the loop, means controlled by said polar transmitting relays for preventing said receiving relays from transmitting signals to the loop when signals are being transmitted over the loop to either polar transmitting relay, and means associated with said polar relays for connecting said first mentioned sources to the junction points of the windings of the polar relays independently of the receiving relays.

9. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels and carrier transmitting channels associated with each line section, a low frequency telegraph loop, a balancing circuit at each end thereof, polar transmitting relays at each end of the loop having windings in the loop and balancing circuit, said polar relays controlling the transmission of carrier currents from said transmitting channels to the line sections, means associated with each carrier transmitting channel for translating carrier currents into low frequency signals, receiving relays associated with each carrier receiving channel, means for connecting oppositely poled sources over certain contacts of the receiving relays to the junction point of the windings of said polar transmitting relays, means for connecting sources oppositely poled in the reverse direction to other contacts of said receiving relays whereby upon the actuation of either receiving relay, mutually opposed sources will be connected to the loop, a transmitting and a receiving apparatus included in the loop for transmitting signals from the loop circuit to the line sections and for receiving signals in the loop circuit from the line sections.

10. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels and carrier transmitting channels associated with each line section, a low frequency telegraph loop, a balancing circuit at each end thereof, polar transmitting relays at each end of the loop having windings in the loop and balancing circuit, said polar relays controlling the transmission of carrier currents from said transmitting channels to the line sections, means associated with each carrier transmitting channel for translating carrier currents into low frequency signals, receiving relays associated with each carrier receiving channel, means for connecting oppositely poled sources over certain contacts of the receiving relays to the junction point of the windings of said polar transmitting relays, means for connecting sources oppositely poled in the reverse direction to other contacts of said receiving relays, whereby upon the actuation of either receiving relay, mutually opposed sources will be connected to the loop, and means controlled by said polar transmitting relays for preventing said receiving relays from transmitting signals to the loop when signals are being transmitted over the loop to either polar transmitting relay, and a transmitting and a receiving apparatus included in the loop for transmitting signals from the loop circuit to the line sections and for receiving signals in the loop circuit from the line sections.

11. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising carrier receiving channels and carrier transmitting channels associated with each line section, a low frequency telegraph loop, a balancing circuit at each end thereof, polar transmitting relays at each end of the loop having windings in the loop and balancing circuit, said polar relays controlling the transmission of carrier currents from said transmitting channels to the line sections, means associated with each carrier transmitting channel for translating carrier currents into low frequency signals, receiving relays associated with each carrier receiving channel, means for connecting oppositely poled sources over certain contacts of the receiving relays to the junction point of the windings of said polar transmitting relays, means for connecting sources oppositely poled in the reverse direction to other contacts of said receiving relays, whereby upon the actuation of either receiving relay, mutually opposed sources will be connected to the loop, means controlled by said polar transmitting relays for preventing said receiving relays from transmitting signals to the loop when signals are being transmitted over the loop to either polar transmitting relay, and means associated with said polar relays for connecting said first mentioned sources to the junction points of the windings of the polar relays independently of the receiving relays, and a transmitting and a receiving apparatus included in the loop for transmitting signals from the loop circuit to the line sections and for receiving signals in the loop circuit from the line sections.

12. In a signaling system, two transmission line sections over which carrier currents may be transmitted, each line section extending from one station to a distant station, a repeater apparatus for interconnect-

ing said line sections, said repeater apparatus comprising means for translating carrier currents received from one line section into low frequency signaling currents, means associated with the other line section for generating carrier currents of the same frequency as those transmitted over said first line section, and means for controlling the carrier currents generated in accordance with the translated low frequency signals.

13. In a signaling system, two transmission line sections over which carrier currents may be transmitted, each line section extending from one station to a distant station, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising a detector for detecting from received carrier currents telegraph signals, a generator of carrier oscillations connected with the other line section for generating currents of the same frequency as said received carrier currents, and means for controlling the carrier oscillations generated in accordance with the detected telegraph signals.

14. In a signaling system, two transmission line sections over which carrier currents may be transmitted, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising a vacuum tube detector associated with one line section for translating received carrier frequencies into low frequency signals, a vacuum tube oscillator associated with the other line section for generating carrier oscillations of the same frequency as said received carrier currents, and means for controlling the carrier oscillations generated in accordance with the detected low frequency signals.

15. In a signaling system, two transmission line sections upon which a plurality of carrier channels may be superposed, each line section extending from one station to a distant station, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising individual means corresponding to each channel associated with one of said line sections for translating the received carrier oscillations corresponding to each channel into corresponding low frequency signals, means associated with the other line section individual to each channel for generating carrier oscillations of the same carrier frequency as those received by the channel, and means for controlling the generated oscillations corresponding to each channel in accordance with the low frequency signals produced by the corresponding translating means.

16. In a signaling system, two transmission line sections upon which a plurality of carrier channels may be superposed, each line section extending from one station to a distant station, a repeater apparatus for interconnecting said line sections, said repeater apparatus comprising detectors associated with one line section, said detectors being individual to the different carrier channels and operating to detect from the corresponding carrier frequencies ordinary telegraph signals, generators of carrier oscillations associated with the other line section, each generator being individual to a corresponding carrier channel and generating currents of the same frequency as those received in the channel, and means associated with each generator for controlling the carrier oscillations generated in accordance with the low frequency telegraph signals detected by the corresponding detector.

17. In a signaling system, two transmission line sections upon which a plurality of carrier channels may be superposed, repeater apparatus for interconnecting said line sections, said repeater apparatus comprising a plurality of vacuum tube detectors, one individual to each carrier channel, said detectors functioning to translate carrier oscillations received from the corresponding carrier channel into low frequency signals, a plurality of vacuum tube oscillators associated with the other line section, each of said oscillators being individual to a corresponding carrier channel, and generating currents of the same frequency as those received, and means associated with each oscillator for controlling the oscillations generated in accordance with the low frequency signals detected by the corresponding vacuum tube detector.

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

RALPH WARNER DEARDORFF.