June 16, 1925.

1,541,878

E. F. WATSON

SINGLE POLAR TELEGRAPH CIRCUITS

Filed Nov. 21, 1921

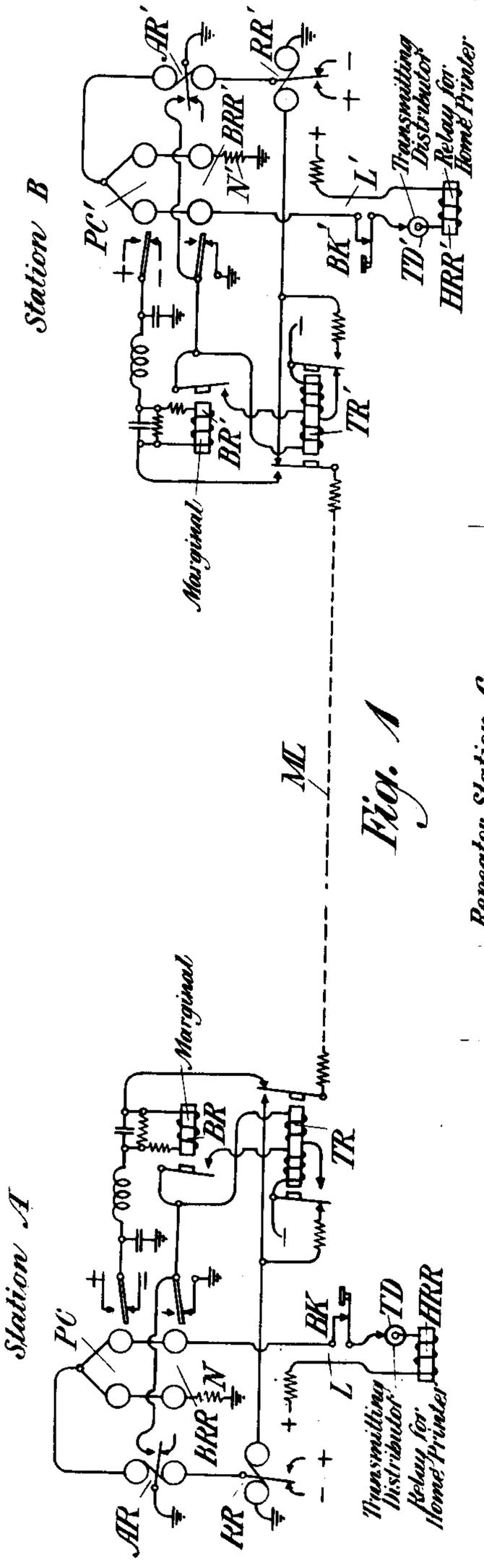

Fig. 1

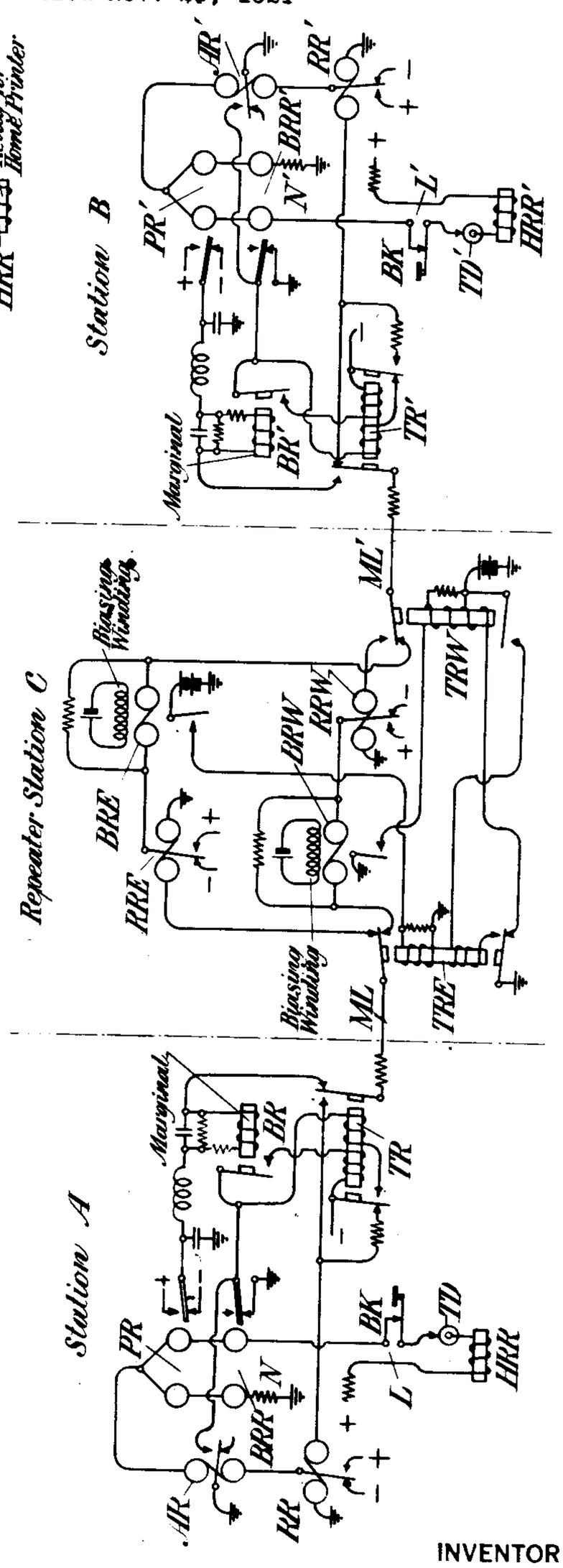

Fig. 2

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UNITED STATES PATENT OFFICE.

EDWARD F. WATSON, OF YONKERS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SINGLE POLAR TELEGRAPH CIRCUITS.

Application filed November 21, 1921. Serial No. 516,868.

To all whom it may concern:

Be it known that I, EDWARD F. WATSON, residing at Yonkers, in the county of Westchester and State of New York, have invented certain Improvements in Single Polar Telegraph Circuits, of which the following is a specification.

This invention relates to telegraph circuits and more particularly to the type of telegraph circuit known as single Morse circuits in which signals are transmitted in but one direction over the same line at one time, although the system is so arranged that signals may be transmitted in either direction.

One of the objects of the invention is to produce a signaling system in which signals may be transmitted in either direction over a line wire without balancing the wire.

Another object of the invention is to produce a signaling system in which signals consisting of positive and negative impulses may be transmitted in either direction over a line wire without balancing the wire.

Another object of this invention is to produce a system in which the line will be switched into connection with the transmitting apparatus at one end and the receiving apparatus at the other end, but, under suitable conditions, may be switched into connection with the receiving apparatus at the first mentioned end and into connection with the transmitting apparatus at the other end for transmitting signals in the reverse direction.

Another object of the invention is to provide a system in which the stations at each end of the line are provided with a transmitting and a receiving apparatus, the transmitting apparatus at one station being connected with the line and the receiving apparatus at the other station being connected with the line when signals are transmitted in one direction, the system being so arranged that, by transmitting a break signal from the station which is receiving, the connections may be interchanged to connect the transmitting apparatus with the line at the receiving station and the receiving apparatus with the line at the transmitting station, whereby signals may be transmitted in the opposite direction.

Another object of the invention is to produce a system having the characteristics above referred to and which is adapted for the transmission of printing telegraph signals.

A still further object of the invention is to provide a system having the characteristics above referred to in which the switching apparatus for determining whether the line will be connected to the transmitting or to the receiving apparatus at a given station will be under the control of a relay responsive only to abnormal current conditions in the line.

The above objects, as well as other objects of the invention, will be clear from the following description thereof when read in connection with the accompanying drawing, Figure 1 of which illustrates a telegraph system embodying the principles of the invention, and Fig. 2 of which illustrates a similar telegraph system provided with a repeater station in addition to terminal signaling stations.

Referring to Fig. 1, ML designates a main transmission line for a telegraph circuit terminating at opposite ends at two stations indicated as A and B respectively. At station A a local loop L extends to a subscriber's station at which suitable transmitting and receiving apparatus may be provided, for example, the loop L is illustrated as including a schematically indicated transmitting distributor TD of a printing telegraph set and a home recording relay HRR of such a set.

The loop L at station A is balanced by means of a balancing circuit or resistance N, and windings of a polar pole changing relay PC and a polar break release relay BRR are included in the loop L and balancing circuit N. At the junction point between the loop L and the balancing circuit N a connection extends to the armature of a polar receiving relay RR, which relay may, under certain conditions, be associated with the main line ML for transmitting signals to the loop. The connection to the armature of the receiving relay may also include an auxiliary polar relay AR for a purpose which will appear hereinafter.

A transfer relay TR is so arranged that it may switch the main line ML either into connection with the receiving relay RR or into connection with the transmitting apparatus controlled by the armature of the pole changer PC. The connection from

the main line ML to the armature of the pole changer PC includes the winding of a break relay BR. The break relay BR is a marginal neutral relay so designed that it will be unresponsive to positive or negative currents transmitted over the line in connection with ordinary signaling, but will be responsive to a current of greater amplitude transmitted over the line as a result of a break signal. The transfer relay TR has two windings, one of which is controlled by the armature of the break relay BR for initially energizing the transfer relay, and the other of which is a locking winding controlled by a locking contact of the transfer relay. The circuit of the locking winding is controlled by the armature of the break release relay BRR and also by the armature of the auxiliary relay AR previously described.

The apparatus at station B is identical with that at station A, and corresponding elements are represented by the same reference characters primed. Further details of the apparatus will be clear from a description of the operation, which is as follows:

As illustrated, the apparatus at stations A and B is in condition for transmitting from station A to station B. Under these conditions transfer relay TR′ at station B is locked up to connect the line ML to the receiving relay RR′. At station A the transfer relay TR is deenergized, so that the line ML is connected to the armature of the pole changer PC. When the transfer relay TR is deenergized a negative battery is connected from the back left-hand contact of the transfer relay to the winding of the receiving relay RR, so that the armature of the latter relay is maintained against its negative contact. Under these conditions, when the loop L is closed, the current flows from the positive battery through the winding of the home recording relay HRR, through the transmitting distributor TD, through the loop windings of the break release relay BRR and pole changer PC and through the winding of the auxiliary relay AR over the contact of the receiving relay RR to negative battery. Current also flows from ground through the balancing resistance N, balancing windings of the break release relay BRR and pole changer PC through the winding of the auxiliary relay AR and over the contact of the receiving relay to negative battery. Obviously the current flowing through the loop windings of the pole changer and the break release relay is substantially twice as great as that flowing through the balancing windings owing to the fact that the positive and negative batteries are connected in series with respect to the loop circuit. The tendency of the current flowing through the balancing windings is to shift the armatures of the pole changer PC and the break release relay BRR to their upper contacts, but owing to the greater pull in the opposite direction, due to the loop windings of said relays, the armatures are held to their lower contacts, so that negative battery is connected through the winding of the break relay BR and over the right-hand back contact of the transfer relay to the main line ML. The resultant line current flows over the front left-hand contact of the transfer relay TR′ at station B and through the winding of the receiving relay RR′ to ground. The armature of the receiving relay RR′ is therefore held against its negative contact, and the current conditions in the loop circuit L′ are the same as described at station A, so that the armature of break relay BR′ is held against its lower contact thereby maintaining a locking circuit through the left-hand winding and over the right-hand front contact of the transfer relay TR′.

The conditions just described obtain during the transmission of marking signals. When a spacing signal is to be transmitted, the loop L will be opened by means of the transmitting distributor TD at station A, so that no current flows through the loop windings of the pole changer PC and the break release relay BRR. The balancing windings of these relays now become effective. The shifting of the armature of the break release relay is without effect, but the armature of the pole changer PC connects positive current to the main line ML, so that the receiving relay RR′ shifts its armature to the positive contact. The positive battery is now connected to both ends of the loop L′, so that no current flows through the loop windings of the pole changer PC′, the break release relay BRR′ and through the winding of the home recording relay HRR′. Current flows through the balancing windings of the relays PC′ and BRR′ in the opposite direction, so that these windings are now energized in such a direction as to tend to hold their armatures against their lower contacts. Consequently, the shifting of the battery connections by means of the relay RR′ is without effect upon the armatures of the pole changer PC′ and the break release relay BRR′. The armature of the auxiliary relay AR′ is shifted to its upper contact to provide an additional locking circuit for the left-hand winding of the transfer relay TR′. The provision of the relay AR′ for this purpose is not strictly necessary, as the locking circuit will be provided over the armature of the break release relay BRR′, but the provision of this additional locking circuit insures against defective operation of the break release relay under the conditions just described.

The home recording relay HRR′ may function as a sounder where the circuit is

used for the transmission of ordinary Morse signals. If a printer is to be controlled by the loop L′, however, the first space signal of a group will be used to release the receiving distributor (not shown) of the printer. Consequently, when the relay HRR′ is deenergized by reason of the fact that positive battery is connected to both ends of the loop during the first space signal of the group, the release of its armature will control the release of the receiving distributor in a well-known manner.

If, while signals are being transmitted from station A, it is desired to transmit signals from station B, the loop circuit L′ may be opened, as, for example, by means of the break key BK′. As soon as a negative or marking signal is received from station A, negative battery will be connected to the loop over the left-hand contact of the receiving relay RR′. As the loop windings of the pole changer PC′ and break release relay BRR′ are deenergized, the balancing windings become effective to shift their armatures to their upper contacts. The shifting of the armature of the break release relay BRR′ opens the locking circuit of the transfer relay TR′, which is deenergized, so that its right-hand back contact connects negative battery to the receiving relay RR′ to hold the armature of the latter relay against its negative contact. At its left-hand back contact transfer relay TR′ connects the line ML through the winding of the break relay BR′ to the armature of the pole changer PC′.

The armature of the pole changer is connected to positive battery at station B, and it will be remembered that the changes just described occur at the time a marking signal is being transmitted from station A, so that negative battery is connected to the line ML at the latter station. This results in a current flow of approximately twice the normal amplitude through the winding of the break relay BR′ over the line ML and through the winding of the break relay BR at station A. Both break relays are energized, but the energization of the break relay BR′ at station B is without effect to energize the transfer relay TR′ owing to the fact that the circuit of the latter relay is held open at the armature of the break release relay BRR′ and at the armature of the auxiliary relay AR′. Consequently, the transfer relay TR′ at station B remains deenergized. At station A, however, the armature of the break release relay will be upon its lower contact owing to the fact that the loop L is closed, and upon the energization of the break relay BR a circuit is completed from ground over the contact of the break release relay BRR over the front contact of the relay BR and through the left-hand winding of the tranfer relay TR to negative battery. The transfer relay TR is energized and at its left-hand contact completes a locking circuit through its right-hand winding. By means of its right-hand armature, said relay shifts the connection of the line ML from the control of the armature of the pole changer PC into circuit with the receiving relay RR. Signals may now be transmitted from station B to station A in an obvious manner.

Fig. 2 illustrates a system similar to that of Fig. 1 provided with an intermediate repeater circuit between the terminal stations. The apparatus at the terminal stations A and B will be identical with that illustrated in Fig. 1. At the repeater station C, however, transfer relays TRE and TRW are provided. The former when deenergized connects the main line section ML to a polar repeating relay RRE whose armature is arranged to repeat the signals to the line section ML′, said line section being connected to the armature of the repeating relay RRE over the front contact of the transfer relay TRW when the latter relay is energized. When the transfer relay TRW is deenergized, the line section ML′ is connected to the repeating relay RRW which is arranged to repeat signals to the main line section ML when the transfer relay TRE is energized. The transfer relays TRE and TRW are controlled by polar break relays BRE and BRW included in circuit with the armatures of the repeating relays RRE and RRW respectively. The polar relays BRE and BRW are so biased that the circuits controlled by their armatures will be held open during the transmission of positive or negative signaling currents. This biasing may be accomplished by means of a spring which pulls the armature with a force equal to that produced by a current flowing through the operating winding in such a direction as to tend to close its contact. As shown, however, the biasing effect is produced by an auxiliary winding having a battery in circuit therewith, so that a current flows through the auxiliary winding of such magnitude as to produce a pull equivalent to that of the spring just referred to. The break relay BRE is so poled that when a current having an amplitude twice that of a normal signaling current flows through its winding in one direction its contact will be closed, and the break relay BRW is so poled that a current of substantially twice a normal signaling current flowing over the line in the opposite direction will close the contact of the latter relay.

Further details will be understood from a description of the operation. Let us assume that signals are being transmitted from station A to station B. The operation of the apparatus at station A will be simi-

lar to that described in connection with Fig. 1. At repeater station C the transfer relay TRE will be deenergized, and the transfer relay TRW will be locked up through its lower winding over the lower back contact of the transfer relay TRE thereby connecting the main line section ML′ to the armature of the repeating relay RRE, whose winding will be connected to the main line section ML over the upper back contact of the transfer relay TRE. Consequently, signals transmitted over the main line section ML from station A will be repeated by the polar relay RRE through the main line section ML′ to be transmitted to the station B, actuating the apparatus at the latter station in a manner similar to that described in connection with Fig. 1. The repeated positive and negative currents flow through the winding of the break relay BRE at station C, but do not actuate the armature of said relay, because the negative currents flowing through the winding only produce a force equal to that produced by the biasing winding which tends to hold the armature in its open position, and the positive currents are in such a direction as to produce a force in the same direction as the biasing winding.

If, now, it is desired to transmit signals from station B to station A, the break key BK′ may be opened thereby deenergizing the transfer relay TR′ and connecting positive battery to the line section ML′ at station B in the manner described in connection with Fig. 1. When the repeating relay RRE at station C connects negative battery to the other end of line ML′, it causes an increased current to flow over the line ML′ and through the main winding of the break relay BRE and thereby causing the break relay BRE to shift its armature and complete a circuit through the upper winding of the transfer relay TRE. The transfer relay TRE is thereby energized, locking itself up over its lower front contact and lower winding, at the same time opening the locking circuit of the transfer relay TRW. As a consequence, the transfer relays operate to shift the connections of the line sections, so that the repeating relay RRW is connected to the line section ML′, and the line section ML is connected to the armature of the repeating relay RRW. The break relay BRW is unaffected by the operations above taking place, for the reason that it was unconnected with the line section ML′ before the switching operation occurred. Likewise, the break relay BR′ at station B produces no effect due to the break signal owing to the fact that the circuit which would normally be closed by the break relay BR′ is opened at another point as described in connection with Fig. 1.

The connection of the repeating relay RRW to the line section ML′ results in the shifting of the armature of said relay owing to the fact that positive battery is connected with the line section at station B. Consequently positive battery will be connected to the repeater end of the line section ML through the winding of the break relay BRW. If negative battery is still connected to the line at station A, or as soon as negative battery is again connected to the line at said station in transmitting a marking signal, an augmented current will flow over the line section ML operating the break relay BR at station A to disconnect the transmitter and connect the receiving relay RR to the line section at said station as described in connection with Fig. 1. An augmented current flows through the main winding of the break relay BRW, but does not actuate this relay, since the relay is so poled that it requires a current of opposite polarity to shift its armature. Transmission may now take place from station B to station A.

Actuation of the break key BK at station A under these conditions will result in connecting positive battery to the line ML at station A, and, when negative battery is connected to the line ML at station C by the repeating relay RRW, an augmented current will flow through the winding of the break relay BRW in a direction opposite to that before described, thereby actuating said break relay to energize the transfer relay TRW, which in turn releases the transfer relay TRE, so that the connections of the repeater are shifted for transmission in the original direction.

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 line circuit, terminal stations, transmitting apparatus and receiving apparatus at each terminal station, switching means connecting the line circuit to the transmitting apparatus at one station and the receiving apparatus at the other station during non-signaling condition so that signals may be transmitted in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction and means whereby said switching means may connect the line to the transmitting apparatus at said last mentioned station and to the receiving apparatus at said first mentioned station for transmitting signals in the opposite direction in response to the actuation of the transmitting apparatus at said second station.

2. In a signaling system, a line circuit,

terminal stations at each end of said circuit, each terminal station having a transmitting apparatus and a receiving apparatus thereat, switching means at each station connecting the transmitting apparatus to the line at one station and the receiving apparatus to the line at the other station during non-signaling condition so that signals may be transmitted in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction and means whereby said switching apparatus at both stations may be controlled from one of said stations to reverse the connections for transmission in the opposite direction in response to the actuation of the transmitting apparatus at said second station.

3. In a signaling system, a line circuit, terminal stations at each end of said circuit, each terminal station having a transmitting apparatus and a receiving apparatus thereat, switching means at each terminal station adapted to connect a transmitting apparatus to the line at one station and a receiving apparatus to the line at the second station during non-signaling condition so that transmission may take place in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said switching means being adapted to connect transmitting apparatus to the line at the second station and receiving apparatus to the line at the first station for transmission in the opposite direction in response to the actuation of the transmitting apparatus at said second station, and means whereby the switching means at both stations may be controlled from either station.

4. In a signaling system, a line circuit, terminal stations at each end of said line circuit, each terminal station having transmitting apparatus and receiving apparatus thereat, switching devices at each station for connecting a transmitting apparatus to the line at one station and a receiving apparatus to the line at the second station during non-signaling condition, so that signaling currents may be transmitted over the line in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said switching devices also functioning to connect the transmitting apparatus to the line at the second station and the receiving apparatus to the line at the first station to transmit signaling currents in the opposite direction in response to the actuation of the transmitting apparatus at said second station, and means unresponsive to normal signaling currents but responsive to abnormal current conditions of the line for controlling said switching devices.

5. In a signaling system, a line circuit, terminal stations at each end of said line circuit, each terminal station having transmitting apparatus and receiving apparatus thereat, switching devices at each station for connecting a transmitting apparatus to the line at one station and a receiving apparatus to the line at the second station during non-signaling condition, so that signaling currents may be transmitted over the line in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said switching devices also functioning to connect the transmitting apparatus to the line at the second station and the receiving apparatus to the line at the first station to transmit signaling currents in the opposite direction in response to the actuation of the transmitting apparatus at said second station, and means unresponsive to normal signaling currents but responsive to abnormal current conditions of the line for controlling said switching devices, said means being controllable from either station.

6. In a signaling system, a line circuit, terminal stations at each end of said line circuit, each terminal station having transmitting apparatus and receiving apparatus thereat, switching devices at each station for connecting a transmitting apparatus to the line at one station and a receiving apparatus to the line at the second station during non-signaling condition, so that signaling currents may be transmitted over the line in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said switching devices also functioning to connect the transmitting apparatus to the line at the second station and the receiving apparatus to the line at the first station to transmit signaling currents in the opposite direction in response to the actuation of the transmitting apparatus at said second station, and means at each station unresponsive to normal signaling currents but responsive to augmented signaling currents for controlling said switching devices.

7. In a signaling system, a line circuit, terminal stations at each end of said line circuit, each terminal station having transmitting apparatus and receiving apparatus thereat, switching devices at each station for connecting a transmitting apparatus to the line at one station and a receiving apparatus to the line at the second station during non-signaling condition, so that signaling currents may be transmitted over the line in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said switching devices also functioning to connect the transmitting

apparatus to the line at the second station and the receiving apparatus to the line at the first station to transmit signaling currents in the opposite direction in response to the actuation of the transmitting apparatus at said second station, means unresponsive to normal signaling currents but responsive to augmented signaling currents for controlling said switching devices, and means whereby augmented currents may be transmitted at will from either station to control said last mentioned means.

8. In a signaling system, a line circuit, terminal stations at each end of said circuit, transmitting apparatus and receiving apparatus at each terminal station, a transfer relay at each terminal station, said transfer relays being arranged to connect the transmitting apparatus to the line circuit at one station and the receiving apparatus to the line circuit at the other station during non-signaling condition so that signals may be transmitted in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said transfer relays being also arranged to shift the connection, so that the transmitting apparatus will be connected to the line circuit at the second station and the receiving apparatus to the line circuit at the first station to transmit signaling currents in the opposite direction in response to the actuation of the transmitting apparatus at said second station.

9. In a signaling system, a line circuit, terminal stations at each end of said circuit, transmitting apparatus and receiving apparatus at each terminal station, a transfer relay at each terminal station, said transfer relays being arranged to connect the transmitting apparatus to the line circuit at one station and the receiving apparatus to the line circuit at the other station during non-signaling condition so that signals may be transmitted in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said transfer relays being also arranged to shift the connection, so that the transmitting apparatus will be connected to the line circuit at the second station and the receiving apparatus to the line circuit at the first station to transmit signaling currents in the opposite direction in response to the actuation of the transmitting apparatus at said second station, and means unresponsive to normal signaling currents but responsive to abnormal current conditions of the line for controlling said transfer relays.

10. In a signaling system, a line circuit, terminal stations at each end of said circuit, transmitting apparatus and receiving apparatus at each terminal station, a transfer relay at each terminal station, said transfer relays being arranged to connect the transmitting apparatus to the line circuit at one station and the receiving apparatus to the line circuit at the other station during non-signaling condition so that signals may be transmitted in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said transfer relays being also arranged to shift the connection, so that the transmitting apparatus will be connected to the line circuit at the second station and the receiving apparatus to the line circuit at the first station to transmit signaling currents in the opposite direction in response to the actuation of the transmitting apparatus at said second station, and relays unresponsive to normal signaling currents transmitted over the line but responsive to abnormal current conditions of the line for controlling said transfer relays.

11. In a signaling system, a line circuit, terminal stations at each end of said circuit, transmitting apparatus and receiving apparatus at each terminal station, a transfer relay at each terminal station, said transfer relays being arranged to connect the transmitting apparatus to the line circuit at one station and the receiving apparatus to the line circuit at the other station during non-signaling condition so that signals may be transmitted in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said transfer relays being also arranged to shift the connection, so that the transmitting apparatus will be connected to the line circuit at the second station and the receiving apparatus to the line circuit at the first station to transmit signaling currents in the opposite direction in response to the actuation of the transmitting apparatus at said second station, and relays unresponsive to normal signaling currents transmitted over the line but responsive to augmented signaling currents for controlling said transfer relays.

12. In a signaling system, a line circuit having an intermediate repeater station associated therewith and terminal stations at each end thereof, transmitting apparatus and receiving apparatus at each terminal station, separate repeating devices for repeating in opposite directions at said repeater station, means whereby during non-signaling conditions the transmitting apparatus will be connected to the line at one of said terminal stations, the receiving apparatus will be connected to the line at the other terminal station, and one of said repeating devices will be connected to the line at the repeater station, so that signals may be transmitted in one direction, means for normally maintaining said connections dur-

ing times that no signals are being transmitted in either direction, and switching means whereby, when it is desired to transmit in the opposite direction, the transmitting apparatus will be connected to the line at the second terminal station, the receiving apparatus will be connected to the line at the first terminal station, and the other repeating apparatus will be connected to the line at the repeater station in response to the actuation of the transmitting apparatus at said second station.

13. In a signaling system, a line circuit, a repeater station associated with said line circuit and terminal stations associated with each end of said line circuit, transmitting apparatus and receiving apparatus at each terminal station, separate repeating arrangements at said repeater station for repeating in opposite directions, and switching devices at said repeater station whereby, during non-signaling condition, the transmitting apparatus may be connected to the line at one terminal station, the receiving apparatus may be connected to the line at the other terminal station, and one of said repeating arrangements may be connected to the line at the repeater station for transmission in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said switching devices functioning when it is desired to transmit in the opposite direction to connect the transmitting apparatus to the line at the second station, the receiving apparatus to the line at the first station, and to connect the other of said repeating arrangements to the line at the repeater station in response to the actuation of the transmitting apparatus at said second station.

14. In a signaling system, a line circuit, a repeater station associated with said line circuit and terminal stations associated with each end of said line circuit, transmitting apparatus and receiving apparatus at each terminal station, separate repeating arrangements at said repeater station for repeating in opposite directions, and switching devices at said terminal station and said repeater station whereby, during non-signaling condition, the transmitting apparatus may be connected to the line at one terminal station, the receiving apparatus may be connected to the line at the other terminal station, and one of said repeating arrangements may be connected to the line at the repeater station for transmission in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said switching devices functioning when it is desired to transmit in the opposite direction to connect the transmitting apparatus to the line at the second station, the receiving apparatus to the line at the first station, and to connect the other of said repeating arrangements to the line at the repeater station in response to the actuation of the transmitting apparatus at said second station, said switching devices being controllable from either terminal station.

15. In a signaling system, a line circuit, a repeater station associated with said line circuit and terminal stations associated with each end of said line circuit, transmitting apparatus and receiving apparatus at each terminal station, separate repeating arrangements at said repeater station for repeating in opposite directions, and switching devices at said terminal station and said repeater station whereby, during non-signaling condition, the transmitting apparatus may be connected to the line at one terminal station, the receiving apparatus may be connected to the line at the other terminal station, and one of said repeating arrangements may be connected to the line at the repeater station for transmission in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said switching devices functioning when it is desired to transmit in the opposite direction to connect the transmitting apparatus to the line at the second station, the receiving apparatus to the line at the first station, and to connect the other of said repeating arrangements to the line at the repeater station in response to the actuation of the transmitting apparatus at said second station, said switching devices being unresponsive to normal signaling currents transmitted over the line but being responsive to abnormal current conditions of the line.

16. In a signaling system, a line circuit, a repeater station associated with said line circuit and terminal stations associated with each end of said line circuit, transmitting apparatus and receiving apparatus at each terminal station, separate repeating arrangements at said repeater station for repeating in opposite directions, and switching devices at said repeater station whereby, during non-signaling condition, the transmitting apparatus may be connected to the line at one terminal station, the receiving apparatus may be connected to the line at the other terminal station, and one of said repeating arrangements may be connected to the line at the repeater station for transmission in one direction, means for normally maintaining said connections during times that no signals are being transmitted in either direction, said switching devices functioning when it is desired to transmit in the opposite direction to connect the transmit-

ting apparatus to the line at the second station, the receiving apparatus to the line at the first station, and to connect the other of said repeating arrangements to the line at the repeater station in response to the actuation of the transmitting apparatus at said second station, said switching devices comprising relays unresponsive to normal signaling currents transmitted over the line, but responsive to augmented currents transmitted over the line.

17. In a signaling system, a line circuit, terminal stations at each end of said line circuit, transmitting apparatus and receiving apparatus at each terminal station, a local subscriber's loop extending from at least one of said terminal stations to a subscriber's station, said loop controlling the transmitting apparatus at the corresponding terminal station and being controlled by the receiving apparatus at said station, and means whereby, for transmission in one direction, the transmitting apparatus at one terminal station will be associated with the line and the receiving apparatus at the other terminal station will be associated with the line, and, for transmission in the opposite direction, the transmitting apparatus will be associated with the line at the latter station and the receiving apparatus will be associated with the line at the former station.

18. In a signaling system, a line circuit, terminal stations at each end of said line circuit, transmitting apparatus and receiving apparatus at each terminal station, a local subscriber's loop extending from at least one of said terminal stations to a subscriber's station, said loop controlling the transmitting apparatus at the corresponding terminal station and being controlled by the receiving apparatus at said station, and switching devices at each terminal station for connecting the transmitting apparatus to the line at one terminal station and the receiving apparatus to the line at the other terminal station or vice versa, depending on the direction of transmission.

19. In a signaling system, a line circuit, terminal stations at each end of said line circuit, a transmitting apparatus and receiving apparatus at each terminal station, a local subscriber's loop extending from at least one of said terminal stations to a subscriber's station, said loop controlling the transmitting apparatus at the corresponding terminal station and being controlled by the receiving apparatus at said station, and switching devices at each terminal station for connecting the transmitting apparatus to the line at one terminal station and the receiving apparatus to the line at the other terminal station or vice versa depending on the direction of transmission, said switching devices being controllable from said loop.

20. In a signaling system, a line circuit, terminal stations associated with said line circuit, transmitting apparatus and receiving apparatus at each terminal station, a loop circuit extending from each terminal station to a local subscriber's station, the transmitting apparatus at each station being controlled by the corresponding loop and the receiving apparatus being under the control of the corresponding loop, switching devices at each station for connecting the transmitting apparatus to the line circuit at one station and the receiving apparatus to the line circuit at the other station, or vice versa, depending on the direction of transmission.

In testimony whereof, I have signed my name to this specification this 19th day of November, 1921.

EDWARD F. WATSON.