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E. F. WATSON

SINGLE POLAR TELEGRAPH CIRCUITS

Original Filed Nov. 21, 1921

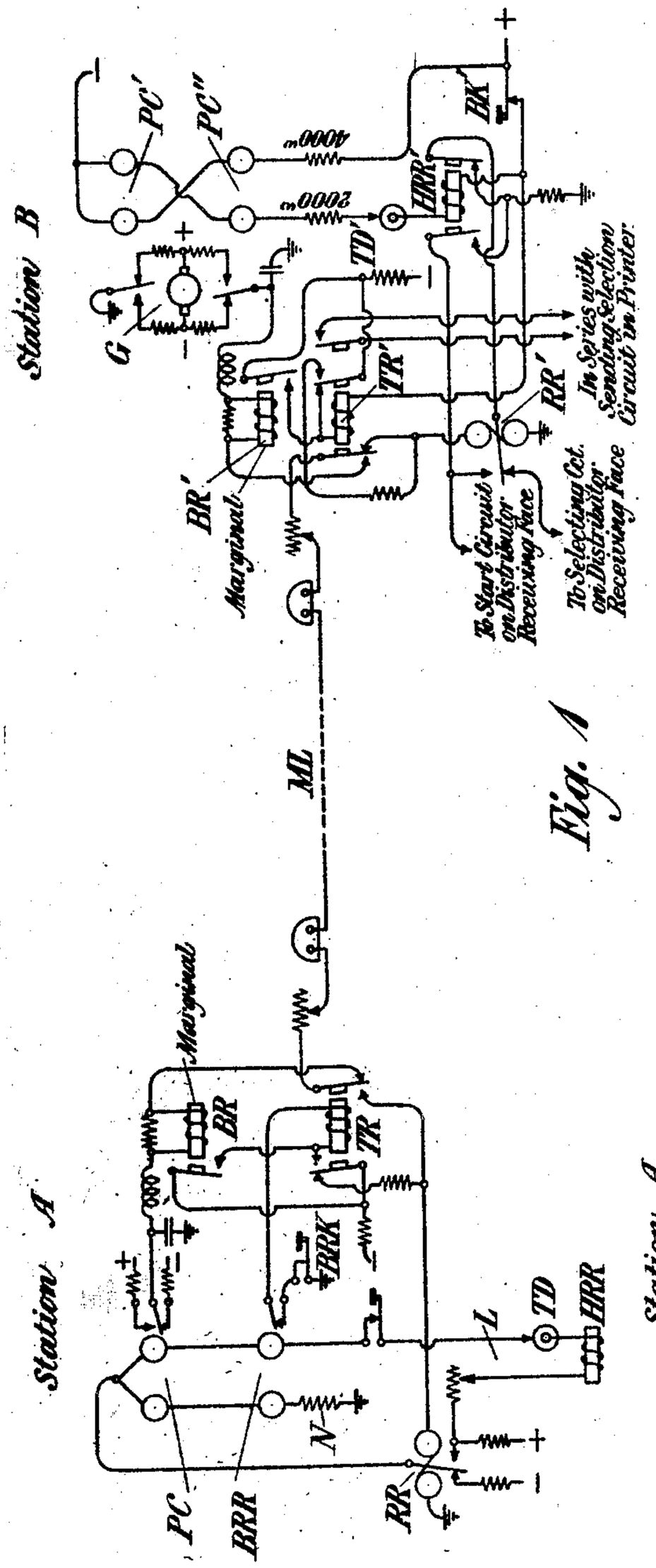

Fig. 1

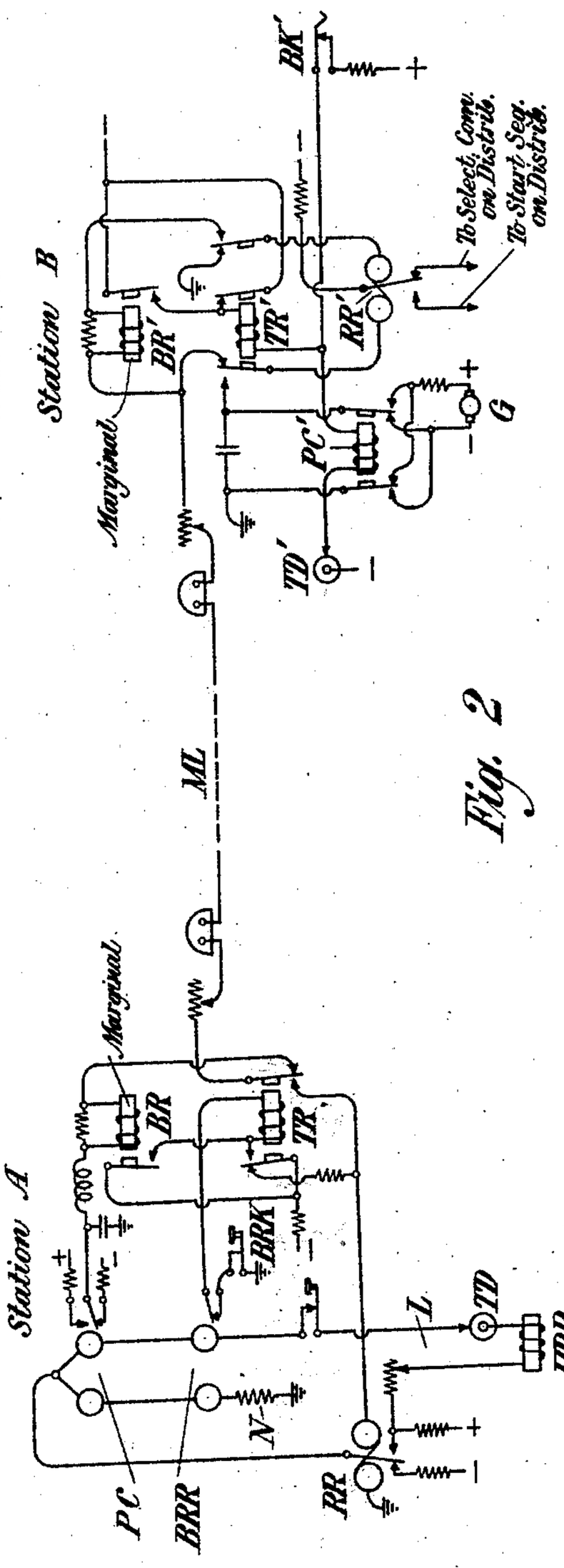

Fig. 2

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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.

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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, Figs. 1 and 2 of which illustrate two forms of telegraph systems embodying the principle of the invention.

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 a 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.

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 the result of a break signal. The transfer relay TR has an initial energizing circuit controlled by the contact of the break relay BR and has a locking circuit controlled by its locking contact and by a contact of the break release relay BRR. This circuit may also include a break release key BRK for performing the functions of a break release relay manually, when desired.

As illustrated, the apparatus at station B is somewhat different from that at station A, as it is so arranged that the terminal apparatus and the printing apparatus may both be installed at the same station instead of have the printer located at a somewhat distant point from the terminal apparatus associated with the terminal station through a loop such as the loop L at station A. In this case the pole changing apparatus comprises two polar relays PC′ and PC″, each having two windings so arranged that one winding of each relay is included serially in circuit with a low resistance, the other windings of the relays being in a high resistance circuit. The forward circuit includes the break key BK′, the transmitting distributor TD′ and the home recording relay HRR′. The windings of the pole changing relays in the two circuits tend to shift the armatures in opposite directions, but as the windings in the low resistance circuit receive the most current, said windings will determine the positions of the armatures normally. When the low resistance circuit is opened either by the break key BK′ or the transmitting distributor TD′, the armatures will be shifted under the control of the windings in the high resistance circuit.

In order to supply signaling current, a motor generator G may be provided, and the circuit of this generator is so arranged that the armatures of the pole changers PC′ and PC″ determine the polarity of the current supplied from the motor generator. A connection extends from this generator through a break relay BR′, similar in all respects to the break relay BR at station A, to the back contact of the transfer relay TR′. The transfer relay TR′ performs the same functions as the transfer relay TR at station A and is initially controlled by the break relay BR′. Its locking circuit, however, is arranged to be opened by the break key BK′, as no release relay is provided. When the transfer relay is locked up, a receiving relay RR′ is connected to the main line, but when the transfer relay is deenergized, the main line is connected to the motor generator set over the contacts of the pole changers. The receiving relay RR′ is arranged to establish connection over its marking contact to the selecting circuit on the receiving distributor face of the receiving printer (not shown). Over its spacing contact it controls the connection to the start circuit of the receiving distributor, so that the first spacing impulse of a group will release the receiving distributor in a well-known manner. The home recording relay HRR′ is arranged, so that when it is energized, as is the case during the transmission of marking signals, it will close the circuit over the marking contact of the receiving relay RR′, and when it is deenergized during the transmission of spacing signals, it may independently control the starting circuit of the receiving distributor. In this manner the receiving relay RR′ will operate the local printer when the station is receiving signals, and when the station is sending signals the home recording relay will operate the local printer independently of the receiving relay.

Further details of the apparatus will now 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 the former to the latter. The transfer relay TR′ at station B is locked up and connects the line to the receiving relay RR′. At station A the transfer relay TR is deenergized, so that the line is connected to the contact of the pole changer PC. The receiving relay RR at station A is locked up over the back contact of the transfer relay TR to negative battery, so that its armature is held against its negative contact. When the loop is closed, therefore, current flows from negative battery over the contact of the receiving relay RR, through the loop windings of the pole changer PC and break relay BRR, over the break key BK, through the transmitting distributor TD and through the winding of the home recording relay HRR to positive battery. Current also flows from the negative contact of the receiving relay through the balancing windings of the pole changer PC and break release relay BRR through the balancing resistance N to ground. 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 armature 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 lower contact, so that a connection is completed from ground over the right-hand front contact of the home recording relay HRR′ and over the lower contact of the receiving relay RR′ to the selecting circuit of the receiving distributor face (not shown).

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 to shift their armatures. The shifting of the armature of the break release relay BRR is without effect, as it merely opens the circuit of the transfer relay TR which is already deenergized. The armature of the pole changer PC, however, connects positive battery to the main line ML, so that the receiving relay RR′ at station B shifts its armature to its upper contact thereby completing a circuit from ground over the right-hand front contact of home recording relay HRR′ and over the upper contact of the receiving relay RR′ to the starting circuit of the receiving distributor face. In the operation of a printer the first space signal of a group functions to release the receiving distributor of the printer in a well-known manner, and succeeding spacing impulses of the group are without effect. The succeeding marking impulses, however, complete selecting circuits in a well-known manner to determine the character to be printed.

If, when signals are being transmitted from station A, it is desired to transmit signals from station B, the break key BK′ may be actuated, thereby opening the low resistance circuit through the windings of the pole changers PC′ and PC″ and incidentally releasing the home recording relay HRR′ and unlocking the transfer relay TR′. The deenergization of the transfer relay TR′ results in the connection of the line ML through the winding of the break relay BR′ to the motor generator G. The windings of the pole changers which are included in the high resistance circuit at the same time become effective to shift the armatures of the pole changers, so that the positive pole of the motor generator set is connected through the break relay BR′ to the line, the negative side of the generator being connected to ground. With the circuit in this condition, whenever the armature of the pole changer PC at station A rests upon its negative or marking contact in the transmission of a marking signal, the line current will be augmented from its normal value to approximately double value. The break relays BR and BR′, being marginal, are unresponsive to the transmission or ordinary marking and spacing signals, but as soon as the augmented current flows, due to the breaking operation, both relays are energized. The operation of the break relay at station B has no effect, as the circuit of the transfer relay TR′ is held open by the break key BK′. The break relay BR at station A, however, closes a circuit through the transfer relay TR over the contact of the break release relay BRR. The transfer relay TR is therefore energized, locking itself up independently of the break relay BR and connecting the line ML at its front right-hand contact to the receiving relay RR, at the same time disconnecting the line from the contacts of the pole changer PC thereby causing deenergization of the break relay BR. Since a spacing or positive impulse is being transmitted from station B while the break key BK′ is open, the armature of the receiving relay will be shifted to its positive contact thereby short-circuiting the loop L and causing current to flow through the balancing windings of the pole changer PC and the break release relay BRR in such a direction as to hold their armatures upon their lower contacts. This prevents the armature of the break release relay from opening the circuit of the transfer relay, which remains locked up.

The short-circuiting of the subscriber's loop, when the armature of the receiving relay is connected to positive battery, causes the home recording relay HRR to remain released, and this results in the stopping of the sending distributor TD in a manner well-known in the art. No further sending operation can take place from station A until the break key BK′ at station B is released. When the break key is released, the receiving relay RR at station A will shift its armature to its negative contact, and current will again flow in the loop, so that the apparatus is ready to receive signals. Signals may be transmitted from station B by interrupting the low resistance circuit of the pole changers through the agency of the transmitting distributor TD′, thus sending positive and negative spacing and mark-

ing currents from the line ML to the receiving relay RR. Each marking signal causes current to flow through the loop by shifting the armature of the receiving relay to negative battery, and each spacing signal causes a no-current condition in the loop by shifting the armature to its positive contact thereby short-circuiting the loop. During the short-circuited condition of the loop, the loop windings of the pole changer PC, the home recording relay HRR and the break release relay BRR will be deenergized in the manner described in connection with the transmission of the break signal.

In order for station A to again send signals to station B, it will be necessary to transmit a break signal from station A. This may be done by operating the break key BK in the loop L at station A, so that no current flow through the loop. As soon as a marking signal is received from station B so that the armature of the receiving relay RR is shifted to its negative contact, the pole changer PC and the break release relay BRR will shift their armatures to their upper position. The break release relay BRR opens the circuit of the transfer relay TR thereby disconnecting the line ML from the receiving relay RR and connecting the line to the contacts of the pole changer PC through the break relay BR. At its left-hand back contact the transfer relay TR connects negative battery to the receiving relay RR, so that its armature is held against its negative contact. The pole changer PC at the same time connects positive battery to the line through the winding of the marginal relay BR, and since negative battery is connected to the line at the station B, an augmented current will flow on the line which will operate the break relays at both stations. At station A the operation of the break relay BR is ineffective, as the circuit for the transfer relay TR, through the contact of the break relay, is open at the contact of the break release relay BRR, and the transfer relay therefore remains deenergized. The operation of the break relay BR′ at station B closes the circuit for energizing the transfer relay TR′ from negative battery over the front contact of the relay BR′ through the winding of the transfer relay TR′ and over the contact of the break key BK′ to positive battery. The transfer relay TR′ is accordingly energized and locked up over its right-hand front contact, and at its left-hand contact the transfer relay disconnects the line ML from the generator G and connects it to the receiving relay RR′.

As soon as the line is disconnected from the generator G further operations of the pole changers PC′ and PC″ under the control of the transmitter TD′ will be without effect so far as the transmission of signals is concerned. Moreover, since a spacing signal is being transmitted from station A as a result of break, the armature of the receiving relay RR′ will be shifted to its upper contact, so that the selecting circuit of the distributor will be held open at the end of the cycle thereby stopping the sending distributor in a well-known manner. The apparatus is now again in condition for the transmission of signals from station A to station B.

It may sometimes occur that when station B has been receiving signals no more signals will be sent from the station A over the line for a period. The apparatus will therefore remain in the condition shown in the drawing, so that signaling can only take place from station A to station B. If, under these circumstances, the operator at station B should start the transmitter to function, the transmitter would not transmit signals to the line, for the line would be disconnected from the transmitter over the front left-hand contact of the locked up transfer relay TR′. Furthermore, there would be nothing to indicate to the operator that signals were not being transmitted. In order to prevent this possibility an additional contact may be provided for the transfer relay TR′, as shown at the extreme right of said relay, and this contact may be included in series with the sending selection circuit of the printer, so that when it is open no signals will be sent. A failure of the apparatus to function under these circumstances will notify the operator that the break key BK′ should be actuated to shift the connections of the line at the terminal station.

A modified form of circuit for use at a terminal station such as that of station B of Fig. 1 is illustrated in Fig. 2. In this case the pole changer PC′ is simply a neutral relay serially connected in a simple series circuit including the transmitting distributor TD′ and the break key BK′. A parallel circuit from the break key BK′ also extends through the transfer relay TR′, which is arranged to be initially energized by the break relay BR′ and to be locked up through the break key BK′. When the transfer relay TR′ is energized, the break relay BR′ will be open-circuited, and the receiving relay RR will be serially included between the main line ML and ground, the line connection to generator G being also open-circuited at the same time. When, however, the transfer relay TR′ is deenergized, as is the case when sending, the receiving relay RR′ will be serially included in a circuit over the line through the break relay BR′ and through the generator G to ground. By thus including the receiving relay in the circuit both for sending and receiving, the local printer may be used as a

receiving printer when the station is receiving and as a home recording printer when the station is transmitting. The receiving relay will thus perform both the functions of the receiving relay and the home recording relay.

Further details of the apparatus will be clear from a description of the operation. Assume that station A is transmitting and station B is receiving. The transfer relay TR′ will be locked up over a circuit from positive battery over the break BK′ through the winding of the transfer relay TR′ and over its inner right-hand front contact to negative battery. The main line ML will be connected through the receiving relay RR′ directly to ground. The negative marking impulses and positive spacing impulses transmitted from the station A will actuate the receiving relay RR′ to control the receiving printer in a well-known manner without in any way affecting the transmitting apparatus.

If it should be desired to transmit signals from the station B, the break key BK′ may be held open thereby deenergizing the pole changing relay PC′ and unlocking and deenergizing the transfer relay TR′. The deenergization of the pole changing relay shifts its contacts to reverse the terminals of the generator, so that the negative terminal is connected to ground and the positive terminal is connected over the left-hand back contact of the transfer relay TR′ through the receiving relay RR′ over the right-hand back contact of the transfer relay TR′ and through the winding of the break relay BR′ to the main line. When a negative marking impulse is transmitted from station A, positive and negative battery will be connected to the opposite ends of the main line under these conditions, so that augmented current flows which operates the break relays at both stations. The break relay at station A performs the functions previously described. Break relay BR′ at station B upon being energized produces no result, as the circuit of the transfer relay TR′ is held open at the break key BK′. As soon as the break key is restored, the apparatus is in condition to transmit signals, and signals may be transmitted by interrupting the circuit of the pole changer PC′ through the agency of the transmitting distributor TD′ thereby sending positive and negative signals over the line.

If, while station A is receiving, it is desired to again transmit to station B, the operation of the break key at station A will apply positive battery to the line ML as already described. When a marking impulse is being transmitted from station B, the distributor TD′ will close the circuit of the pole changer PC′ to connect the negative side of the generator G to the line ML, so that augmented current flows over the line operating the break relays at both stations. The break relay at station A produces no effect upon being energized, but the break relay BR′ at station B closes the circuit of the transfer relay TR′ through the contact of the key BK′. The transfer relay TR′ is accordingly energized and locked up, open-circuiting the break relay BR′ and connecting the receiving relay RR′ directly between the main line and ground. The apparatus is now again in condition to receive signals, and signals may be transmitted from station A to station B.

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 at each end of said line circuit, transmitting apparatus and receiving apparatus at each terminal station, a local subscriber's loop extending from one of said terminal stations to a subscriber station, telegraph apparatus at the subscriber station whereby the transmitting apparatus at the corresponding terminal station may be controlled from the subscriber station over the loop and whereby the telegraph apparatus will respond to the receiving apparatus at the terminal station, telegraph apparatus at the other terminal station directly controlled by the transmitting and receiving apparatus thereat, and means whereby during non-signaling condition 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 for transmission in one direction, and for transmission in the opposite direction the connections will be reversed.

2. In a signaling system, a line circuit, a terminal station associated with said line circuit, transmitting apparatus at said terminal station including pole changing contacts, a receiving relay at said terminal station and switching means whereby, under certain conditions said receiving relay may be connected between said line circuit and a return path, and means whereby, under other circumstances, both said receiving relay and said pole changing contact may be included between said line circuit and a return path.

3. In a signaling system, a line circuit, a terminal station associated with said line circuit, transmitting apparatus at said terminal station including pole changing contacts, a receiving relay at said terminal station, a break relay and a break key at said terminal station and a transfer relay jointly

controlled by said break key and said break relay, means controlled by said transfer relay whereby under certain conditions to connect said receiving relay between said line circuit and a return path, and means functioning under other conditions to connect said break relay, said receiving relay and said pole changing contact between said line circuit and a return path.

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

EDWARD F. WATSON.