

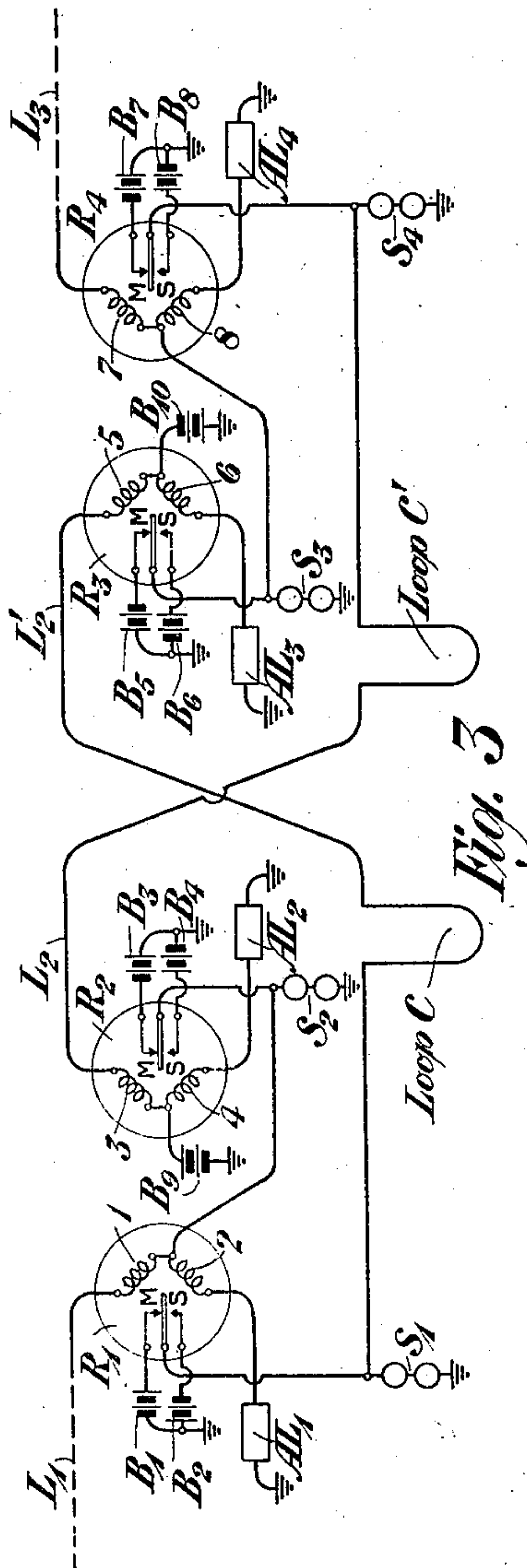
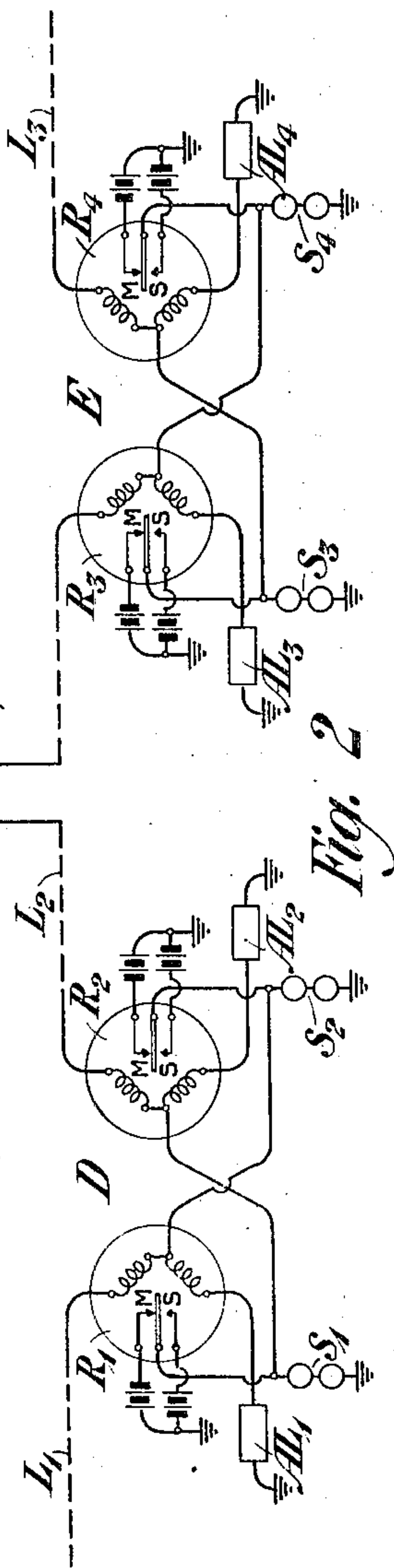
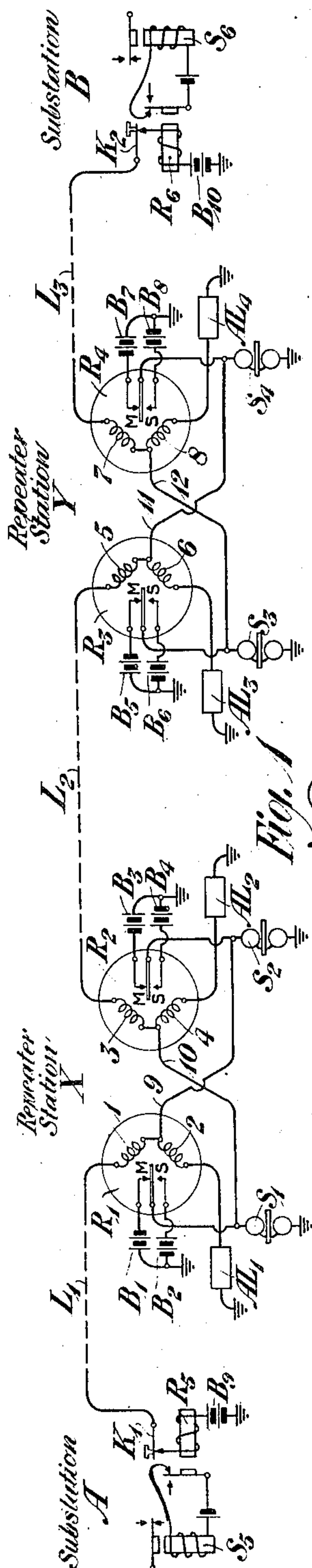
Aug. 11, 1925.

1,548,873

J. M. FELL

TELEGRAPH SIGNALING SYSTEM

Filed March 15, 1920



INVENTOR.
J. M. Fell
BY *John H. ...*
ATTORNEY

UNITED STATES PATENT OFFICE.

JOHN M. FELL, OF HACKENSACK, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEGRAPH SIGNALING SYSTEM.

Application filed March 15, 1920. Serial No. 365,911.

To all whom it may concern:

Be it known that I, JOHN M. FELL, residing at Hackensack, in the county of Bergen and State of New Jersey, have invented certain Improvements in Telegraph Signaling Systems, of which the following is a specification.

This invention relates to telegraph signaling systems, and more particularly to means for applying the duplex and half duplex methods of operation to local loop circuits in order to obtain greater efficiency in the operation of the said circuits.

The practice heretofore followed in connecting the local loop circuits with a duplex or half duplex line circuit was to connect into the loop circuit the winding of a neutral relay which constituted the pole changer for transmitting impulses of the proper polarity to the duplex or half duplex line circuit. It has been found that under practical operating conditions neutral relays have a strong tendency to bias telegraph signals. It is therefore desirable to use for this purpose a polarized relay as a pole changer. One of the objects of this invention is to provide means to permit the use of polarized relays responsive to the operation of the keys of the loop circuit to transmit to the line circuit impulses of the proper polarity and which will not be biased.

Another object of this invention consists in providing means for combining the sets above referred to in order to form telegraph repeaters which are adapted for use either as through repeaters or as terminal repeaters with sending and receiving loops to subscribers' offices.

Other and further objects of this invention will become apparent from the following description of the invention when read in connection with the attached drawings, of which Figure 1 shows schematically the arrangement of the circuit for half duplex operation between two telegraph subscribers' stations, Fig. 2 shows the combination of these sets to form a repeater with an intermediate loop circuit, and Fig. 3 shows the combination to form a full duplex repeater.

In Fig. 1 are shown two telegraph sub-stations A and B which are connected to two repeater stations X and Y by means of the subscribers' loop circuits L_1 and L_3 respectively. A telegraph line circuit L_2 connects the two repeater stations. The equipment

represented at sub-station A consists of a key K_1 , a neutral relay R_5 and a battery or other source of direct current potential B_9 . Controlled by the contacts of the relay R_5 is a sounder S_5 . At sub-station B the equipment is similar, comprising a key K_2 , a neutral relay R_6 , a battery B_{10} and a sounder S_6 . At the repeater stations X and Y are polarized relays R_1 , R_2 , R_3 and R_4 which as shown in the drawing are arranged in groups of two. The midpoint of the windings 1 and 2 of relay R_1 is connected by conductor 9 to the armature of relay R_2 . Similarly the midpoint of windings 3 and 4 of relay R_2 is connected by means of conductor 10 to the armature of the relay R_1 . The loop L_1 and the line L_2 are connected with windings 1 and 3 respectively, and the artificial line networks AL_1 and AL_2 , adapted to balance loop L_1 and line L_2 respectively, are connected to windings 2 and 4 respectively. Connected with the marking and spacing contacts of relay R_1 are the batteries B_1 and B_2 respectively, and similarly connected to relay R_2 are the batteries B_3 and B_4 respectively. The sounders S_1 and S_2 , connected in leak circuits of the armatures of the two relays, are designed for monitoring purposes.

The arrangement of the apparatus at the repeater station Y is similar to that at X. The line L_2 is connected with winding 5 of relay R_3 , and loop L_3 to winding 7 of relay R_4 . Artificial lines AL_3 and AL_4 designed to balance L_2 and L_3 respectively are connected to windings 6 and 8 respectively. The midpoint of windings 5 and 6 is connected by conductor 11 to the armature of R_4 , and similarly the midpoint of windings 7 and 8 is connected by a conductor 12 to the armature of relay R_3 . Batteries B_5 and B_7 are connected with the marking contacts and batteries B_6 and B_8 are connected with the spacing contacts of relays R_3 and R_4 respectively. It is important to point out that the polarity of the battery or other source of a direct current potential normally connected with the sub-station end of the loop circuits, such as batteries B_9 and B_{10} , shall be equal and opposite to the polarity of the battery that is connected with the marking contact of that relay whose armature is connected to the midpoint of the windings of the relay with which the subscriber's loop is permanently connected. Thus in the drawing batteries B_9 and B_{10} are represented

as having their positive sides connected with the loop circuits, and batteries B_3 and B_5 are represented as having their negative sides connected with the marking contacts of relays R_2 and R_3 respectively. This is important, since the operation of the system is dependent upon this principle and the reasons for this will be apparent from a description of the manner in which the circuit operates.

The mode of operation of this circuit is as follows: Let it be assumed that station A is sending and station B is receiving; that is, key K_1 will be opened and closed for spacing and marking, and key K_2 will remain closed for receiving. If the key K_1 is closed to transmit a marking signal, current will flow through the circuit from battery B_9 , relay R_5 , key K_1 , loop L_1 , winding 1 of relay R_1 , conductor 9, marking contact of relay R_2 and battery B_3 to ground. Current will also flow through winding 2 and the artificial balancing network AL_1 . The armature of relay R_1 will be held to the marking contact of this relay since there is an excess of current through winding 1 in a direction to hold the armature in this position.

Since the batteries B_1 and B_7 are opposed to each other, no current will flow through the line L_2 and the windings 3 and 5 of relays R_2 and R_3 respectively. Current will flow through windings 4 and 6 of the said relays, but its direction will be such as to hold the armatures of the said relays against their marking contacts. Since, as has been pointed out, the polarity of battery B_{10} is opposite that of battery B_5 , current will flow from battery B_{10} , relay R_6 , key K_2 , line L_3 , winding 7 of relay R_4 , conductor 12, armature of relay R_3 , battery B_5 to ground. Current will also flow through winding 8 and artificial line AL_4 , but since the preponderance of current flows through winding 7 and is in the direction to hold the armature of relay R_4 on its marking contact, the armature will so remain. By the flow of current through relay R_6 the marking signal transmitted from station A will be received at station B and indicated by the sounder S_6 .

If the key K_1 be opened to transmit a spacing signal, no current will flow through the winding 1 of relay R_1 , but current will flow through winding 2, and its direction and magnitude will be such as to move the armature of the said relay to its spacing contact. Since batteries B_2 and B_7 are now in conjunction, current will flow from battery B_2 , conductor 10, winding 3, line L_2 , winding 5, conductor 11, marking contact of relay R_4 and battery B_7 to ground. Current will also flow through windings 4 and 6 of relays R_2 and R_3 respectively. The magnitude of the current in winding 3 is greater than that in winding 4, and its

direction is such as to hold the armature of relay R_2 upon its marking contact. But the magnitude and the direction of current in winding 5 is such as to move the armature of the relay R_3 to its spacing contact to which battery B_6 is connected. It will be seen that since battery B_6 is in opposition to battery B_{10} , no current will flow through winding 7 of relay R_4 , line L_3 or relay R_6 at station B. Accordingly a spacing signal will be transmitted to station B.

If, during the period of transmission of signals from station A to station B, the operator at B should break the circuit by opening his key K_2 , the spacing signal would be transmitted to A in the following manner. If at the instant of breaking, the operator at A was sending a marking signal, all of the armatures of the polarized relays would be on their marking contacts. The opening of key K_2 will stop the flow of current from battery B_5 through winding 7 of relay R_4 , but the flow of current through winding 8 will be in such direction and magnitude as to move the armature of the said relay to its spacing contact. Batteries B_1 and B_8 being in conjunction, current will flow through line L_2 and the windings of the relays connected thereto. The armature of relay R_3 will be held upon its marking contact but the armature of relay R_2 will be moved to its spacing contact. Since batteries B_4 and B_9 are opposed to each other, no current will flow over the loop L_1 , and in consequence thereof relay R_5 will remain unoperated. This will cause the sounder S_5 to indicate a spacing signal, and, since this is unusual, because the key K_1 is in its marking position, the operator at A will be apprised of the fact that the operator at B is endeavoring to get control of the circuit.

From the foregoing it will be seen that one of the two relays at each repeater point constitutes a non-biasing pole changer, and the other relay of each group constitutes a polarized relay for the proper reception of signals. Thus in Fig. 1, R_1 is a pole changer controlled by impulses received over the loop L_1 , and adapted to apply impulses of the proper polarity to line L_2 and in turn to relay R_3 which is the polar relay for signals intended to be received at sub-station B. In transmitting from sub-station B to sub-station A, relay R_4 constitutes a pole changer controlled by impulses received over loop L_3 and adapted to impress impulses of the proper polarity upon the line L_2 and relay R_3 which constitutes the standard polar relay for signals intended to be received at sub-station A. By the use of polarized relays such as R_1 and R_4 for transmitting pole changes, greater efficiency of operation is attainable than was heretofore practicable where neutral relays were utilized for this purpose, in view of

the elimination of biased signals which was caused heretofore by sluggish armature action resulting from residual magnetism of the neutral relays.

Fig. 2 illustrates a combination of the elements shown in Fig. 1, which constitutes a half duplex repeater with loop circuits. Where loop circuits are located only at terminal stations, the outer end of each of the loop circuits is terminated in a battery as shown in Fig. 1, and in a manner as described in connection with the said figure. Where loops are required at a repeater station such as is represented in Fig. 2 by the loop C, both ends of the line with which the said loop is connected must terminate in duplex sets, such as are represented at D and E, which together constitute the repeater. In Fig. 2, L_1 represents a telegraph line circuit extending in one direction from the repeater station, and L_3 represents a similar line extending also from the same repeater station. L_2 represents a circuit for connecting the loop C through the repeater with the lines L_1 and L_3 . In this circuit arrangement R_1 and R_4 represent pole changers controlled by lines L_1 and L_3 respectively, and adapted to impress upon the loop C amplified or repeated signals, in accordance with impulses received over the lines L_1 or L_3 . R_2 and R_3 constitute polar relays for the reception of signals from lines L_3 and L_1 respectively. Thus marking and spacing impulses received over the line L_1 will cause corresponding movements of the armature of the relay R_1 , which will in turn impress upon the loop C and upon relay R_3 marking and spacing impulses. Relay R_3 will in turn impress upon the line L_3 corresponding signals. In like manner marking and spacing signals received over the line L_3 will accordingly operate relay R_4 which will in turn impress marking and spacing signals upon loop C and upon relay R_2 , which likewise will impress the proper signals upon the line L_1 .

Fig. 3 represents the application of this invention to a full duplex repeater circuit with loops, which is represented as being inserted between sections L_1 and L_3 of a through telegraph line. This repeater comprises the four polar relays R_1 , R_2 , R_3 and R_4 , the midpoint of the windings of relay R_1 being connected to the armature of relay R_2 , and similarly the midpoint of the windings of relay R_4 being connected to the armature of relay R_3 . The midpoints of the windings of relays R_2 and R_3 are connected directly with the batteries B_9 and B_{10} respectively, which are of opposite polarity. Connected with the said relays are the artificial lines AL_1 , AL_2 , AL_3 and AL_4 , and also the monitoring sounders S_1 , S_2 , S_3 and S_4 . It is important to note that the

polarity of battery B_1 shall be opposite to that of battery B_{10} , and that of battery B_7 shall be opposite to that of battery B_9 . That is to say that the two batteries of each group shall be conjunctively related. It is also important that the batteries connected with lines L_1 and L_3 shall be poled so as to be conjunctively related to batteries B_3 and B_5 respectively.

The mode of operation of this repeater circuit is as follows: When a marking impulse is being transmitted over line L_1 from a station connected therewith, current will flow through windings 1 and 2 of relay R_1 , but its direction will be such as to maintain the armature of this relay on its marking contact. Current will then flow from the battery B_1 over line L_2 and windings 5 and 6 of relay R_3 , and battery B_{10} to ground. The direction and magnitude of the current will be such as to maintain the armature of relay R_3 upon its marking contact, which causes a flow of current over circuit from battery B_5 , winding 7 of relay R_4 and line L_3 to the station connected therewith. Similarly a spacing signal transmitted from a station connected with the line L_1 will cause a movement of the armatures of relays R_1 and R_3 consecutively to their spacing positions, and will in turn impress a spacing signal upon line L_3 . If the signals are being transmitted by the stations connected with the line L_3 simultaneous with the transmission from line L_1 they will be repeated by the action of relays R_4 and R_2 . Thus, if a marking signal is being transmitted over the line L_3 at the same time a marking signal is being received over the line L_3 , the armature of the relay R_4 will be held upon its marking contact, and current will flow over a circuit from battery B_9 , windings 3 and 4 of relay R_2 , conductor L_2 and battery B_7 to ground. The difference in magnitude of current in windings 3 and 4 will be of such value and in such direction as to hold the armature of the said relay upon its marking contact, which will cause the transmission of a marking signal to the line L_1 . If a spacing signal is being transmitted over the line L_3 at the same time that a marking signal is being transmitted over the line L_1 , no current will flow through winding 7 of relay R_4 and the direction of current through winding 8 will be such as to move the armature to its spacing position. Since batteries B_8 and B_9 are opposed to each other, no current will flow in winding 3 of conductor L_2 . The flow of current in winding 4 will cause the armature of relay R_2 to move to its spacing contact, thereby applying a spacing signal to the line L_1 .

By means of the foregoing arrangement of a duplex repeater circuit, higher efficiency of operation is attained through the use of polarized relays for pole changers than has

been heretofore practicable. Although there has been shown at the sub-stations simple Morse apparatus, it is to be understood that any form of telegraph signaling apparatus such as duplex sets might be used, without changing the mode of operation of this invention. Further, although this invention has been shown in certain specific forms, it is to be understood that it is not limited to these forms, but is capable of embodiment in other and different forms within the scope of the appended claims.

What is claimed is:

1. In a telegraph signaling system, the combination of two polarized relays having the midpoint of the windings of each relay connected with the armature of the other relay, oppositely poled batteries adapted to be connected with said armature, a line circuit connected with one of said polar relays, a loop circuit connected with the other polar relay and having a key, a neutral relay, and a source of potential associated therewith, the polarity of which is opposite that of the battery normally connected with the midpoint of the windings of that polar relay with which the said loop is connected, whereby each polar relay constitutes the pole changer for the transmission of signals from its respective loop circuit.

2. In a telegraph signaling system, the combination of polarized relays arranged in groups of two each, the midpoint of the windings of each relay being connected with the armature of the said other relay, a plurality of sources of potential of opposite polarity adapted to be applied to each of said armatures, a loop circuit connected with one winding and an artificial line connected with the other winding of each relay, the said loop circuit comprising a key, a neutral relay and a source of potential, the polarity of the said source being opposite that of the source normally connected with the midpoint of the windings of the polar relay with which said loop is connected whereby each of said relays acts as a transmitting pole changer for signals transmitted over the loop directly connected thereto.

3. In a telegraph signaling system, the combination of two telegraph loops, each having keys a neutral relay and a source of potential associated therewith, and a plurality of polarized relays, the midpoint of the windings of each relay being connected with the armature of the other of said relays, the said armatures being normally in

contact with a source of potential, the polarity of which is normally opposite that of the source associated with the loop circuit with which the said armature is electrically connected.

4. In a telegraph repeater adapted for half duplex operation, the combination of four polar relays arranged in groups of two each, each relay of a group having the midpoint of its windings connected with the armature of the other relay of the same group, sources of current of opposite polarity connected with the marking and spacing contacts respectively of the armatures of each of said relays, a loop circuit connecting both groups of relays, having a neutral relay connected therewith, and a line circuit connected with each group, having associated therewith a source of potential of opposite polarity to that normally connected with the midpoint of the windings of the relay with which said line circuit may be connected.

5. In a telegraph repeater circuit, the combination of a plurality of polar relays arranged in groups of two each, having sources of current of opposite polarity connected with the marking and spacing contacts respectively of the armatures of each of said relays, and having the windings of one relay of each group connected with an artificial line and with a line circuit respectively, and having also the midpoint of said windings connected with the armature of the other relay of the same group, and the windings of the other relay of each group connected respectively with an artificial line and with the armature of the said first mentioned relay in the other group, and also having the midpoint of its windings connected with a source of current the polarity of which is opposite that of the source, normally connected with the marking contact of the armature with which said winding may be connected and a line circuit connected with the said first mentioned relay of each group and having a source of potential associated therewith opposite that of the source normally connected with the armature with which the midpoint of the windings of the said first mentioned relays may be connected.

In testimony whereof, I have signed my name to this specification this 12th day of March 1920.

JOHN M. FELL.