Oct. 14 , 1924. 1,511,326

J. M. FELL

DUPLEX TELEGRAPHY

Filed Nov. 16 . 1921

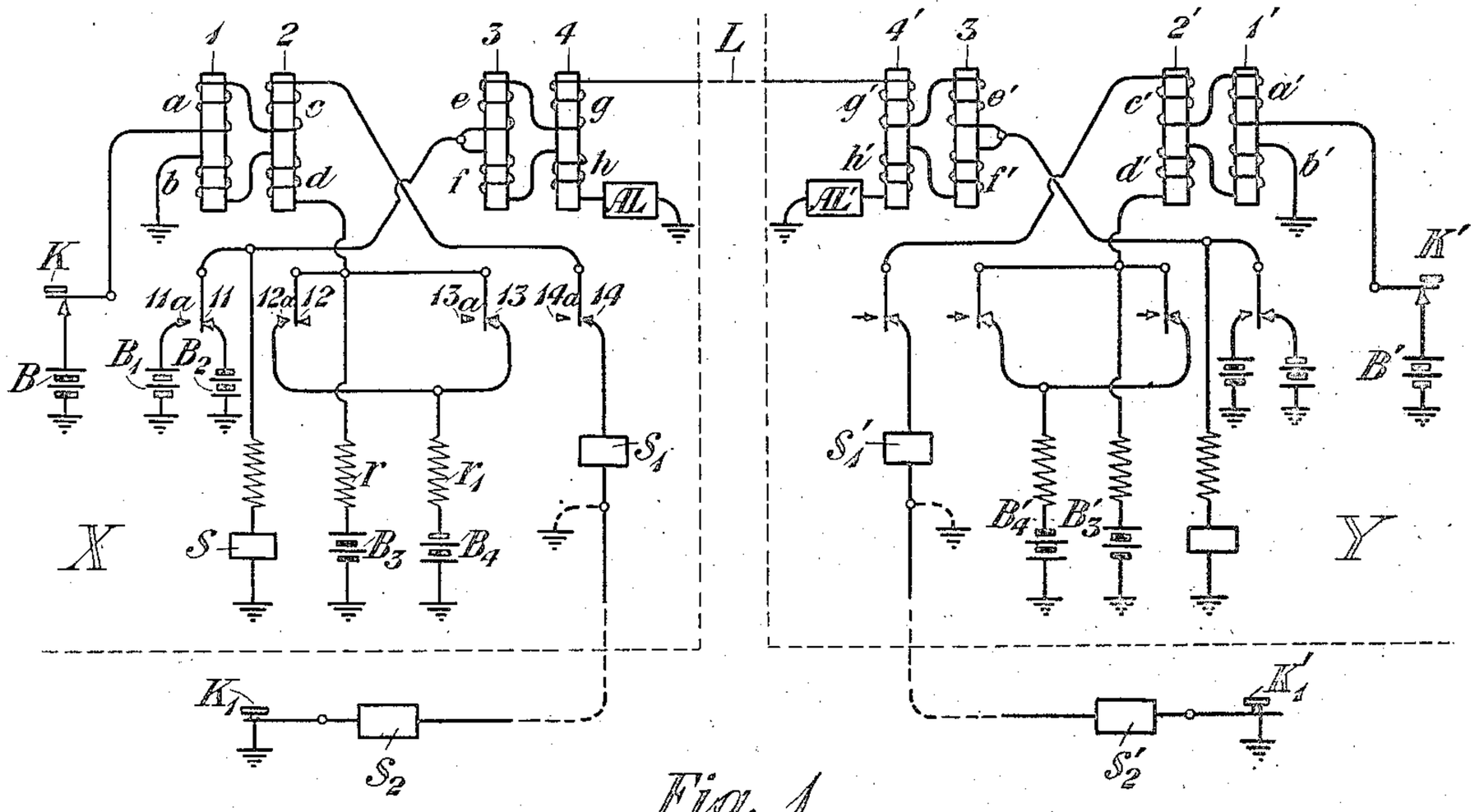

Fig. 1

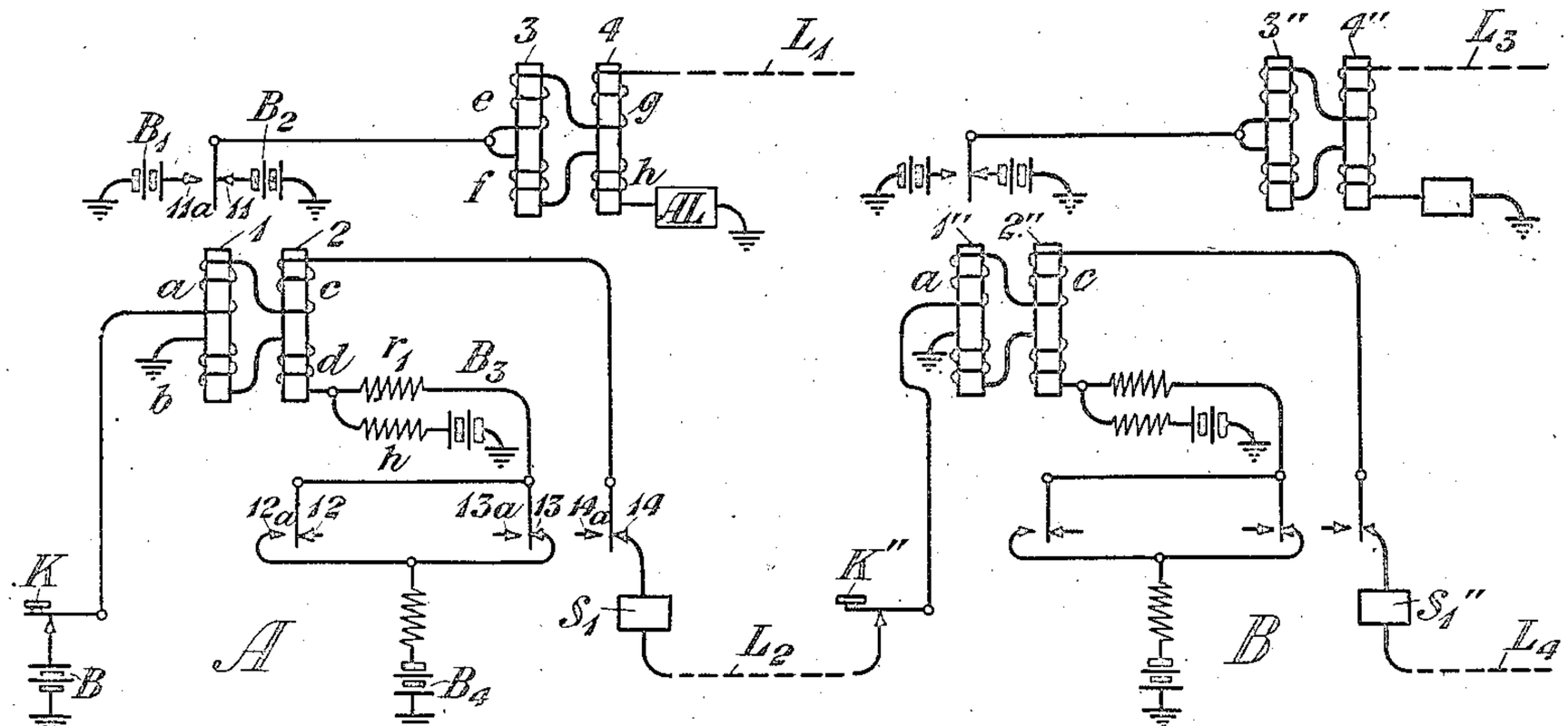

Fig. 2

INVENTOR
J. M. Fell
BY
ATTORNEY

Patented Oct. 14, 1924. 1,511,326

UNITED STATES PATENT OFFICE.

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

DUPLEX TELEGRAPHY.

Application filed November 16, 1921. Serial No. 515,643.

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 Duplex Telegraphy, of which the following is a specification.

This invention relates to duplex telegraph systems and particularly to such systems utilizing lines operated with a ground return. While the arrangements of the invention may be utilized for full duplex operation, i. e., transmission both ways simultaneously, they are particularly applicable for so-called half duplex operation, i. e., transmission one way at a time. One of the cardinal features of the invention consists in the utilization of polarized relays and the novel arrangement of such relays and associated apparatus at the telegraph stations. With such arrangements the transmission and service on duplex telegraph systems may be materially improved.

In half duplex transmission one loop is used for both transmitting and receiving signals. The pole changer which transmits into the line is included in this loop. Signals are produced in the loop by opening and closing it. Outgoing signals must operate the pole changer but incoming signals must not. To prevent operation of the pole changer by incoming signals, means are provided for locking it in its closed position when the loop is opened by an incoming signal. In former well known arrangements of duplex systems for grounded lines, incoming signals operate a polarized line relay and this, in turn, operates a local circuit relay called a control relay which repeats the signals into the loop circuit and, at the same time, by means of a supplementary contact, actuates a locking winding on the pole changer when the loop is opened by a space signal. The control relay and pole changer are both neutral type relays and, consequently, the efficiency of such systems is somewhat limited.

Another requirement of half duplex operation is to provide means for "breaking", i. e., getting control of the circuit from a loop while incoming signals are being repeated into the loop. A "break" can always be started when the contact which repeats incoming signals into the loop is closed, but to insure its complete transmission the repeating and pole changer locking contacts must be made inoperative as soon as the "break" is initiated. In former well known arrangements of duplex systems this was accomplished by causing a sounder, which is released by a "break" signal, to close a circuit through the control relay causing it to keep the repeating contact closed and the pole changer locking circuit inoperative. To establish this condition the pole changer armature must first move a sufficient distance to open the sounder circuit; then the sounder armature must move from its front to its back contact. This relay is undesirable and reduces the efficiency of the "break" feature in former types of systems.

In the arrangements of this invention polarized relays are used as pole changer, control and "break" relays, instead of the neutral pole changer and control relays and neutral sounder of the former systems heretofore referred to. The receiving relay is also polarized as in former arrangements. The pole changer and "break" relays each have two windings. One winding of each relay, referred to as the marking winding, is connected in series in the local loop circuit and when current flows in this circuit the armatures of both relays are moved to their marking contacts. The other winding of each relay, referred to as the spacing winding, is in a local battery circuit normally kept closed. The current in these windings is limited to about one half of that in the marking windings and this current tends to pull the armatures toward their spacing contacts. When the loop circuit is closed, the greater current in the marking windings keeps the armatures on their marking contacts, but when the loop circuit is opened, except at the receiving relay, current in the spacing windings instantly moves the armatures to their spacing contacts. The receiving relay and the control relay are operated simultaneously by incoming signals. Each time the receiving relay opens the loop circuit, the control relay causes a reversal of current in the spacing windings of the pole changer and "break" relays, thus converting them temporarily to holding windings which keep the armatures on their marking contacts. This prevents a transmission of incoming signals back to the line circuit.

The "break" relay operates simultaneously with the pole changer. When its armature is moved to the spacing contact, spacing

battery is directly connected to the pole changer and "break" relay spacing windings. This makes the transmission of a "break" signal, once it is started, independent of the action of the receiving and control relays. The only time required to establish this condition is the armature travel time of the polarized "break" relay. This time is less than that required for the "break" operation as pointed out for former types of duplex systems and accordingly the efficiency of the "break" operation is increased.

The arrangements of the invention serve to materially improve the service on duplex telegraph systems. A few features of such improvement may be specifically enumerated as,—a reduction of the number of repetitions over former systems by repeating directly from the line to the loop; improved transmission by utilizing polarized instead of neutral relays; an improvement in the "break" feature by reducing the time required to establish it. Furthermore the relay arrangements of the invention are such as to permit the combination of two or more sets to make a repeater for joining two or more lines in one circuit, operable from any station in it.

The invention may be more fully understood from the following description when read in connection with the accompanying drawing. In Fig. 1 of the drawing the arrangements of the invention are illustrated in a circuit arranged for half duplex transmission between two stations. In Fig. 2 the duplex sets of the invention are shown as repeaters for interconnecting a plurality of lines.

In Fig. 1 of the drawing are shown two terminal stations X and Y joined by a line L and the equipment at each station when the system is used for half duplex operation. The duplex set at station X has four polar relays 1, 2, 3 and 4, each relay having two windings arranged differentially. Relays 3 and 4 are connected differentially in the line and artificial line circuits, L and AL respectively, in a manner well known in the art, and are operated by signals arriving from station Y but are non-responsive to signals originating at station X. Relays 1 and 2 each have one winding, *a* and *c*, in the local receiving circuit. This circuit includes battery B, key K, windings *a* and *c*, contact 14 of relay 4, sounder S_1, and a loop circuit which may extend to a substation and include key K_1 and sounder S_2. This loop circuit, however, may be omitted and the sounder S_1 may be grounded. The second windings of relays 1 and 2, *b* and *d* respectively, are in series in a local circuit as follows,—from ground, through windings *b* and *d*, thence through parallel paths, one of which includes resistance *r* and battery B_3, while the other path includes resistance r_1 and battery B_4. The potential of, or the resistances in series with, the batteries B_3 and B_4 are so proportioned that when both circuits are closed the current through windings *b* and *d* opposes the current which normally flows through windings *a* and *c*, but when the circuit from battery B_4 is open the current in windings *b* and *d* (then due to battery B_3) is reversed and produces the same effect in relays 1 and 2 as the normal current in windings *a* and *c*. The relay 4 may be termed the line relay, relay 3 the control relay, relay 2 the "break" relay, and relay 1 the pole changer. Relay 4 controls contacts 14 and 14^a, relay 3 controls contacts 13 and 13^a, relay 2 controls contacts 12 and 12^a, and relay 1 controls the marking and spacing contacts 11 and 11^a respectively. The equipment at station Y is substantially similar to that at X, like parts being represented with like reference characters with prime indices added.

The operation of these arrangements is as follows: The relays and keys are represented in the drawing in their normally closed positions. If now the key K′ or K_1' at Y is opened to produce a space signal the spacing impulse arriving at X moves the armatures of relays 3 and 4 from contacts 13 and 14 to contacts 13^a and 14^a respectively. When contact 14 opens, current ceases to flow in windings *a* and *c* of relays 1 and 2 and in sounders S_1 and S_2. Sounders S_1 and S_2 open but since contact 13 of relay 3 opens simultaneously with contact 14 of relay 4 battery B_4 is disconnected and current from battery B_3 flows through the windings *b* and *d* of relays 1 and 2 in a direction to keep contacts 11 and 12 closed; thus relays 1 and 2 do not operate and relay 1 does not repeat the incoming signal back to station Y. Closing the key at station Y causes a marking impulse to be transmitted to station X, which moves the armatures of relays 3 and 4 to contacts 13 and 14 respectively and thus restores the apparatus to the condition as shown in the drawing.

Opening key K at station X to transmit a spacing signal stops the flow of current through windings *a* and *c* of relays 1 and 2 and through sounders S_1 and S_2. As contact 13 of relay 3 is closed current from battery B_4 flows through the windings *b* and *d* of relays 1 and 2 in a direction to move their armatures from contacts 11 and 12 to contacts 11^a and 12^a respectively as soon as current ceases to flow in windings *a* and *c*. When contact 11^a closes, current from spacing battery B_1 flows to line L through windings *e* and *g* and to artificial line AL through windings *f* and *h* of relays 3 and 4. This reversal of current through both windings of relays 3 and 4, as the windings are differentially arranged, pro-

duces no operative effect in them, but the reversal of the current in the line L operates the line relays 3′ and 4′ at station Y. When contact 12ª of relay 2 closes, a new circuit is provided from battery B_4 to windings *b* and *d* of relays 1 and 2 which is in parallel with the circuit through contact 13 of relay 3. The purpose of this circuit will be described hereinafter in connection with the "break" feature of the system.

Sounders S_1 and S_2 are released when key K or K_1 is opened. The polarized sounder S, which is connected in a leak circuit from the armature of the pole changer relay 1, is also released when the line battery is reversed. Sounders S_1 and S_2 indicate to the terminal station and substation attendants respectively the signals produced in the loop circuit and sounder S indicates to the terminal station attendant that signals originating in the loop circuit are properly transmitted to line L.

When key K or K_1 is again closed relays 1 and 2 and sounders S_1 and S_2 are restored to their normally closed conditions and when contact 11 of relay 1 closes sounder S closes, and a marking impulse is transmitted which restores the instruments at station Y to their normally closed positions.

It will be seen that when the sets are used with four relays in the above described manner that signals can be transmitted one way at a time only, for when key K or K_1 is open no signal can be produced in the receiving circuit by the operation of relay 4, and when the contacts of relays 3 and 4 are open relays 1 and 2 can not be operated by key K or K_1.

In single transmission systems it is essential that an operator at a receiving station shall have means for "breaking" the operator who is sending in order that the "breaking" operator may himself transmit when he has an important message to deliver. For efficient telegraph service the "breaking" means must be quick and reliable. In the arrangements of this invention an efficient "breaking" means is provided through the agency of the relay 2. As has been heretofore described relays 1 and 2 are kept closed when signals are being received, for when relays 3 and 4 are closed the greater current in windings *a* and *c* hold relays 1 and 2 closed and when relays 3 and 4 are open the current from battery B_3 flows through windings *b* and *d* in a direction to keep them closed. If key K or K_1 is opened to "break" while relays 3 and 4 are closed current ceases to flow in windings *a* and *c* of relays 1 and 2, thereupon, current in windings *b* and *d* from battery B_4 moves the armatures from contacts 11 and 12 to contacts 11ª and 12ª respectively. Contact 12ª closes the circuit from battery B_4 forming a new path from that battery to winding *b* and *d* and consequently relays 1 and 2 will still receive spacing current from battery B_4 even though contact 13 of relay 3 should again be opened by an incoming spacing signal. Since these relays are now under control of the open key (K_1 or K), a space signal is sent to station Y from battery B_1 over contact 11ª and this signal cannot be interrupted by any operation of relay 3 and 4. If the second circuit from battery B_4 through contact 12ª were not provided relays 1 and 2 would be closed by current from battery B_3 when contact 13 opened in response to an incoming space signal. Opening a key in the local loop circuit while relays 3 and 4 are open produces no effect on relays 1 and 2 as they are then under control of battery B_3. It sometimes happens when dots are being received that a key is opened to transmit a "break" signal while relays 3 and 4 are open. In this case the "break" is delayed until contact 13 of relay 3 is closed. When this contact closes current from battery B_4 through windings *b* and *d* opens relays 1 and 2 (although contact 14 closes simultaneously no current flows in windings *a* and *c* because of the open key) and then contact 12ª provides a new path for battery B_4 and places relays 1 and 2 (and the transmission of the "break" signal) under control of the open key even though relays 3 and 4 may again open.

In Fig. 2 are shown a plurality of the duplex sets of this invention, such as A and B, utilized to connect a plurality of lines such as L_1 and L_3 into one operating circuit for single transmission. Like reference characters have been used to denote like parts with respect to Fig. 1. In this arrangement the line relays, such as 3 and 4 and 3″ and 4″, are connected with their respective line circuits L_1 and L_3. The windings *a* and *c* of the relays such as 1 and 2 and 1″ and 2″ are connected, as shown, in series in a local loop circuit. This circuit may be terminated by ground at conductor L_4 or may be continued to other sets if desired. With this arrangement signals originating in any line circuit are repeated into the local loop circuit and thence into each other line circuit. Signals originating in the local loop circuit are repeated into all connected lines. As the principles of operation of the arrangements would be substantially the same as heretofore described with respect to Fig. 1 no further description thereof will be given.

While the invention has been illustrated in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many other and widely varied forms without departing

from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. A duplex telegraph set comprising a loop circuit, a polarized pole changer relay and a polarized break relay having windings serially included in said loop circuit and additional windings on said relays, a circuit the potential of which is normally opposite to that of said loop circuit, said additional windings being included in said circuit.

2. A duplex telegraph set comprising a receiving relay and a control relay, a loop circuit, a polarized pole changer relay and a polarized break relay having windings included in said loop circuit, additional windings on said two last mentioned relays, said additional windings being included in a circuit the potential of which is normally opposite to that of said loop circuit, and means controlled by said receiving relay and said control relay for opening said loop circuit and reversing the potential in the other circuit.

3. A duplex telegraph set comprising a receiving relay and a control relay, a loop circuit, a polarized pole changer relay having a winding serially included in said loop circuit, a source of current in said loop circuit of a polarity such that when said loop circuit is closed the contacts of said relay will be maintained in a predetermined position, a second winding on said polarized relay, said winding being included in a local circuit, a second source of current associated with said local circuit of a polarity tending to reverse the predetermined position of said relay contacts, a third source of current associated with said local circuit of a polarity tending to maintain said relay contacts in said predetermined position, the potential of said first mentioned source of current being greater than the potential of said second source and the potential of said second source being greater than said third source, and means whereby said receiving relay may control said loop circuit and whereby said control relay may control said local circuit.

4. A duplex telegraph set comprising a receiving relay and a control relay, a loop circuit, a polarized pole changer relay and a polarized break relay having windings included in said loop circuit, additional windings on said two last mentioned relays, said additional windings being included in a local circuit the potential of which is normally opposite to that of said loop circuit, means controlled by said receiving relay and said control relay when operated for opening said loop circuit and reversing the potential in said local circuit, and means controlled by said break relay when operated for preventing the potential in said local circuit from being reversed upon the aforementioned operation of said control relay.

In testimony whereof, I have signed my name to this specification this 15th day of November 1921.

JOHN M. FELL.