(No Model.) 2 Sheets—Sheet 1.

T. B. DIXON.

POLAR RELAY.

No. 560,313. Patented May 19, 1896.

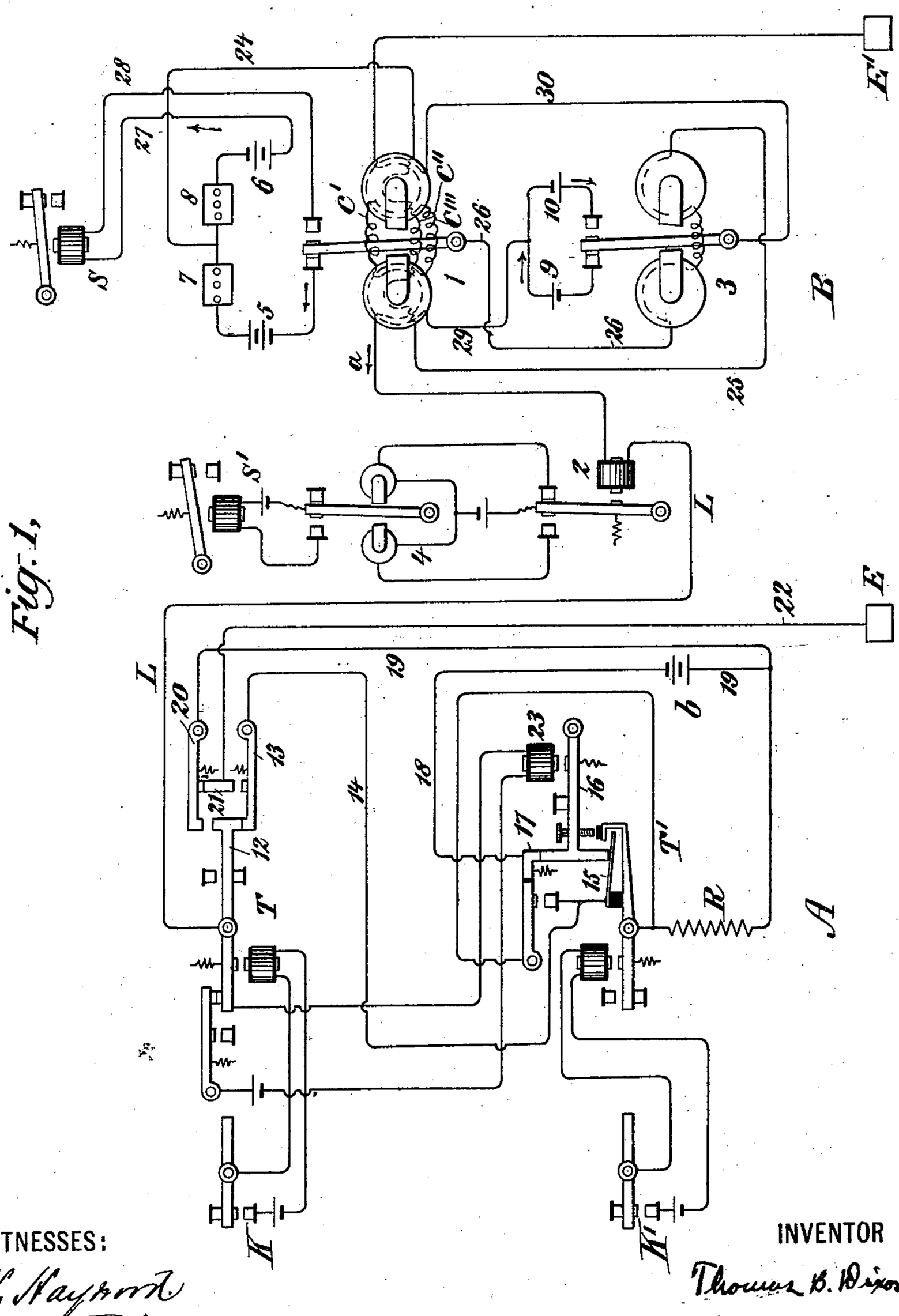

Fig. 1.

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Fig. 3.

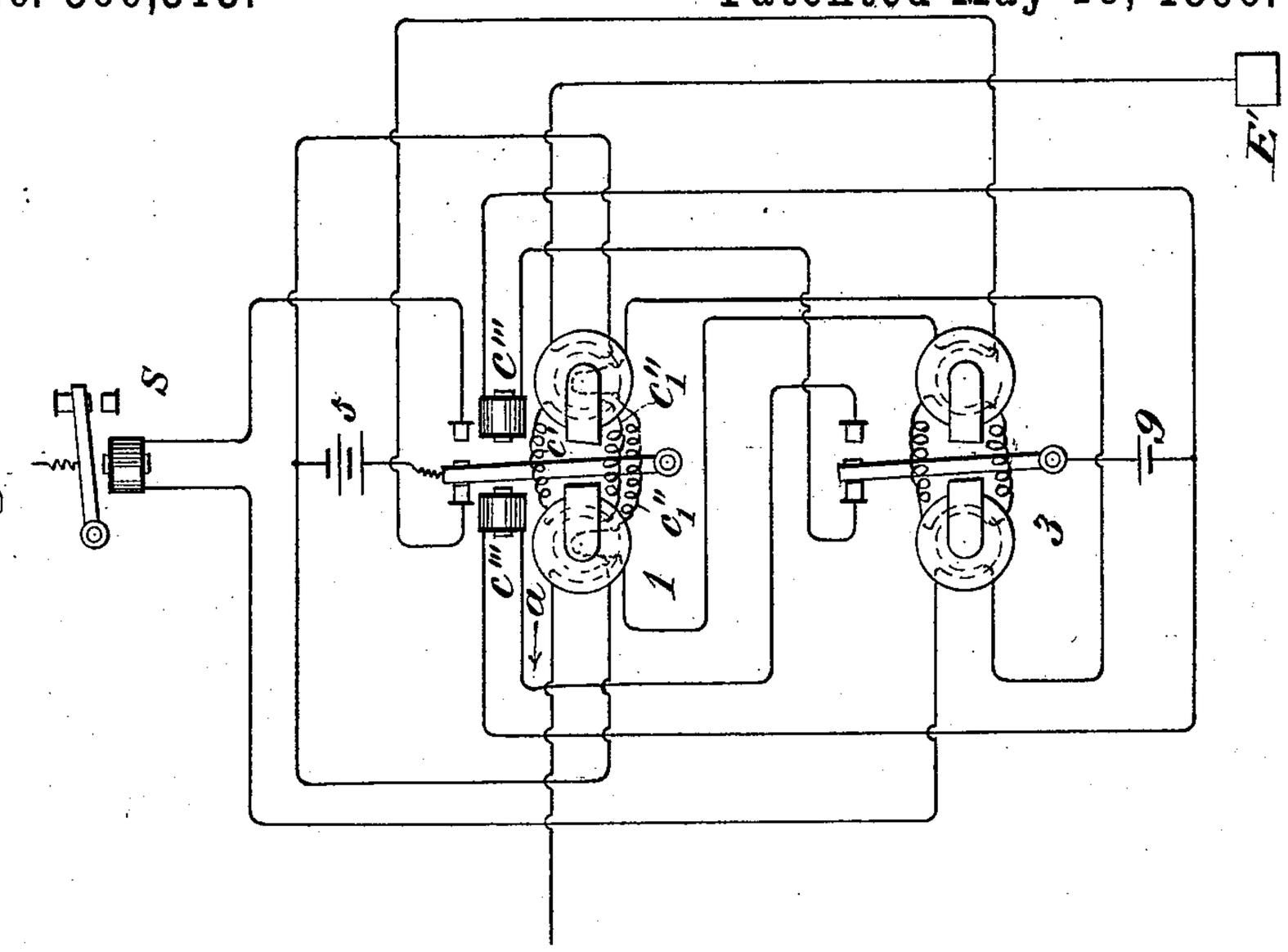
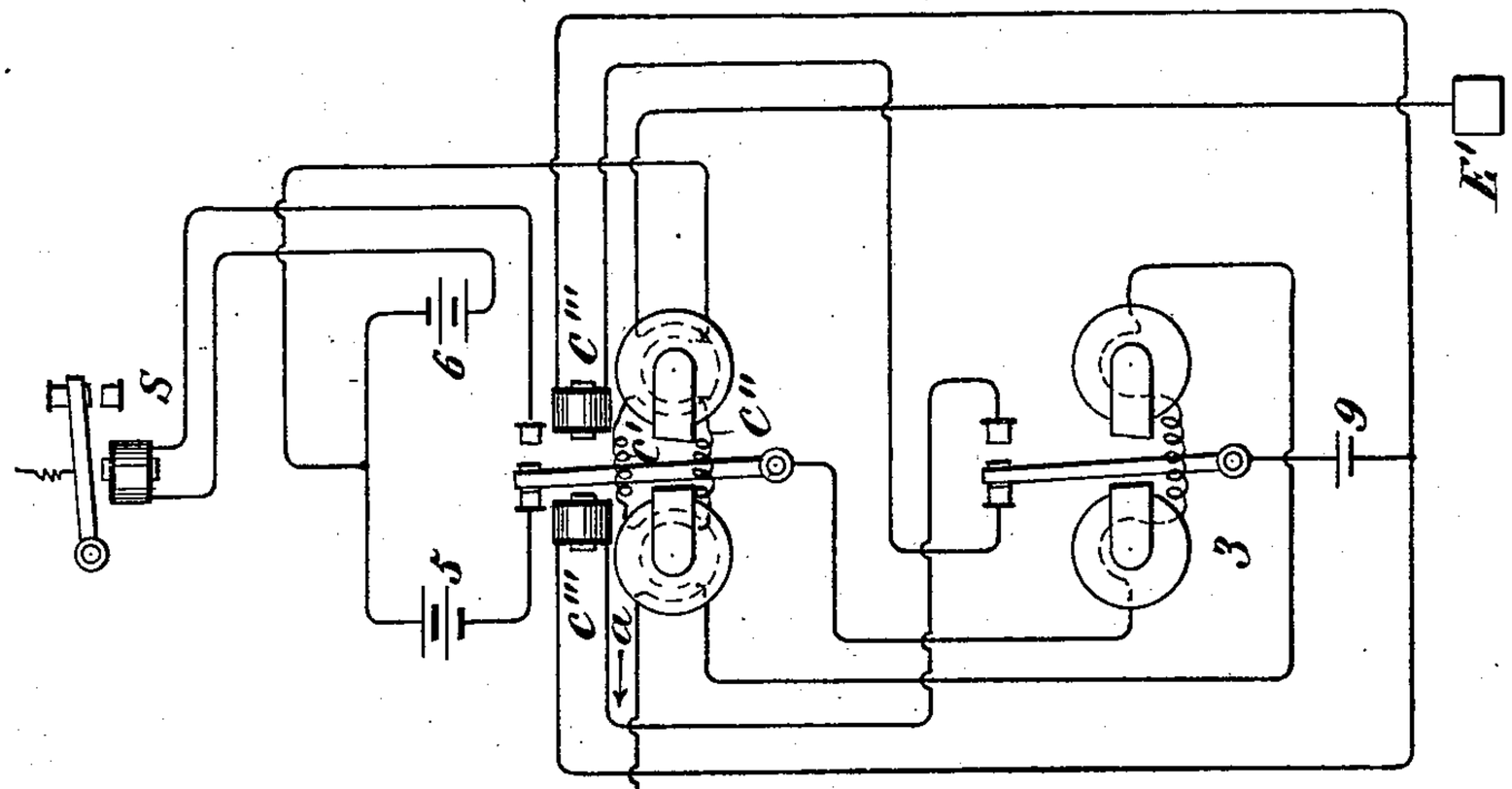


Fig. 2.



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POLAR RELAY.

SPECIFICATION forming part of Letters Patent No. 560,313, dated May 19, 1896.

Application filed March 27, 1896. Serial No. 585,055. (No model.)

To all whom it may concern:

Be it known that I, THOMAS BULLITT DIXON, a citizen of the United States, residing at Henderson, in the county of Henderson and State of Kentucky, have invented certain new and useful Improvements in Polar Instruments; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates generally to polar instruments, such as polar relays, employed in systems of signaling, such as telegraphy, and operated by reversals of current or polarity in the circuits to which they are connected; and my invention relates particularly to means for preventing such polar instruments from being influenced by false currents in the line.

In systems of signaling which operate by the reversal or change of polarity of the circuit there sometimes occur times when the current in the circuit is weak or ceases entirely, and it is well known that at such times of no current the polar instruments are liable to be falsely operated by false currents, such as may be induced by currents in neighboring lines, thus giving rise to false operations of the polar instruments.

My present invention is particularly applicable to the system of multiple telegraphy for which Letters Patent were granted to me on November 12, 1895, No. 549,709. In this system there are employed one or more current-varying transmitting instruments arranged to vary the current strength in the line or to stop the flow of current through the line altogether and a current-reversing or pole-changing transmitter arranged to reverse the current in the line, together with suitable receiving instruments which are operated by the variations in current strength or direction produced by said transmitting instruments. In this system means are provided, when the pole-changing transmitter is operated at a time when no current is flowing through the line, for producing a brief pulsation of current at the instant when the polarity of the line is reversed, so that by this means the receiving instrument corresponding to the pole-changing transmitter may be operated; but in this system there is some liability that during the period of no current in the line false induced currents set up in the line by induction from neighboring lines may cause false operation or mutilation of the signals of the polar receiving instrument.

My invention consists in the means whereby false operation of polar instruments by false or induced currents, weaker or of shorter duration than the current by which the polar instruments are normally operated, may be prevented.

The objects of my present invention are to provide means for so controlling polar instruments that they may not be operated or in any manner affected by false currents in the lines and to make the means for preventing such false operation as simple as possible. These objects are attained in the invention herein described and illustrated in the drawings which accompany and form a part of this application, in which the same reference letters and numerals indicate the same or corresponding parts, and in which—

Figure 1 is a diagram illustrating the application of the polar instrument operating in accordance with my invention to a multiple-telegraph system, the particular system illustrated being that described in my above-mentioned patent. The figure shows, diagrammatically, telegraphic circuits for transmitting two messages simultaneously in one direction, one by variation of current strength in the line and the other by reversal of polarity in the line. Figs. 2 and 3 are similar diagrams of the polar instruments and connections, showing different circuits for controlling the instrument.

In the drawings, A is the transmitting-station of the telegraph-line, and B the receiving-station, the two stations being connected by a line-wire L.

T is the pole-changing transmitter, and T′ the current-varying transmitter, both of which are electrically operated and are controlled by finger-keys K and K′, respectively, in the ordinary manner.

b is the line-battery, which transmitter T′ is arranged to throw into and out of the line-circuit, and R is the usual resistance for maintaining the resistance of the line constant when battery *b* is cut out of the line-

circuit. Transmitter T is arranged when operated to reverse the polarity of the line.

At station B, 1 is the polar relay responding to transmitter T'. 2 is the line polar relay responding to transmitter T'. 3 is a local polar relay controlling and controlled by the line polar relay 1 in the manner to be hereinafter described.

4 is a dead-beat relay controlled by line neutral relay 2, such as is described in Letters Patent No. 543,894, granted to me on August 6, 1895, for a system of multiplex telegraphy, and which is controlled by line neutral relay 2 in the manner described in said patent and in Patent No. 549,709, above mentioned.

S is the sounder or receiving instrument operated by polar relay 1, and S' a sounder operated by neutral relay 2. Polar relay 1 is wound with three independent series of coils c' c'' c''', termed "main," "secondary," and "tertiary" coils, respectively.

5 and 6 are local batteries, each connected to one contact-point of polar relay 1, the negative pole of battery 5 being connected to the contact-point of relay 1 and the positive pole of battery 6 being connected to the opposite contact-point of relay 1 through the sounder S.

7 and 8 are rheostats in the circuits of batteries 5 and 6. Their function is to equalize and regulate the currents of the two batteries.

9 and 10 are local batteries connected to opposite contact-points of local polar relay 3, the negative pole of battery 9 and the positive pole of battery 10 being connected each to one of these contact-points.

In the drawings the instruments and circuits are shown in normal positions. The normal direction of current is from E', where the line is grounded at station B, through main coils c' of relay 1, relay 2, and the line conductor L, through lever 12 and contact-point 13 of transmitter T, conductor 14, contact-tongue 15 of transmitter T', contact-levers 16 and 17, conductor 18, battery b, conductor 19, contact-points 20 and 21 of transmitter T, and conductor 22 to earth at E. The normal direction of current in the line is indicated by an arrow a at station B. The effect of the operation of the current-varying transmitter T', due to the depression of key K', is to throw battery b out of circuit, so as to stop the flow of current in the line, the line-circuit, however, remaining complete through resistance R. The effect of the operation of pole-changing transmitter T is to reverse the line polarity, and if this takes place at a time when battery b is out of the line the operation of transmitter T, due to the depression of key K, breaks the circuit of magnet 23 of transmitter T', causing lever 16 to fall and make contact with tongue 15, thus throwing battery b into circuit, and an instant thereafter causing the contact-lever 17 to break contact with lever 16, thus again throwing battery b out of circuit, the effect of the fall of lever 16 being to produce in the line conductor L a brief pulsation of current, which passes through the line an instant after the contact-points of transmitter T reverse the polarity of the line. This operation of the transmitting instrument is more fully described in my Patent No. 549,709, above mentioned.

The effect of the reversal of polarity in the line, as above described, is to move the armature of relay 1 from the left-hand contact-point, as shown in the drawings, to the right-hand contact-point. When key K is released, a corresponding reversal of line polarity takes place, together with a second production of a pulsatory current in the line, if transmitter-key K' is still depressed, and the armature of relay 1 is again deflected, this time against its left-hand contact-point.

The current of battery 5, when the armature of relay 1 is in normal position, passes through rheostat 7, conductor 24, secondary coils c'', conductor 25, the coils of local polar relay 3, conductor 26, and the armature of relay 1, to the left-hand contact-point of the polar relay, and back to battery 5. When the armature of relay 1 is deflected to the right, the circuit of battery 5 is broken, and the circuit of battery 6 is completed as follows: from the positive pole of battery 6 through conductor 27, sounder S, conductor 28, to the right contact-point of relay 1, through the armature of relay 1, conductor 26, coils of relay 3, conductor 25, coils c'' of relay 1, conductor 24, rheostat 8, and so back to battery. This current, as will be noted, passes through the coils of relays 1 and 3 in the reverse direction to the current of battery 5. The current of battery 5 passes through the coils c'' in the same direction that the line-current passes through the coils c' when the direction of current in the line is normal—that is, the direction indicated by the arrow a—and the current of battery 6 passes through the coils c'' only when the line-current has been reversed. Therefore the direction of the current in secondary coils c'' is always the same as that of the current in the main coils c', or of the last current which flowed through coils c' in case the main current is interrupted. Therefore the secondary coils c'' tend to hold the armature in the position in which it is placed by the main coils c'. The effect of the substitution of battery 6 for battery 5 upon the local circuits of the polar receiving instruments therefore is but to reverse the direction of the current in the circuit of the secondary coils c''; but this reversal moves the armature of relay 3 from its left-hand contact-point to its right-hand contact-point. In the normal position of the armature of relay 3 a current passes from the positive pole of battery 9 through conductor 29, tertiary coils c''', conductor 30, and the armature, and the left-hand contact-point of relay 3 back to battery. The direction of current of battery 9 through the coils c''' is the reverse therefore of that of battery 5 through coils c'', and the influence of coils c''' upon the armature of relay 1 is opposed to that of coils c''; but battery 9 is weaker than battery 5. Therefore

the magnetizing influence of coils c'' upon the armature is not entirely neutralized by that of coils c'''. When the armature of relay 3 is deflected to the right, the current of battery 10 passes through the coils c''' in the reverse direction to that of the current of battery 9; but the armature of relay 3 is only deflected to the right when the armature of relay 1 is also deflected to the right. Therefore when the armatures of these relays are to the right the influence of coils c''' upon the armature of relay 1 is still opposed to that of coils c'', but does not completely neutralize the same, since battery 10 is weaker than battery 6.

The effect of the substitution of battery 10 for battery 9, as with the substitution of battery 6 for battery 5, is merely to reverse the direction of the current in the circuit.

To simplify the explanation of the operation of this invention, definite values of current strength will be as follows: batteries b, 5, and 6, one hundred units each, and batteries 9 and 10 fifty units each, it being assumed that the coils c', c'', and c''' are so constructed and so placed that if their currents were of equal strength they would affect the armature equally. It is obvious that the same effect on the armature may be obtained by using batteries of equal strength and by employing coils c', c'', and c''' of different length or resistance, or by placing the coils at different distances from the armature, so as to affect it unequally.

With the values of current strength assumed there exists normally in the coils of the relay 1 a total influence upon the armature of relay 1 equal to that of the current of battery b, one hundred units, plus that of battery 5, one hundred units, minus that of battery 9, fifty units—in all, one hundred and fifty units. If now key K is depressed, thus reversing the polarity of the line and causing the line-current to flow through the coils c' of relay 1 in the opposite direction to that indicated by the arrow a, then the influence upon the armature of the main coils c', one hundred units strength, is added to that of the tertiary coils c''', fifty units strength, thus overbalancing the influence of secondary coils c'', one hundred units, by a margin of fifty units, causing the armature of relay 1 to be deflected to the right. The instant the armature leaves its left-hand contact-point the circuit of secondary coils c'' is broken, so that the full current strength of coils c' and c''' tends to move the armature of relay 1 to the right, and even if battery b should be thrown out of circuit at the instant when the armature of relay 1 is moving to the right, as by the breaking of contact between tongue 15 and lever 16 of transmitter T′, or between levers 16 and 17, there would still remain the influence of coils c''' to move the armature of relay 1 to the right. The instant the armature of relay 1 reaches its right-hand contact the circuit of coils c'' is completed, the current being from battery 6 and in the opposite direction to the former current and in a direction parallel to the new direction of current of battery b through coils c', while the armature of relay 3 is deflected to the right, throwing battery 9 out of the circuit of tertiary coils c''' and throwing battery 10 into the circuit of coil c''', thus reversing the direction of the current in the tertiary coils. When key K is released, transmitter T restores the line to its normal polarity and a similar but reverse operation takes place, the armature of relay 1 being moved to the left by the combined influence of coils c' and c''', opposed to the influence of coils c'', the influence of coils c'' ceasing, however, the instant the armature of relay 1 leaves its right-hand contact-point.

The operation of the receiving instruments is the same as above described when key K is depressed or released while key K′ is depressed, battery b, although out of circuit at the time when key K begins to be depressed or released, being thrown into the line-circuit momentarily by the operation of the contact-points of transmitter T′ at the instant of or immediately after the reversal of line polarity by transmitter T and being kept in the line long enough to at least start the armature of relay 1 to moving. It will be seen, therefore, that for the operation of the polar receiving instruments it is only necessary that the current of battery b shall continue for a period long enough to permit the armature of relay 1 to break contact with the stop against which it is resting when the reversal of line polarity takes place. The instant the armature has left this stop the circuit of the secondary coils c'' is broken, and after that the armature is or may be moved by the tertiary coils c''' alone. This is important, as it is this feature which makes it possible to operate the receiving instruments by a pulsatory current over a long line. If transmitter-key K′ is already depressed at the time when key K is depressed, so that battery b is out of the line, then battery b is thrown into the line for a brief instant by the operation of levers 16 and 17 and magnet 23 at the instant when the reversal of line polarity takes place, and the current flowing through the line in the brief instant of reversal of line polarity has but to be continued for a sufficient period of time to permit the armature of relay 1 to break contact with the contact-point against which it is resting at the instant of reversal of line polarity, after which the movement of the armature continues, owing to the influence of the tertiary coils c'''. It is therefore possible to operate relay 1 by a very brief pulsatory current, such as will be obtained even on very long lines.

It will be observed that at no time when there is no current flowing through the main coils c' is the armature of relay 1 free to move. The secondary coils c'', the influence of which is only partly counteracted by the tertiary coils c''', always act to hold the armature in

that extreme position in which it was placed by the coils c' when those coils were last energized. False currents induced in the line conductor by currents in neighboring lines can never have sufficient strength to overcome the influence of the secondary coils c'' on the armature. The influence of the coils c'' can only be overcome by the coils c' sufficiently to permit the armature to move.

The transmitters T and T' (shown in the drawings) are arranged to keep the line-circuit normally closed; but the polar relay 1 and the circuits by which it is controlled operate equally well in normally open circuits, the relay being as free from disturbance while the line-batteries are cut out for considerable intervals of time as when cut out only momentarily.

All of the three sets of magnet-coils of relay 1 need not be wound upon the same cores. Instead, one or all sets may be wound upon separate cores, all acting upon the same armature-lever. This is illustrated in Fig. 2, in which the tertiary coils are wound upon separate cores.

As already pointed out, the batteries 5 and 6 of the secondary coils and the batteries 9 and 10 of the tertiary coils serve merely as convenient means for reversing the direction of the current in these coils when the armature of relays 1 and 3 are moved. Instead of using two batteries to effect the reversal of the current in each of said circuits, other well-known circuit-reversing devices may be used, or the secondary and the tertiary coils, one or both, may be divided and placed upon opposite sides of the armature, the current being passed through the coils on one side of the armature when the armature is to be attracted toward that side, and vice versa. This is illustrated in Figs. 2 and 3, in which the tertiary coils are so divided. Thus when the armature of relay 3 is against its left-hand contact-point the current of battery 9 passes through the coils c''' on the right-hand side of relay 1, and when the armature of relay 3 is against its right-hand contact-point the current from battery 9 passes through the coils c''' on the left-hand side of relay 1.

Instead of dividing up the secondary or tertiary coils in the manner shown in Fig. 2, these coils may be divided in the manner shown in Fig. 3, in which the magnets of the polar relay 1 are provided with two independent sets of secondary coils c_1'' each similar to the coils c'' of Fig. 1. The contact-points of relay 1 are arranged to send the current of battery 5 through the coils c_1'' when the armature is against the left-hand contact-point and to send the current of battery 5 through the coils c_1'' in the opposite direction when the armature is against the right-hand contact-point. This it will be seen is merely another method of reversing the polarity of the secondary coils equivalent to the reversal of current accomplished by the circuits of Fig. 1.

Having thus completely described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a polar instrument, the combination, with a polarized armature movably mounted, and main, secondary, and tertiary magnet-coils each arranged when energized to tend to deflect the armature in one direction or the other according to the polarity of said coils, of circuit-controlling devices operated by the movement of said armature and controlling the circuit of said secondary coils, arranged when the armature is in either extreme position to cause said circuit to energize said secondary coils so as to tend to hold the armature in that position, and electrically-controlled circuit-controlling devices controlled by the circuit of said secondary coils and controlling the circuit of said tertiary coils and arranged when the armature is in either extreme position to cause said circuit to energize said tertiary coils to tend to move the armature to the opposite position, substantially as described.

2. In a polar instrument, the combination, with a polarized armature movably mounted, and main, secondary, and tertiary magnet-coils each arranged when energized to tend to deflect the armature in one direction or the other according to the polarity of said coils, the influence of the tertiary coils on said armature being weaker than that of the main or secondary coils and the influence of the secondary coils on said armature being weaker than that of the combined influence of the main and tertiary coils, of circuit-controlling devices operated by the movement of said armature and controlling the circuit of said secondary coils, arranged when the armature is in either extreme position to cause said circuit to energize said secondary coils to tend to hold the armature in that position, and electrically-controlled circuit-controlling devices controlled by the circuit of said secondary coils and controlling the circuit of said tertiary coils and arranged when the armature is in either extreme position to cause said circuit to energize said tertiary coils to tend to move the armature to the opposite position, substantially as described.

3. In a polar instrument, the combination, with a polarized armature movably mounted, and main, secondary, and tertiary magnet-coils each arranged when energized to tend to deflect the armature in one direction or the other according to the polarity of said coils, of circuit-controlling devices operated by the movement of said armature and controlling the circuit of said secondary coils, arranged when the armature is in either extreme position to cause said circuit to energize said secondary coils to tend to hold the armature in that position, electrically-controlled circuit-controlling devices controlled by the circuit of said secondary coils and controlling the circuit of said tertiary coils, and arranged when the armature is in either extreme position to cause said circuit to energize said

tertiary coils to tend to move the armature in the opposite position, and means for supplying current to said secondary and tertiary coils, arranged to make the strength of the tertiary coils less than that of the main or secondary coils and to make the strength of the secondary coils less than the combined strength of the main and tertiary coils, substantially as described.

4. In a polar instrument, the combination, with a polarized armature movably mounted, and main, secondary and tertiary magnet-coils each arranged when energized to tend to deflect the armature in one direction or the other according to the polarity of said coils, of circuit-controlling devices arranged to reverse the currents in said secondary and tertiary coils successively when the direction of the current in the main coils is reversed, and to give the secondary coils the same polarity as the main coils and the tertiary coils the opposite polarity, substantially as described.

5. In a polar instrument, the combination, with a polarized armature movably mounted, and main, secondary, and tertiary magnet-coils each arranged when energized to tend to deflect the armature in one direction or the other according to the polarity of said coils, of circuit-controlling devices arranged to reverse the current in said secondary coils when the direction of the current in the main coils is reversed and to give said coils the same polarity as the main coils, and a polar relay, operated by the circuit of said secondary coils and controlling the circuit of said tertiary coils and arranged to reverse the current in said tertiary coils when the direction of current in the secondary coils is reversed, and to give the tertiary coils the opposite polarity to the main coils, substantially as described.

6. In a polar instrument, the combination, with a polarized armature movably mounted, and main, secondary, and tertiary magnet-coils each arranged to deflect the armature in one direction or the other according to the polarity of said coils, of circuit-controlling devices, operated by the said armature and controlling the circuit of said secondary coils, and arranged to give said secondary coils the same polarity as the main coils, to deënergize the secondary coils when the said armature moves, and to reverse the polarity of said secondary coils when the polarity of the main coils is reversed, and circuit-controlling devices operated by the circuit of the secondary coils and controlling the circuit of the tertiary coils, and arranged to reverse the polarity of the tertiary coils when the polarity of the secondary coils is reversed, and to give the tertiary coils the opposite polarity to the main coils, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

THOMAS BULLITT DIXON.

Witnesses:

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U. B. JENKINS.