(No Model.) 2 Sheets—Sheet 1.

S. P. FREIR.

DIPLEX AND QUADRUPLEX TELEGRAPHY.

No. 352,865. Patented Nov. 16, 1886.

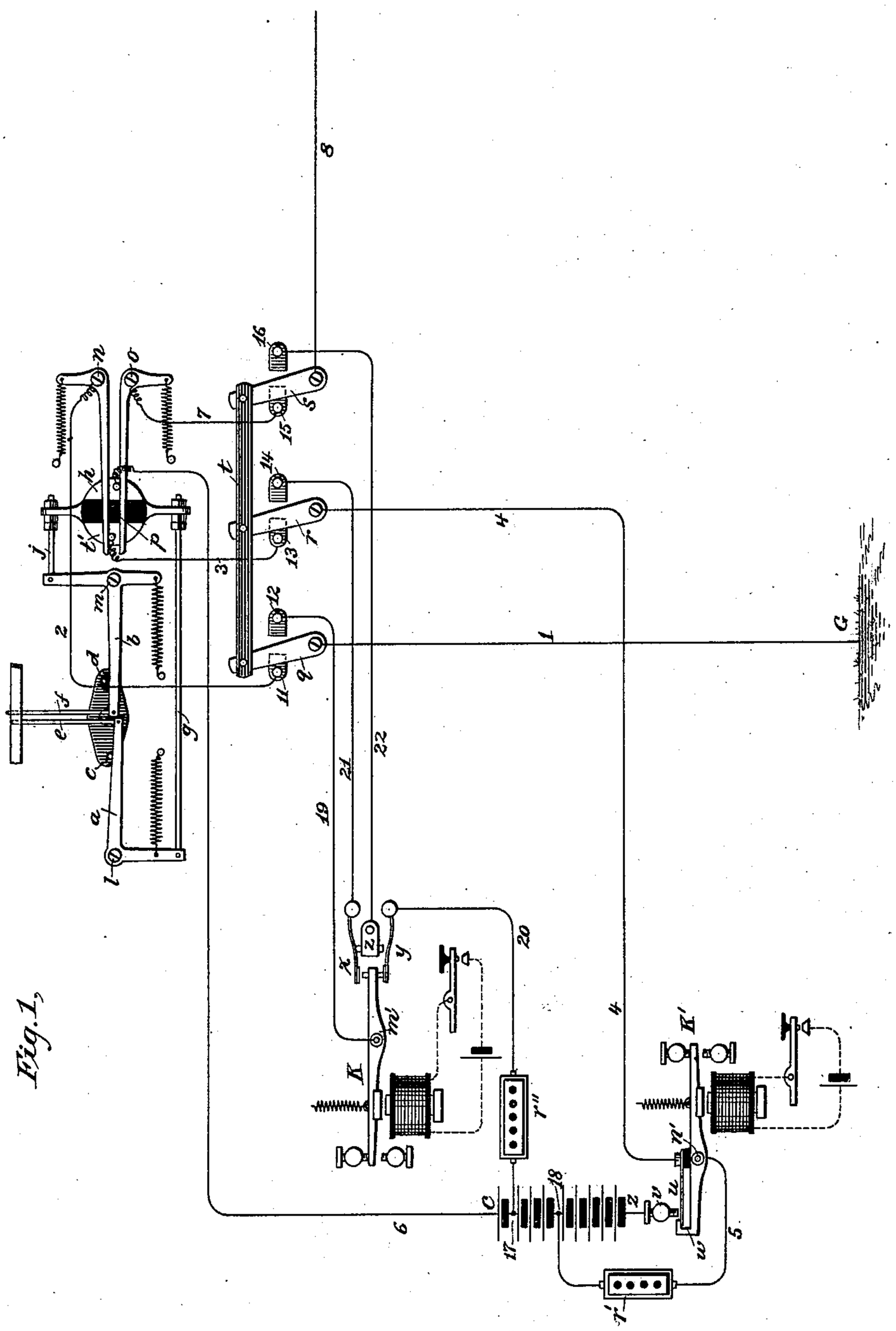

Fig. 1.

Witnesses
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Carrie E. Ashley

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Fig. 2,

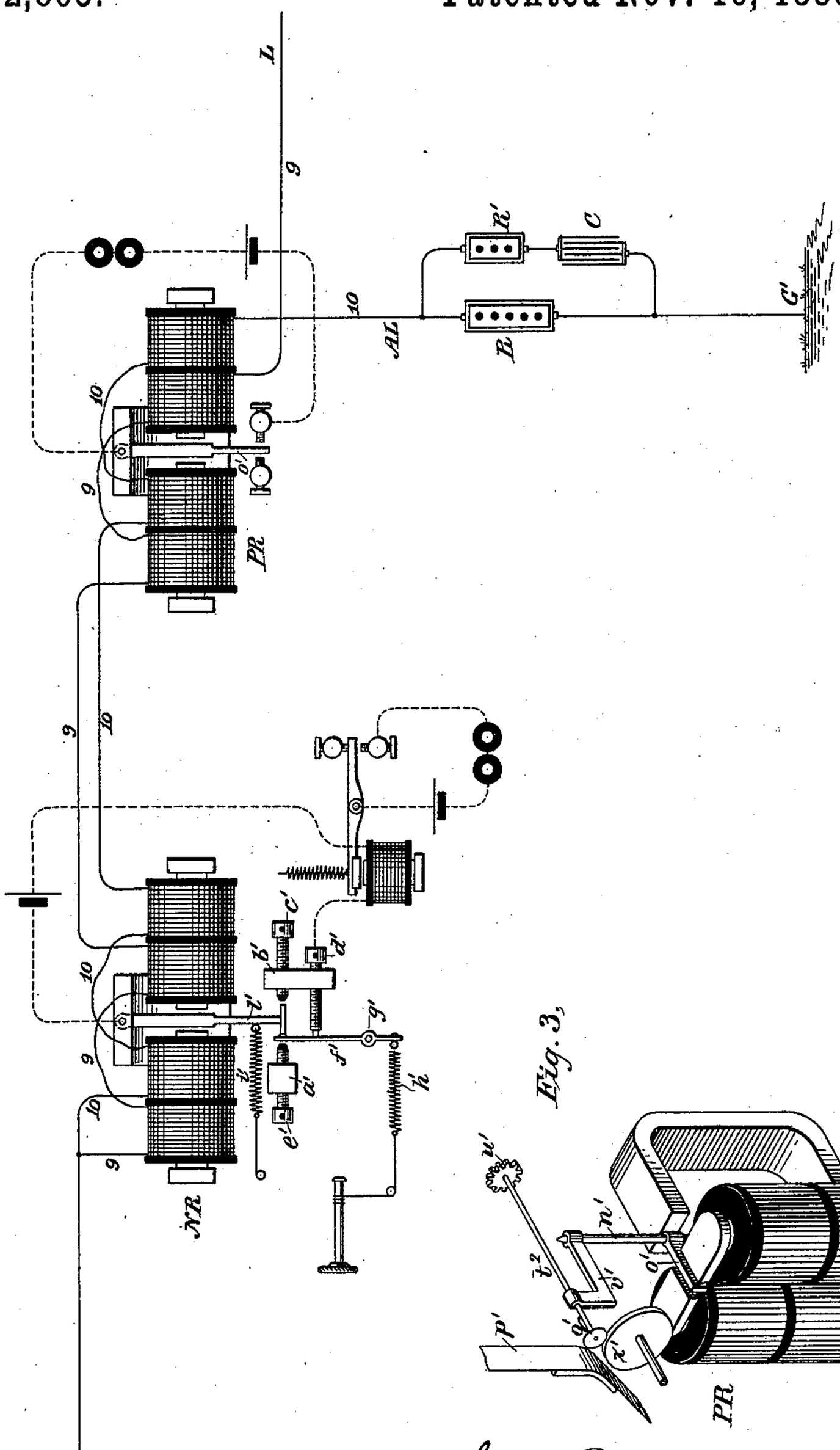

Fig. 3,

Witnesses

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UNITED STATES PATENT OFFICE.

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DIPLEX AND QUADRUPLEX TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 352,865, dated November 16, 1886.

Application filed August 13, 1886. Serial No. 210,780. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL PHILIP FREIR, residing in Roselle, county of Union, State of New Jersey, a subject of the Queen of Great Britain, have made a new and useful Improvement in Diplex and Quadruplex Telegraphy, of which the following is a specification.

In quadruplex telegraphs as heretofore employed two messages are transmitted from a station while two messages are simultaneously received from a distant station. The four transmitters—the two at the home station and the two at a distant station—have heretofore been manually operated—that is, by the hand of the transmitting-operator.

The object of this invention is to enable two of the manual transmitters—one at each station—to be replaced by automatic transmitters.

To this end, for convenience of illustration, I have shown the apparatus of a quadruplex system at one station, in which one message is transmitted wholly by changes in current strength, while the other is transmitted, either automatically or manually, wholly by current reversals, the arrangement being such that when the automatic transmitter is connected for operation the manual transmitter is cut out or disconnected, and vice versa.

To enable automatic and manual transmitters to be alternately used at the pleasure of the transmitting-operator, modifications of battery arrangement and improvements in apparatus of the receiving-instruments are employed, which will hereinafter be fully explained.

Figure 1 represents the transmitting apparatus of my improved quadruplex system at one station; Fig. 2, the receiving apparatus at the same station, while Fig. 3 shows the polarized receiving-instrument, such as is usually employed in automatic-telegraph systems. Both ends of the telegraph-line are provided with similar apparatus, each with the other, as is common in systems of quadruplex and duplex telegraphy.

Referring to Fig. 1, K and K′ represent two manual transmitters, K being employed to send a message by reversals of current independent of changes in strength, while K′ is employed to send a message by changes in current strength independent of reversals. Electrical connections of transmitter K are joined to the main line 8 through a switch consisting of an insulating-bar, *t*, three switch-levers, *q r s*, and contact-pieces 11 12 13 14 15 16. An automatic transmitter is also connected to the main line through said switch, and the connections of the two transmitters are such that when the switch is thrown to the left the automatic transmitter will be placed in circuit for transmission, and the manual transmitter will at the same time be disconnected. On the other hand, when the switch is thrown to the right, the automatic transmitter is disconnected and the manual transmitter joined to the line for operation. When the switch is thrown to the left, as shown in the drawings, the circuit from earth G is completed by means of wire 1, switch-lever *q*, contact-wire 2, arm *n*, a pin mounted upon *t′* forming part of the automatic pole-changer, wire 3, contact 13, switch-lever *r*, wire 4, spring *u*, lever *w*, wire 5, resistance *r′*, to point 18 of the battery; thence through the upper section of battery, wire 6, conducting-pin upon the metallic portion *h* of said automatically-vibrating disk pivoted at *p*, lever *o*, wire 7, contact 15, and switch-lever *s*, to line 8.

It will be apparent that as the oscillating disk provided with metallic portions *t′ h* oscillates about its axis *p* the upper section of the transmitting-battery will be reversed with each movement of said disk. The oscillating movement of said disk is primarily controlled by a strip of paper in which apertures are arranged in a zigzag line to represent the message to be transmitted, so that when an aperture is brought opposite either of two pins, *e* or *f*, that pin, through the agency of any suitable motor, as a clock-work, is pressed into said aperture and the other pin correspondingly depressed. Thus as the paper strip is moved along in the direction of its length the pins *e f* are alternately raised and lowered, thereby oscillating a cross-head carrying pins *c d*, which operate upon bell-crank levers *a b*, pivoted, respectively, at *l n*. Said levers are provided with retracting-springs and connecting-rods *g j*, thus mechanically joining them with the commutator-disk and causing it to oscillate about its pivot *p*. This apparatus is commonly known as the "Wheatstone Automatic Transmitter." My invention, however, is not limited to this specific form of transmit-

ter, inasmuch as any automatic transmitter for automatically effecting reversals of current might be employed. With the switch thrown to the right, cutting out the automatic transmitter, the circuit from earth G is as follows: wire 1, switch-arm *q*, contact 12, wire 19, lever *m'* of the manual transmitter, spring *y*, wire 20, resistance *r''*, the central section of battery between points 17 and 18, resistance *r'*, wire 5, lever *w*, spring *u*, wire 4, switch-arm *r*, contact 14, wire 21, spring *x*, anvils *z*, wire 22, contact 16, switch-arm *s*, and main line 8. When, however, the armature-lever of the manual transmitter K is operated, the section of main-line battery between points 17 and 18 is reversed in respect to the main line, and positive and negative currents are alternately transmitted.

The circuits heretofore referred to—one through the automatic transmitter and the other through the manual transmitter—have been traced with the transmitter K' in its retracted position; but if the arm of the transmitter K' were attracted the circuit through resistance *r'* and wire 5 would be broken, and in that case—that is, when the automatic transmitter is in operation—the entire battery between poles *c* and *z* would be reversed, while in the case of the operation of the manual transmitter only the section of battery between points 17 and pole *z* would be reversed.

I have found in practice that where very rapid reversals are required, as in connection with an automatic transmitter, a stronger battery is required, and in view of this consideration I have so arranged my battery that when the automatic transmitter is employed more cells are brought into operation than when the manual transmitter is used. The necessity for this arrangement arises from the fact that disturbances upon that relay which is responsive to changes in current strength only are rendered practically the same by employing a smaller battery with the slow manual transmitter K and a larger battery with the more rapid automatic transmitter. If the same battery were employed in connection with both the manual and the automatic transmitter, the relay at the distant station which is responsive to changes of current strength would be more difficult of adjustment, since the disturbance arising from the manual transmitter would be unlike that due to the automatic transmitter. It being well understood in the art of quadruplex telegraphy that the relay which is responsive to changes of current strength is subject to disturbing effects due to reversals of current arising from the transmission of a second message, no explanation of the cause of such difficulty is here necessary. To enable an adjustment for this element of disturbance, the difficulty should be rendered as nearly uniform as possible, and, as I have found, uniformity of disturbance is only practically attained by employing with the manual transmitter a weaker battery than is used with the automatic transmitter.

When the section of battery from 18 to pole *z* is connected in circuit, wire 5 and rheostat *r'* are disconnected, and vice versa. To render the resistance of the circuit practically constant, it is therefore necessary that the resistance of *r'* be made equal to that of the battery between 18 and pole *c;* and inasmuch as the upper section of battery is only used with the automatic transmitter it is obviously necessary to employ a rheostat, *r''*, in wire 20 of a resistance equal to that of the section of battery between 17 and pole *c*.

The receiving apparatus shown in Fig. 2 consists of a relay, N R, which is responsive only to changes in current strength, while relay P R is responsive only to current reversals. The operation of relay N R is wholly controlled by the manual transmitter K' at the distant station, while the relay P R is controlled either by the manual transmitter K or the automatic transmitter at said distant station. The relay N R consists, primarily, of the ordinary Siemens polarized electro-magnet, consisting of a permanent magnet, to one end of which is pivoted a vibrating soft-iron tongue forming the relay-armature, and upon the opposite end of the permanent magnet are mounted two soft-iron cores which are differentially wound, substantially as shown in the drawings. The soft-iron tongue *l'* is provided with a retracting-spring, *i'*, which holds the free end of said tongue against one end of lever *f'*, pivoted at *g'*, and to the opposite end of said lever *f'* is connected a stronger retracting-spring, *h'*. *a'* is a post carrying an insulated stop-screw, *e'*, while *b'* is a post carrying an insulated stop-screw, *c'*, and an adjustable contact-screw, *d'*. With this arrangement a weak current—say of positive polarity—will cause the relay-arm *l'* to press against lever *f'*, but not with sufficient force to separate *f'* from the contact-screw *d'*. A weak current of opposite or negative polarity will tend to throw the relay-arm *l'* in an opposite direction, but not with sufficient force to overcome the tension of spring *i'* and separate it from contact with lever *f'*. On the other hand, a strong positive current—such as is employed when the entire battery, or that portion between point 17 and pole *z* is employed—will serve to press armature-lever *l'* against lever *f'* with such force as to separate *f'* from contact-screw *d'*, thereby breaking the local circuit connected with contact *d'* and the armature-lever *l'*. Likewise said local circuit is broken if a strong negative current is transmitted, for in that case armature-lever *l'* will be attracted to the right with such force as to overcome the tension of spring *i'*, thereby separating lever *l'* from contact with lever *f'*. Thus a weak current of neither polarity suffices to break the local sounder-circuit; but a strong current of either polarity will break said local circuit and cause a signal to be recorded.

Relay P R, for receiving signals due to current reversal, is of the ordinary Siemens type of polarized electro-magnet and responds

equally to the manual transmitter K and the automatic transmitter—that is, the vibrating armature *o'* is operated by either transmitter. When the manual transmitter is in operation, the message will usually be received by sound upon the sounder of a local circuit, although a record at the same time may or may not be made upon a strip of paper by the automatic receiver. When, however, the automatic transmitter is in use, its operation being so rapid, signals cannot be received by sound upon the local sounder; but they will be recorded upon a strip of paper, *p'*, (shown in Fig. 3,) by means of an inking point or disk, *q'*, which is alternately pressed upon and withdrawn from the paper strip *p'* by means of an arm, *v'*, mounted upon an axis, *w'*, to which the vibrating relay-tongue *o'* is attached.

Fig. 2 shows the receiving-instruments arranged in a differential-duplex system, of which the wire 9 is a fragment of the main line L, and wire 10 a portion of the artificial line A L, which is grounded at G'. The artificial line A L is provided with a large rheostat, R, and a condenser branch, including a small rheostat, R', and a condenser, C, of the usual form and arrangement. My invention, however, is not limited to a differential system, as it may equally well be applied to the Bridge or other well-known species of quadruplex apparatus; nor is my invention limited to the use of an automatic pole-changing transmitter. An automatic transmitter might be used in which signals are sent by effecting changes in current strength; but in such case the switch would have to be so arranged as to either connect the automatic or the manual transmitter K' with the main line. In this case the manual pole-changing transmitter K would always be connected to the circuit. In like manner any well-known form of quadruplex could be employed in connection with an automatic transmitter so arranged that one of the manual transmitters could be cut out and replaced with the automatic transmitter.

My invention is not limited to use in a quadruplex, as the arrangement of apparatus is applicable to a diplex where an automatic transmitter is employed to replace one of the manual transmitters at the pleasure of the transmitting-operators.

What I claim, and desire to secure by Letters Patent, is—

1. In a quadruplex telegraph, the combination, at a transmitting-station, of an automatic and two manual transmitters and a switching arrangement, the whole being so arranged that either both manual transmitters, or one manual transmitter and the automatic transmitter, may be simultaneously used to send independent messages.

2. In a diplex or quadruplex telegraph system, the combination of two manual transmitters, an automatic transmitter, a switching arrangement for connecting a manual transmitter and disconnecting the automatic transmitter, and vice versa, and two receiving-instruments at a distant station, as and for the purpose described.

3. In a diplex or quadruplex telegraph system, the combination of a manual and an automatic transmitter which may be independently and interchangeably used, a battery-section which is used with the manual transmitter, an additional battery, and a switch for adding such additional battery to the first-named battery-section when the automatic transmitter is used, as and for the purpose described.

4. In a quadruplex-telegraph system, a manual transmitter for effecting changes in current strength, a manual and an automatic transmitter, each for effecting current reversals, and a switching arrangement and electrical connections, by which said automatic and manual transmitters may be interchangeably used, as and for the purpose described.

5. In a quadruplex-telegraph system, a manual transmitter for effecting changes in current strength, an automatic and a manual transmitter, each for effecting current reversals, a switching apparatus for interchangeably connecting said transmitters in circuit, and a battery so arranged that a weaker section is employed with said manual transmitter than is used with the automatic transmitter, as and for the purpose described.

6. In a diplex or quadruplex telegraph system, the combination of the main line, a manual transmitter and an automatic transmitter, and a second manual transmitter which may be interchangeably used with the automatic transmitter for simultaneously sending two independent messages, and two receiving-instruments at a distant station, one of which is responsive to the first manual transmitter and the other to the automatic or second manual transmitter, as and for the purpose set forth.

7. In a quadruplex-telegraph system, a relay responsive to signals due to current reversals, a relay-tongue controlling a local sounder-circuit, and an ink-recorder, in combination with manual and automatic transmitters which may be interchangeably brought into operation, as and for the purpose described.

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