(No Model.)

2 Sheets—Sheet 1.

S. D. FIELD.

QUADRUPLEX TELEGRAPH.

No. 253,027. Patented Jan. 31, 1882.

Fig. 1.

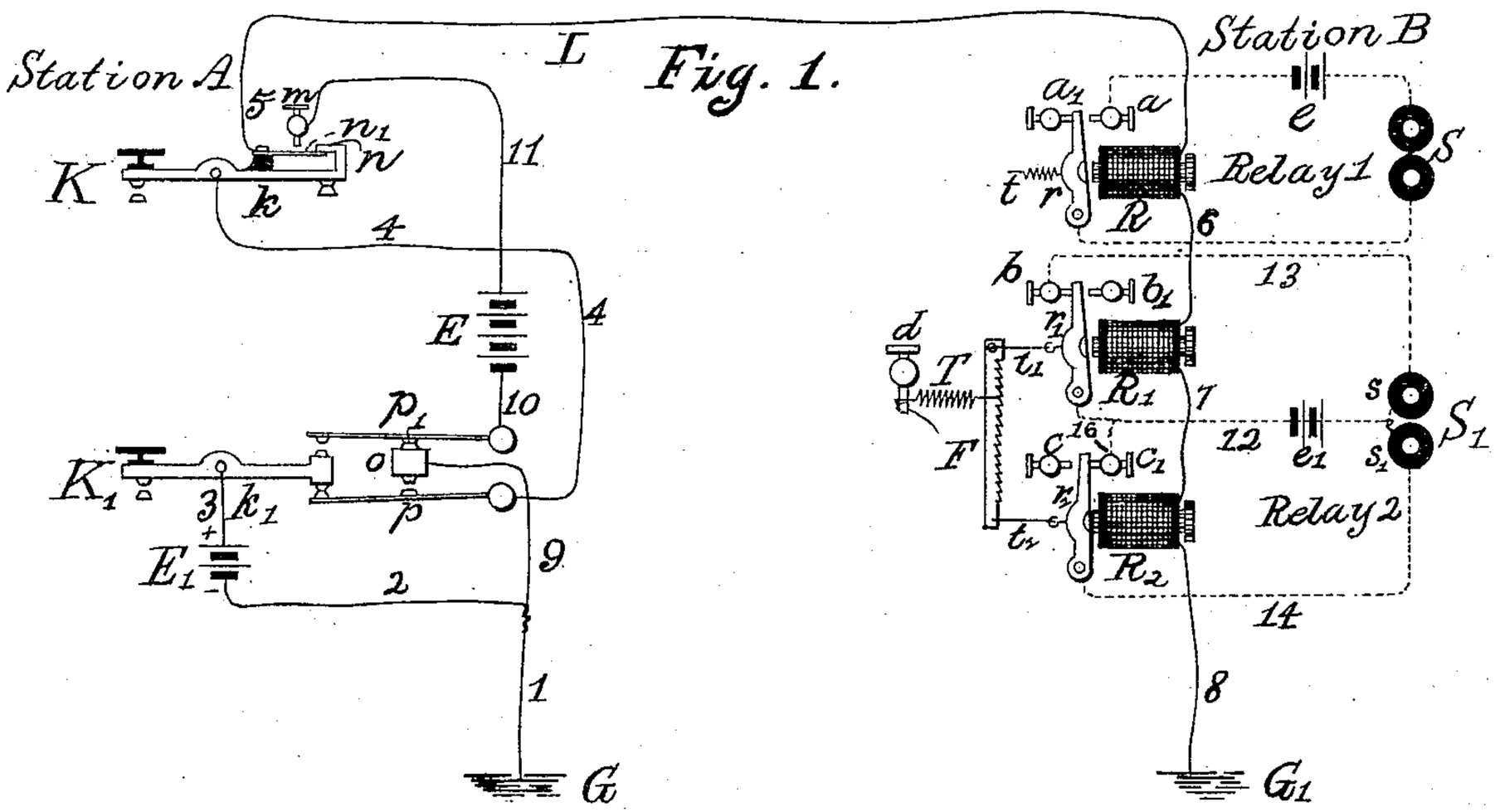
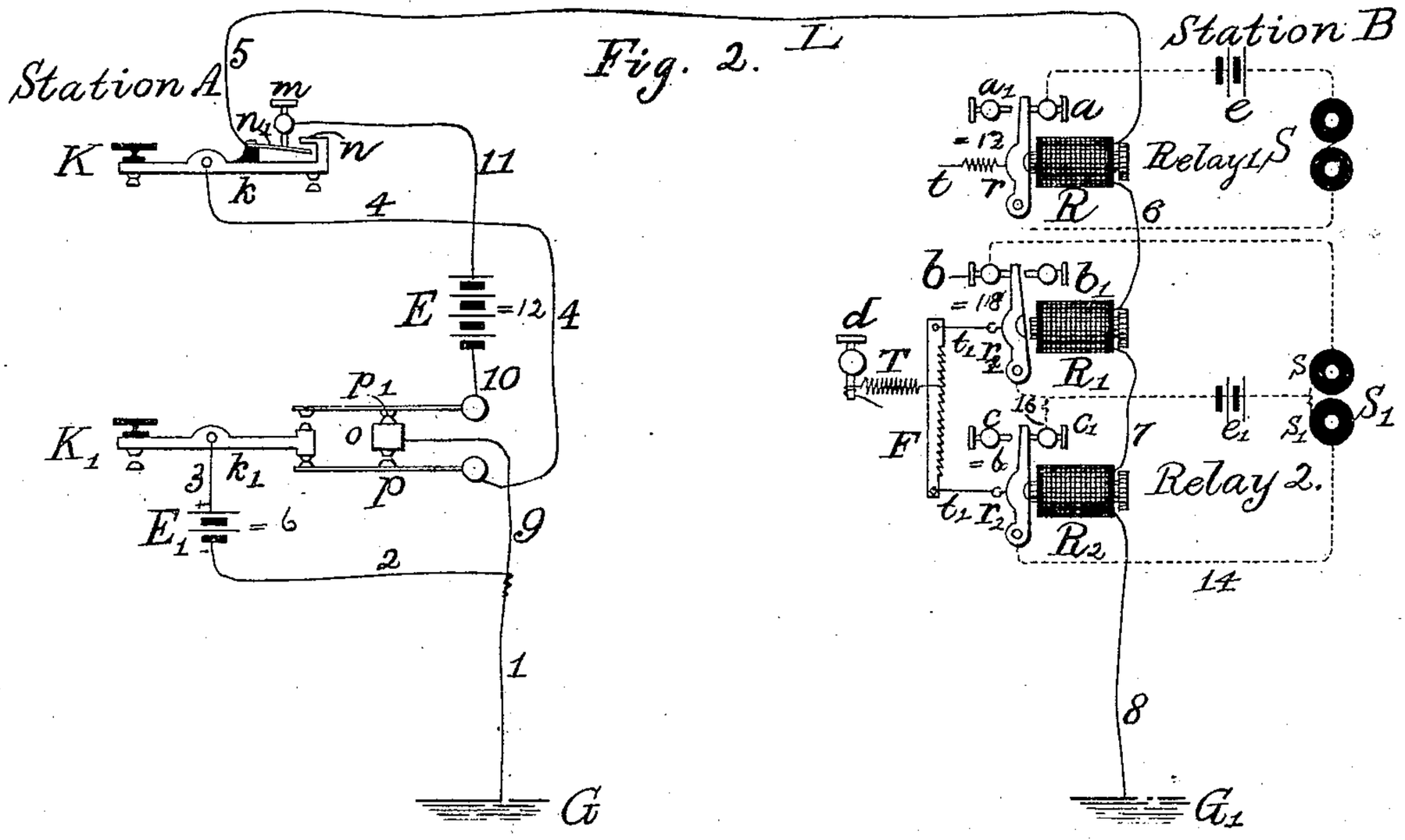


Fig. 2.



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(No Model.) 2 Sheets—Sheet 2.

S. D. FIELD.

QUADRUPLEX TELEGRAPH.

No. 253,027. Patented Jan. 31, 1882.

Fig. 3.

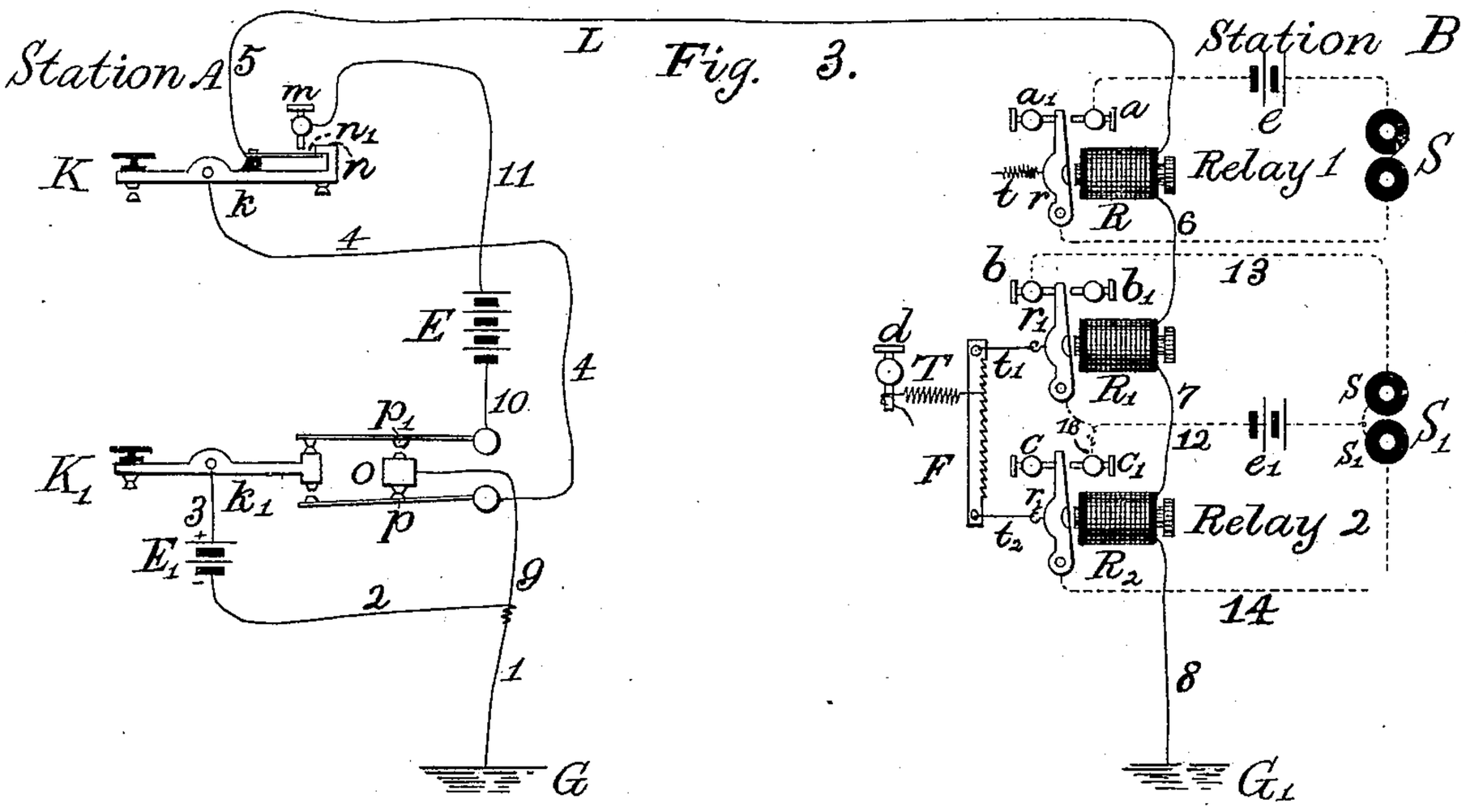


Fig. 4

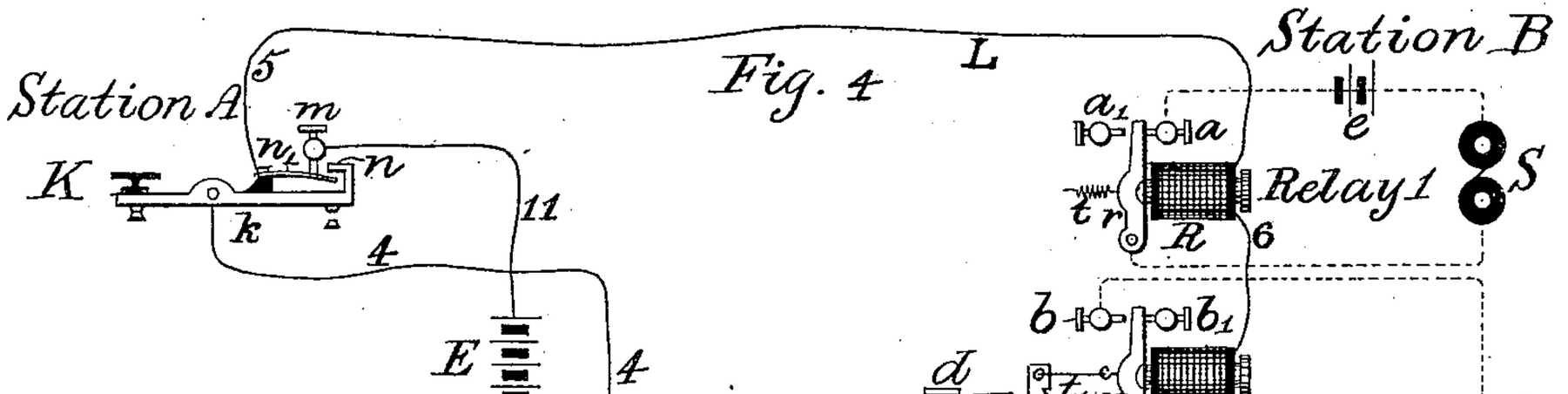
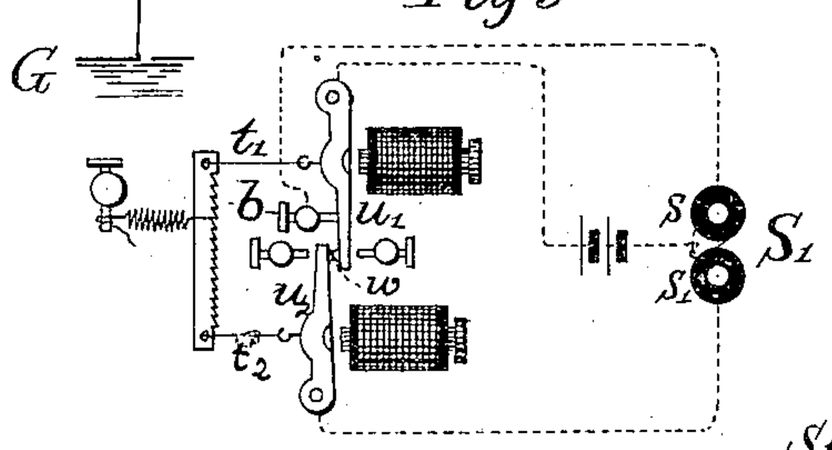


Fig 5



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UNITED STATES PATENT OFFICE.

STEPHEN D. FIELD, OF NEW YORK, N. Y.

QUADRUPLEX TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 253,027, dated January 31, 1882.

Application filed November 25, 1881. (No model.)

To all whom it may concern:

Be it known that I, STEPHEN D. FIELD, a citizen of the United States, residing in New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Quadruplex Telegraphs, of which the following is a specification.

My invention consists in the combination, with a main line and a duplex or quadruplex telegraphic apparatus, of two receiving-relays included in the same main circuit, and in a novel organization of the local circuits, and of a single sounder or other receiving-instrument, whereby the said instrument is operated by the joint action of the said relays.

My invention further consists in the combination, with the two relays, of an improved adjusting device whereby both the armature-levers may be simultaneously adjusted. Two keys or transmitters are placed at the sending-station, and these are connected with two main batteries of unequal electro-motive force, the connections of the keys being so arranged that when both are in a position of rest a current flows over the main line having a strength just sufficient to maintain the armature-lever of one of the three relays at the receiving-station in contact with its front stop. By the depression of one or the other of the keys independently, or of both simultaneously, the normal current is interrupted, or currents of different strengths are transmited over the line in such a manner that the movement of each key is properly responded to by the respective sounders or other receiving-instruments which are placed in local circuits at the receiving-station.

For the sake of simplicity of explanation I have shown my invention as applied to the transmission of two independent communications simultaneously in the same direction over a single conductor, constituting what is technically termed a "duplex," or, more properly, a "diplex" telegraph; but it is to be understood that any of the well-known methods of equating or balancing may be applied to my invention, or combined with it in a manner well understood, so as to enable four distinct communications—two in each direction—to be transmitted over the said conductor simultaneously.

In the accompanying drawings, Figures 1, 2, 3, and 4 are diagrams illustrating my invention and its operation under different conditions, showing its application to the transmission of two independent communications simultaneously in the same direction. Fig. 5 is a diagram showing a modification in the arrangement of one of the relays.

In the drawings, the main telegraph-line consists of an insulated telegraph-conductor extending from station A to station B, as shown at L. These two stations are assumed to be situated at a suitable distance from each other. At station A two independent transmitters are placed in connection with the line, as shown in the figures, where they are respectively designated as K and K′. These transmitters may consist of ordinary key-levers worked directly by the finger of the operator, as shown in the several figures, or they may be operated by a special electro-magnet, local battery, and independent finger-key in a well-known manner. The transmitters K and K′ are each provided with circuit-preserving contact-springs or other equivalent devices of well-known construction, so that when either transmitter is actuated a current may be transferred from one branch of the circuit to another without at any time interrupting the same. The contact-points which form the terminals of the respective branch circuits may conveniently be designated as "resting" and "working" contacts, respectively, meaning by the former the contact against which the circuit-spring bears when the transmitter is elevated or in its normal position and by the latter the contact against which it bears when the transmitter is depressed or in the act of transmitting a signal.

The transmitting-batteries are shown at E and E′. These are respectively placed in branch circuits, and so connected with the respective keys or transmitters K and K′ that their currents may be thrown upon the line, either separately or conjointly, without at any time interrupting the circuit. It will be more convenient in explaining the operation of the system to consider the batteries E and E′ as two sections of one and the same battery (which they in fact are) the section E being preferably so constructed and arranged that its total electro-motive force is about twice as

great as that of section E′. For convenience of illustration it may be assumed that the section E consists of twelve cells or elements. The number of cells required in practice will necessarily vary in each particular case, as it must be made proportionate to the length of the line through which the apparatus is designed to be operated or to the resistance to be overcome by the electric current; but it is essential to maintain in every case substantially the same relative proportion between the electro-motive force of the two sections of the battery.

Considering, in the first place, the operation of the transmitters K and K′, when they are employed for simultaneously sending two independent sets of signals, as in quadruplex working, it will be observed that they may occupy four different positions or relations, as follows: first, both transmitters up; second, transmitter K down and transmitter K′ up; third, transmitter K up and transmitter K′ down, and, fourth, both transmitters down.

The organization of the several branch conductors between the transmitters K and K′, the batteries E and E′, and the line L is such that four different electrical conditions may be produced upon the line, depending respectively upon the positions of the keys, as hereinbefore stated. In the first position referred to (which is that shown in Fig. 1 of the drawings) both transmitters are up or in a position of rest, and a current from the battery E passes over the line L. The circuit through the transmitting apparatus may be traced as follows: from the earth at G at station A, by the wire 1 and 2, to the negative pole of the battery-section E′; thence from the positive pole of the said battery, by the wire 3, to the lever *k′* of the key or transmitter K′; thence by the circuit-spring *p*, wire 4, lever *k* of transmitter K, resting-contact *n* upon said lever, circuit-spring *n′*, and line-wire L to station B. Thus when the transmitters are in their normal position, as shown in Fig. 1, a positive current from six cells traverses the line from the battery E′, which for convenience of explanation may be assumed to have an electro-motive force of six volts. If transmitter K alone be depressed, the connections of the branch circuit at the sending-station are changed and assume the relation shown in Fig. 2. The circuit may now be traced as follows: from the earth at G, by the wires 1 and 9, resting-contact *o*, circuit-spring *p′*, wire 10, to the negative pole of the battery-section E, and from the positive pole of said battery-section, by wire 11, to working-contact *m* of the transmitter K, and thence by the circuit-spring *n′* and wire L to station B. Thus transmitter K, when depressed, sends to line a positive current from the battery-section E, having an electro-motive force of twelve volts. If now the transmitter K′ be depressed, the transmitter K remaining at rest, the circuit will be as follows, (referring to Fig. 3:) from the earth at G, by the wires 1 and 9, to the resting-contact *o*; thence by circuit-spring *p* and wire 4 to the lever *k* of the key K; thence by the resting-contact *n* of said transmitter, circuit-spring *n′*, and wire 5 to the line-wire L, and thence to station B. In this position of the keys no battery whatever is in circuit at the transmitting-station, a direct connection being established between the earth at G and the line at L, and consequently no current will traverse the line. In case both transmitters K and K′ are depressed simultaneously, the route of the current will be as follows, (see Fig. 4:) from the earth at G, by the wires 1 and 2, to the negative pole of the battery-section E′, and from the positive pole of said section, by the wire 3, to the lever *k′* of the transmitter K′; thence by the circuit-spring *p′* and wire 10 to the negative pole of the battery-section E, and from the positive pole of said battery-section, by the wire 11, to working-contact *m*, and thence by circuit-spring *n′* and wire L to station B. In this case both battery-sections E and E′ are in circuit, and a positive current is transmitted to line, having an electro-motive force of eighteen volts. The effect of these different strengths of current upon the receiving apparatus at station B will be next considered. R, R′, and R² represent the electro-magnets, which actuate three independent relays, which electro-magnets are included in series in the main line.

The electro-magnet of relay 1 is provided with an armature mounted upon a pivoted lever in the usual manner, as shown at *r*, an adjustable retractile spring, *t*, and adjustable stops *a a′*. A sounder, register, or other equivalent receiving-instrument, S, is included with a battery, *e*, in a local circuit traversing the armature-lever *r* and contact-stop *a*, as indicated by the dotted lines in the figures.

The two electro-magnets R′ and R² are provided with armatures *r′* and *r²*, mounted upon pivoted levers in the usual manner, and provided with adjustable stops *b b′ c c′*, adjustable retractile springs or links *t′* and *t²*, the tension of which is preferably controlled by the operator through a device hereinafter to be described. The sounder or other receiving-instrument, S′, is provided with a differential electro-magnet having two separate coils, *s* and *s′*, which are so arranged with reference to the battery and connecting-wires that the effect of a current traversing one coil will be neutralized by that of an equal current traversing the other coil. This is effected by the following arrangement: One of these coils, *s*, is included in a circuit from the positive pole of the local battery *e′*, the wire 13, contact-stop *b*, armature-lever *r′*, wire 12, whence it returns to the negative pole of the battery. The remaining coil, *s′*, is included in a circuit from the positive pole of the battery *e′*, wire 14, armature-lever *r²*, contact-stop *c′*, wires 16 and 13, whence it returns to the negative pole of the battery. The armature-lever *r²* is normally attracted to the magnet R² when both keys at the sending-

station are at rest, and rests against contact-stop c', as hereinafter explained. Thus equal currents traversing the coils s s' in opposite directions from the battery e' neutralize the effects of each other upon the receiving-instrument. In order to insure an equal division of the current from the local battery through the two opposing coils, the resistance of the branch circuits should be approximately equal. In most instances this will not require special adjustment, but when found necessary such adjustment may be readily effected by inserting an artificial resistance in one or the other of the lines, as required.

In practice I have found it to be a matter of considerable difficulty for the receiving-operator to maintain the adjustment of two independent retractile springs attached to two different relays, especially when the insulation of the lines is variable, with such accuracy as to preserve at all times a proper relation between them, and thus insure the proper working of the apparatus. In order to avoid this difficulty I have devised the apparatus shown in the figures, in which I make use of an equalizing-bar, F. To the extremities of this equalizing-bar are attached two links or tension-rods of thin wire, t' and t^2, the opposite ends of which are respectively attached to the armature-levers r' and r^2. A single retractile spring, T, the tension of which may be adjusted by milled head and spindle d in the usual manner, is attached to the equalizing-bar F at an intermediate point between the point of attachment of the links t' and t^2. The particular point at which the spring T is attached to the equalizing-bar F determines what proportion of the total elastic force of the spring shall be exerted upon the armature-levers r' and r^2, respectively. For example, in the operation of the apparatus it is necessary that the mechanical resistance offered to the movement of the armature lever r' should be about three times as great as that offered to the movement of the armature-lever r^2, and hence the spring T should be attached to the equalizing-bar F by placing it in a notch of the bar at a point distant about one-fourth of its length from the end to which the link t' is attached.

The precise point for attaching the spring T to the equalizing-bar F may be determined by experiment, or otherwise, for each particular instrument by moving it along the notched bar, and when once fixed it will seldom, if ever, need to be changed. The tension of the single spring T will require adjustment by the operator with reference to the varying attractive force developed in the electro-magnets R′ and R² in accordance with the electrical condition of the line-wire. The proportionate distribution of the total retractile force of the spring T between the armature-levers r' and r^2 will be automatically effected with the utmost nicety by the apparatus described. The retractile force exerted upon the levers r, r', and r^2 is so adjusted that the lever r will be attracted to its magnet by a current of twelve volts passing over the line L, the lever r' by a current of eighteen volts, and the lever r^2 by a current of six volts. With both transmitters at rest (see Fig. 1) the current over the line will have an electro-motive force of six volts. This, while not sufficient to overcome the tension of the spring t nor to move the lever r', will be just sufficient to move the lever r^2 against the contact-point c'. Hence the circuit of the battery e' will be closed through both the coils s and s', and the sounder S′ will be inactive, as hereinbefore explained. When transmitter K alone is depressed (see Fig. 2) a current of twelve volts is sent to line. This is sufficient to overcome the tension of the spring t and thus close the circuit of the battery e and operate the sounder S. It is not, however, sufficient to move the lever r', and therefore the sounder S′ remains inactive. When transmitter K′ alone is depressed (see Fig. 3) no current passes over the line. Hence the lever r remains against the stop a' and the sounder S is inactive. The lever r^2 also falls back, breaking the circuit through the coil s' of the receiving-instrument S′, which is thereupon actuated by the current passing through the coil s. When both transmitters K and K′ are simultaneously depressed (see Fig. 4) a current of eighteen volts is sent to line. This overcomes the tension of the spring t and actuates the sounder S. It also causes the levers r' and r^2 to be drawn against the stops b' and c', respectively. The sounder S′ is thereupon actuated by the current passing through the coil s' alone.

In Fig. 5 I have shown a modification of my invention, in which I replace the two independent armatures r' and r^2 by two interlocking armature-levers, u' and u^2. The armature-lever u' is normally held against a fixed stop, b, by means of a tension-rod, t'. The working-contact w of the armature-lever u^2, instead of being stationary, is mounted upon the extremity of the pivoted armature-lever u', and a fixed stop is placed in front of the lever u' at such a distance as to permit this lever, which is held against the stop b by the tension-rod t', to yield slightly under the application of sufficient force, and thus to move toward its magnet until arrested by the said stop. The operation of the local circuit of a relay constructed in this manner is similar to that hereinbefore described in connection with Figs. 1, 2, 3, and 4, a differential receiving-instrument being included in the circuit of the local battery in the same manner as in the former case. When a current of six volts is passing over the line the armature u^2 will be attracted toward its magnet, but the force exerted thereby will not be sufficient to overcome the tension of the armature-lever u'. Thus the circuit will be closed through each coil of the receiving-instrument S′ and no effect produced thereon. A current of twelve volts, though sufficient to actuate the relay R, will not be sufficient to attract the armature u'. A current of eighteen volts,

however, will attract both armatures w' and w^2, thus completing a circuit through one coil, *s*, only of the receiving-instrument S′. When no current is upon the line, as is the case when the transmitting-instrument K′ alone is depressed, neither armature will be attracted, and both will rest against their back contacts, thus closing the local circuit through the coil *s* only of the receiving-instrument S′. I prefer to use the adjusting device described in connection with Figs. 1, 2, 3, and 4 for regulating the tension upon the armature-levers w' and w^2, though it is evident that the usual tension-spring may be applied to each.

I do not herein specifically claim the peculiar arrangement of the transmitting device described in the specification and shown in the drawings, as it forms the subject-matter of a claim in another pending application.

I claim as my invention—

1. The combination, substantially as hereinbefore set forth, of two independent electro-magnets included in the same circuit, two armatures and armature levers actuated by the respective electro-magnets, an equalizing-bar having its extremities attached one to each of said armature-levers, and an adjustable retractor acting upon said equalizing-bar.

2. The combination, substantially as hereinbefore set forth, of two independent electro-magnets included in the same circuit, two armatures and armature-levers actuated by the respective electro-magnets, an equalizing-bar having its extremities attached one to each of said armature-levers, an adjustable retractor acting upon said equalizing-bar, a receiving-instrument actuated by a differential magnet, a local battery, two branch circuits from said battery, each including one coil of said differential magnet, and means, substantially such as described, for closing a circuit through one or through both of said branches, according to the position of said armatures.

3. The combination, substantially as hereinbefore set forth, of two independent electro-magnets, each provided with an armature and armature-lever, one of said levers constituting a yielding contact-stop for the other, an equalizing-bar having its ends connected one with each of said levers, and an adjustable retractor acting upon said equalizing-bar.

4. The combination, substantially as hereinbefore set forth, of two electro-magnets, two armatures mounted upon pivoted levers, an equalizing-bar having its respective ends mechanically connected with said levers, a retractor attached to said equalizing-bar, a device for regulating the tension of said retractor, and means, substantially as described, for varying the point of attachment of the retractor to the equalizing-bar.

In testimony whereof I have hereunto subscribed my name this 21st day of November, A. D. 1881.

STEPHEN DUDLEY FIELD.

Witnesses:

CHARLES A. TERRY,

M. C. EARL.