G. SMITH.

QUADRUPLEX TELEGRAPH.

No. 185,588. Patented Dec. 19, 1876.

Fig: 1.

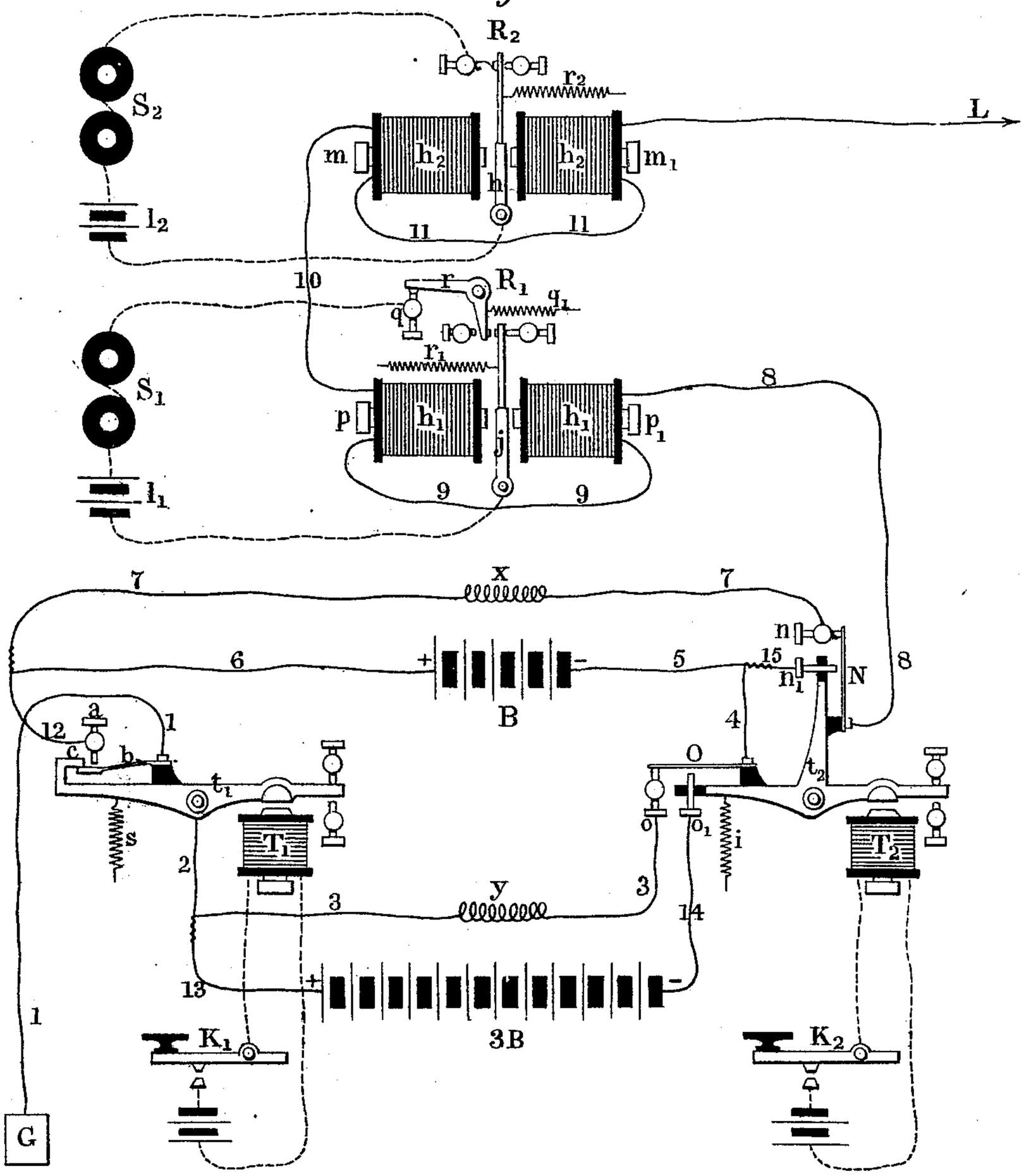
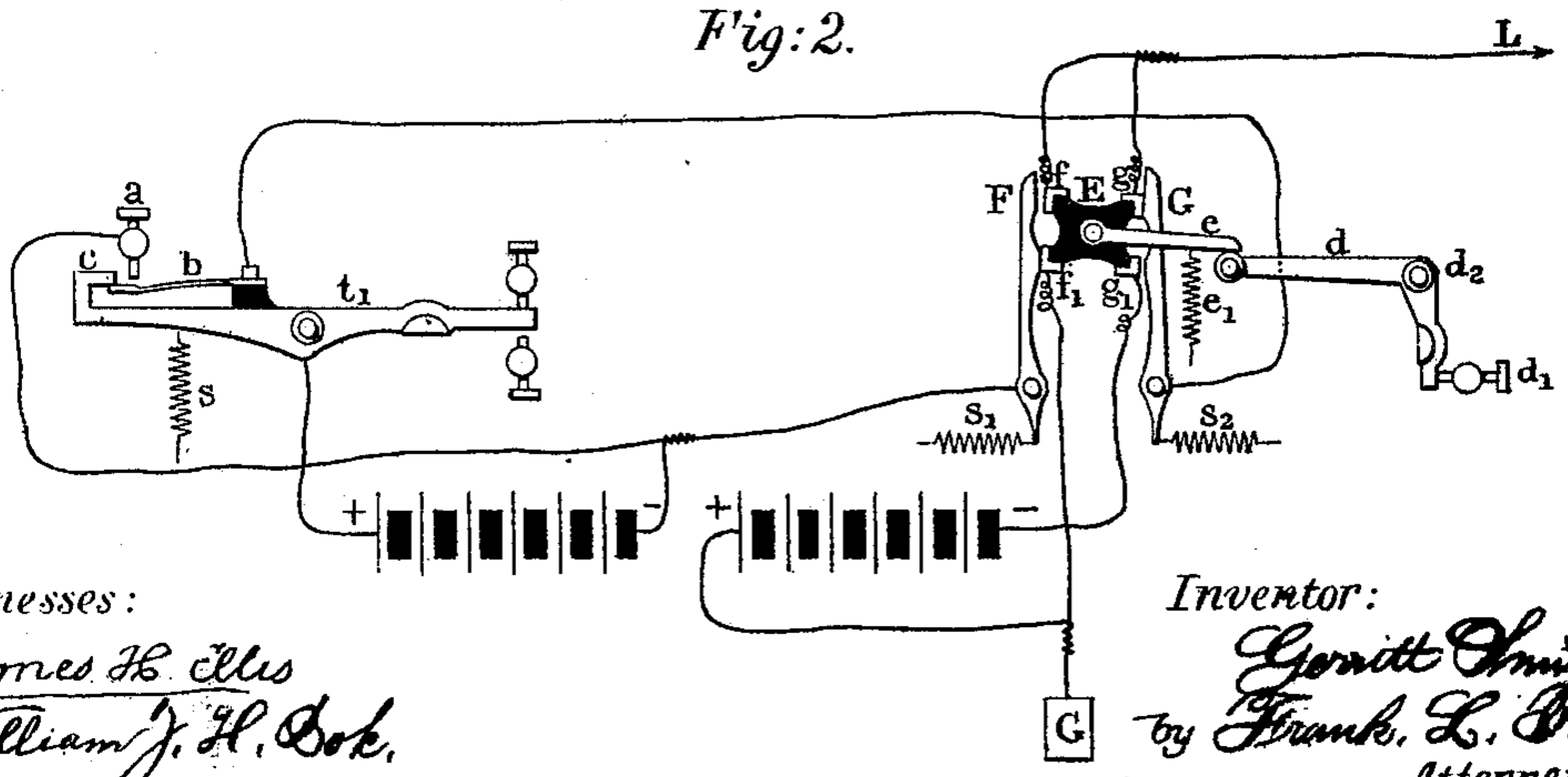


Fig: 2.



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UNITED STATES PATENT OFFICE.

GERRITT SMITH, OF ASTORIA, ASSIGNOR OF ONE-HALF HIS RIGHT TO GEORGE B. PRESCOTT, OF NEW YORK, N. Y.

IMPROVEMENT IN QUADRUPLEX TELEGRAPHS.

Specification forming part of Letters Patent No. **185,588**, dated December 19, 1876; application filed December 27, 1875.

CASE C.

To all whom it may concern:

Be it known that I, GERRITT SMITH, of Astoria, in the county of Queens and State of New York, have invented a new and useful Improvement in Multiple Telegraphs, which improvement is fully set forth in the following specification, reference being had to the accompanying drawing.

The object of my invention is to provide an improved means whereby two distinct communications may be simultaneously transmitted over one telegraphic conductor in the same direction, and which is also capable of being combined with any suitable known method of simultaneous double transmission in opposite directions, by means of which combination four distinct communications, two in each direction, may be made to pass simultaneously over a single conductor without interference.

My present invention is an improvement upon the apparatus and method described in my former application, designated as "Case B," which application was filed in the United States Patent Office on the 7th of December, 1875; and it consists in an improved arrangement of the transmitting-keys or devices in reference to the main batteries, whereby a certain prearranged combination of currents is caused to traverse the line, in consequence of the different relative positions of the keys, which combination differs materially from any of those hitherto used for similar purposes, and by means of which I am enabled not only to simplify the receiving apparatus, but also to transmit communications with greater facility and certainty through long circuits.

My invention further consists in an improved arrangement of a relay at the receiving-station, provided with a polarized armature and a supplementary contact-lever, in combination with an ordinary receiving-instrument and local circuit, whereby I am enabled to dispense with the auxiliary relays and local circuits, or differential receiving-instruments hitherto employed.

In the accompanying drawing, Figure 1 is a general plan of my invention, showing both the transmitting and receiving instruments, with their various connections. Fig. 2 is a modification in the arrangement of the apparatus at the transmitting station, which may be employed in lieu of that illustrated in Fig. 1.

In order that two communications may be simultaneously transmitted in the same direction over the same conductor, it is necessary to make use of two independent transmitting instruments or devices at the sending-station, and also of two independent receiving-instruments at the receiving-station.

For the purposes of this description it will be assumed that the method of telegraphic transmission known as the Morse system is used, although any other electro-magnetic system may be substituted therefor.

The transmitting devices are preferably operated by connecting them either mechanically or electrically with the levers of common Morse keys.

The operation of two independent transmitters or keys, when arranged in this manner, gives rise to four distinct electrical conditions of the line, as follows: First, first and second keys both open; second, first key closed and second key open; third, second key closed and first key open; fourth, first and second keys both closed.

The manner in which these four different electrical conditions of the line are brought about by the operation of two transmitters will now be explained.

In Fig. 1 t^1 is a lever capable of a slight vertical movement upon its axis in one direction by the attraction of the electro-magnet T^1, and in the other by the retractile force of the springs *s*. The lever t^1, with its appendages, constitutes the first or single-point transmitter, and is operated by means of a key, K^1, and a local battery, *t*, in a manner well understood. One end of a flat metallic contact-spring, *b*, is fixed to an insulating-support, which is mounted upon the extremity of the lever t^1, while its free end, by its own elasticity, presses upward against the projection *c*, formed upon the extremity of the lever t^1, and

is therefore in electrical contact therewith. When, however, the key K^1 is depressed, the attraction of the electro-magnet T^1 for its armature elevates the opposite end of the lever t^1, which carries with it the contact-spring b, and presses the latter against the fixed stop a. The further movement of the lever t^1 in the same direction causes the spring b to yield, and the projection c is separated from it. Thus the effect of closing the key K^1 is to first form an electrical contact between the spring b and stop c, and then to break, almost at the same instant, the previously-existing contact between the spring b and lever t^1. As the electric circuit passing through the spring b is, by this arrangement, never interrupted, being at all times continuous either through a or c, or both, it may be termed a "continuity-preserving transmitter."

The second or double-point transmitter is preferably constructed substantially in the same manner as the single-point transmitter last described, except that a three-armed lever, t^2, is employed in order to accommodate two continuity-preserving circuit-springs, N and O. When the transmitter is at rest, the springs N and O, which are mounted on insulating-supports upon the lever t^1, rest upon stationary contact-points n and o. When the key K^2 is depressed the electro-magnet T^2 attracts its armature, and draws down one end of the lever t^2, in consequence of which contacts are formed between the respective springs N and O and the insulated contact-points n' and o', while the previously-existing contacts with n and o are broken. This action takes place simultaneously in the case of both springs N and O, and is the same in principle as that which occurs when the single transmitter is operated, as before described.

I will next proceed to describe the effect produced upon the electrical condition of the line by the different positions of the keys at the transmitting-station.

1. *When the first and second keys are both open.*—This is the position of the apparatus represented in Fig. 1. Disregarding for the present the receiving-instruments and their connection with the line, the circuit may be traced as follows: From the earth-plate G, through wire 1, spring b, lever t^1, wires 2 and 3, contact-point o, spring O, wires 4 and 5, battery B, wires 6 and 7, contact-point n, spring N, and thence by wire 8, through the receiving-instruments, to the line L. In this position of the keys the smaller main battery B is in circuit with its positive or + pole to the line.

2. *When the first key is closed and the second key open.*—The route is from the earth at G, by wire 1 and spring b, to the contact-point a, wires 12 and 7, and thence, by the same route as in the first case, to the line L. The battery B is now thrown out of circuit, and there is no current upon the line.

3. *When the second key is closed and the first key open.*—The route is from the earth at G, by wire 1, spring b, and lever t^1, wires 2 and 13, large main battery 3B, wire 14, contact-point o', spring O, wires 4 and 15, contact-point n', spring N, and wire 8, to line L. In this case the large main battery 3B is in circuit with its negative or — pole to the line.

4. *When both the first and second keys are closed.*—The route is from the earth at G by wire 1, spring b, contact-point a, wires 12 and 6, small main battery B, wires 5 and 15, contact-point n', spring N, and wire 8, to line L. In this case the smaller battery B is in circuit with its negative or — pole to the line.

The receiving apparatus consists of two sounders, or other suitable receiving-instruments, S^1 and S^2, which are controlled by two relays, R^1 and R^2. (See Fig. 1.)

It is obviously necessary that the sounder S^1 should respond to the movements of the key K^1, and the sounder S^2 to the movement of the key K^2, while both sounders should, in like manner, respond when both keys are depressed. The manner in which this is accomplished will now be explained. The line-wire L, on entering the receiving-station, passes through the helices of the respective relays R^2 and R^1, and thence to the earth. The relay R^2 is preferably constructed with two electro-magnets, m m', arranged with their poles facing each other, and provided with a polarized—that is to say, a permanently magnetized—armature, h, mounted between the opposite poles of the electro-magnets, as shown in the figure.

The circuit of the line L, entering the relay R^2, passes through the helix or coil h^2 of electro-magnet m', and thence through the helix h^2 of electro-magnet m, and these helices are arranged in a manner well understood, so that a negative current, for example, passing through both helices will cause the polarized armature h to be attracted by the magnet m and repelled by m', while with a positive current precisely the opposite effect will take place.

I will here remark that there are many different methods of constructing relays with polarized armatures, by which this effect may be produced; and although I prefer to make use of the arrangement herein described, I do not desire to confine myself to it. The armature of relay R^2 is provided with a retracting-spring, r^2, and operates the sounder S^2 by means of a local battery, l^2, in the ordinary manner. The relay R^1, like the relay R^2, consists of two electro-magnets, p and p', placed opposite each other, and is provided in like manner with a polarized armature, j, having a retracting-spring, r^1. These armatures may be composed of hardened steel and permanently magnetized, which is the arrangement shown in the drawing; or they may be of steel or soft iron, polarized either by contact with a permanent magnet or by a helix, through which the current of a constant local battery is made to circulate. The relay R^1 differs materially, however, from the relay R^2 in the arrangement of its local-circuit con-

nections, by means of which the sounder S^1 is operated. The polarized armature *j*, instead of being held against a fixed stop by the tension of the spring r^1 when no current is passing, rests against the free end of a contact-lever, *r*, which moves upon a pivot. The contact-lever *r* is, in turn, held against the fixed stop *q* by the tension of a spring, *q'*, which tension should be considerably greater than that of the spring r^1. The normal position of the apparatus, when neither key at the transmitting-station is depressed, is that shown in Fig. 1.

The manner in which the receiving-instruments operate in each of the four conditions of the line hereinbefore mentioned is as follows:

1. *Positive current from battery B.*—The local circuit of sounder S^1 is kept open by the action of the positive current upon the polarized armature *j* of the relay R^1, (which is sufficient to overcome the tension of the spring r^1,) and it remains inactive. The local circuit of the sounder S^2 is kept open by the action of the positive current of the line upon the polarized armature *h* of the relay R^2, and also by the tension of the spring r^1, and therefore it also remains inactive.

2. *No current.*—The armature *j* of relay R^1 is drawn by the tension of the spring r^1 over against the contact-lever *r*, thus completing the local circuit of the sounder S^1 and actuating it, while the armature *h* of relay R^2 remains in the same position as before, in consequence of the action of the spring r^2, which holds it against the insulated stop whenever there is no current traversing the helices of the relay, and, therefore, the sounder S^2 is not affected.

3. *Negative current from battery 3B.*—In this case the action of the more powerful negative current is sufficient to press the polarized armature *j* against the movable contact-lever *r* with sufficient force to overcome the tension of the spring *q'*, and thus, although the local circuit is still closed between the armature *j* and contact-lever *r*, it is now broken between the latter and the fixed stop *q*, and hence the sounder S^1 is not actuated. On the other hand, the negative current causes the armature *h* of relay R^2 to be moved to the left, closing the local circuit and actuating the sounder S^2.

4. *Negative current from battery B.*—The negative current from the smaller battery is not sufficiently powerful to overcome the tension of the spring q^1, and, therefore, the contact-lever *r* remains in contact with stop *q*, and the armature *j* with the contact-lever also, thus completing the local circuit of sounder S^1, and operating it. Relay R^2, which is so arranged as to close its local circuit by negative currents of any strength, actuates the sounder S^2 precisely as in the third position.

By this arrangement of the apparatus the difficulties which inevitably arise from a reversal of the polarity of the line-current while a signal is being given upon one of the receiving-instruments, which difficulties have hitherto seriously interfered with the use of multiple telegraphs, especially upon long circuits, are entirely avoided, for the reason that in my apparatus the reversal of the polarity always takes place either at the beginning or at the end of a signal, and in no instance during the continuance of one, as in the apparatus heretofore employed for this purpose.

Fig. 2 represents another arrangement of the transmitters and their connections, which may be employed in lieu of that hereinbefore described, and shown in Fig. 1, and by means of which the required combination of currents may be obtained from a smaller number of cells of battery. The single-point transmitter is the same as the one shown in Fig. 1. The double-point transmitter may be constructed as shown in Fig. 1, or, if preferred, in the modified form shown in Fig. 2, in which the circuit-springs N and O are replaced by contact-levers F and G, these being pressed against opposite sides of the oscillating circuit-changer E by springs s^1 s^2.

The circuit-changer E is constructed of insulating material, and provided with contact-points *f g f' g'* upon its four corners. It is caused to oscillate upon an axis passing through its center by means of an arm, *e*, which is rigidly attached to it, and receives its movement from the armature-lever or key-lever *d*, the latter turning upon an axis at d^2. When the lever *d* is at rest, as in Fig. 2, the point *f'* is in contact with the lever F, and the point *g* with the lever G; but when it is depressed, then the point *f* comes in contact with the lever F, and the point *g'* with the lever G, the contact of each lever being transferred from one point to the other by the oscillation of the circuit-changer E upon its axis without interrupting the circuit. By tracing the connections it will be seen that the currents sent to the line in the various positions of the keys are relatively the same as in Fig. 1, the only difference being that in the second method the strength of the more powerful current is limited to twice that of the less powerful, while in the first method the strength of the more powerful current may be increased to any extent simply by increasing the battery 3B.

In order to adapt the hereinbefore described apparatus to the simultaneous transmission of four communications upon the same wire, two in each direction, it is only necessary to use it in connection with some suitable method of duplex telegraphy.

I prefer to make use for this purpose of the method set forth in Letters Patent of the United States No. 136,874, which was granted to Joseph B. Stearns on the 18th of March, 1873.

To this end I place an additional helix or coil upon both the electro-magnets of each of the relays R^1 and R^2, which helices contain the same length of wire, and the same num-

ber of convolutions, as the helices h^1 h^1 and h^2 h^2, but exert an opposing or neutralizing effect upon the cores of the electro-magnets, and which are included in the circuit of an artificial or branch line, in a manner well understood.

I also make use of a condenser for the purpose of compensating the return or static charge of the line, in the manner fully set forth in Letters Patent of the United States No. 126,847, issued to Joseph B. Stearns on the 14th day of May, 1872, to which reference is had.

The duplex method set forth in Letters Patent of the United States No. 132,932, granted to Joseph B. Stearns on the 12th of November, 1872, and known as the "bridge" method, may be used, if preferred; or, instead of either of these methods, I sometimes prefer to employ a combination of the two, in which the relay R^1 is placed in the bridge wires, and the relay R^2 is composed of a double set of electro-magnets provided with differential helices, acting in conjunction with each other upon a single armature-lever, common to all, the different sets of differential helices being arranged in the sides of the bridge.

In making use of my method, in combination with the so-called duplex methods, for the purpose of transmitting four communications simultaneously over one wire, it is requisite that the resistance interposed between the line and the earth at the sending-station should always be the same, whether the batteries are in circuit or not. This is effected by the insertion of compensating resistances x and y, x being equal to the resistance of battery B, and y being equal to the battery 3B.

I am aware that the simultaneous transmission of two communications in the same direction by the use of positive and negative currents, combined with currents of one or the other polarity, but of a different strength, is not new, it having been shown and described in Letters Patent of Great Britain, No. 2,755 of 1855, and in other printed publications, and I, therefore, do not claim, in general, such combination of currents; nor do I claim a relay having an armature provided with a supplementary contact-lever, in combination with a local circuit and receiving-instrument, except when the said receiving-instrument is so connected therewith as to be caused to operate substantially in the manner and for the purpose specified.

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

1. Two keys or transmitters and one or more main batteries at one station, in combination with a line-wire, and with one or more receiving-instruments at another station, when so arranged that a current of one polarity will traverse the line when both keys are depressed, and a current of equal strength, but of opposite polarity, when both keys are elevated, substantially as and for the purpose specified.

2. Two keys or transmitters and one or more main batteries at one station, in combination with a line-wire, and with one or more receiving-instruments at another station, when so arranged that a current of a given strength and polarity will traverse the line when both keys are at rest, which current will be diminished or interrupted by the depression of one key, while it will be increased, and its polarity reversed by the depression of the other key, substantially as and for the purpose specified.

3. A receiving-instrument or sounder and a local battery, in combination with a relay, consisting of one or more electro-magnets, provided with an armature or armatures capable of being moved from one extreme position to the other by a change in polarity in the line-current, and a supplementary contact-lever, so arranged in reference to said armature that the receiving-instrument will be actuated when the armature is at rest in an intermediate position, but not when at rest in either of its extreme positions, substantially as herein specified.

Signed by me this 23d day of December, 1875.

GERRITT SMITH.

Witnesses:
FRANK L. POPE,
ROBERT BROWNE.