J. B. STEARNS.

Duplex Telegraphs.

No. 136,874. Patented March 18, 1873.

Fig: 1

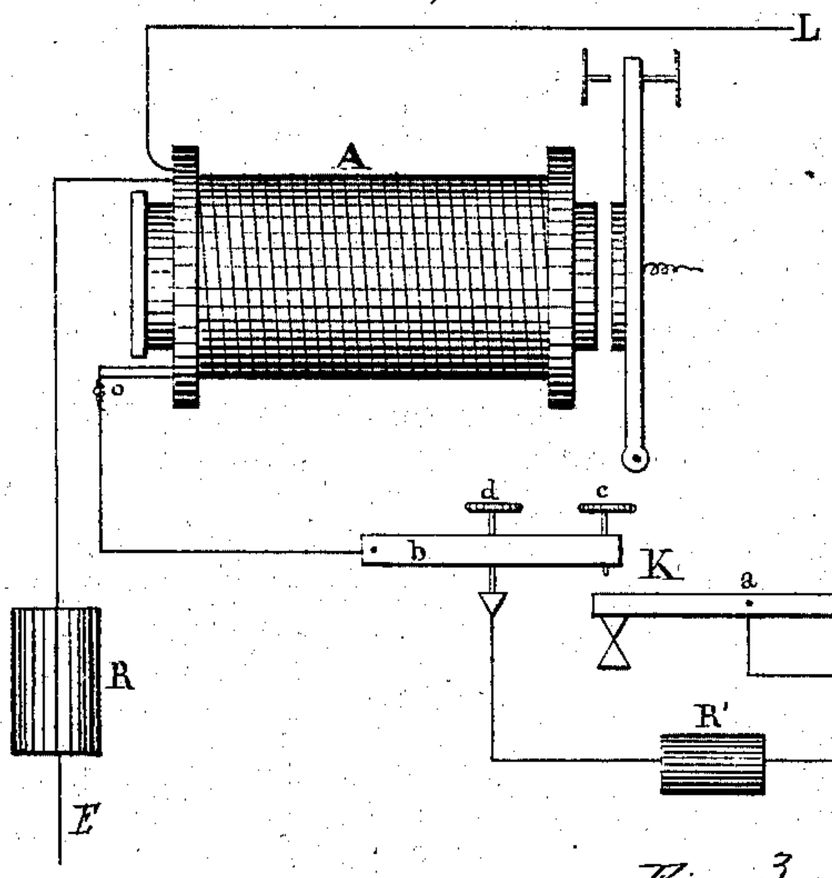


Fig: 4

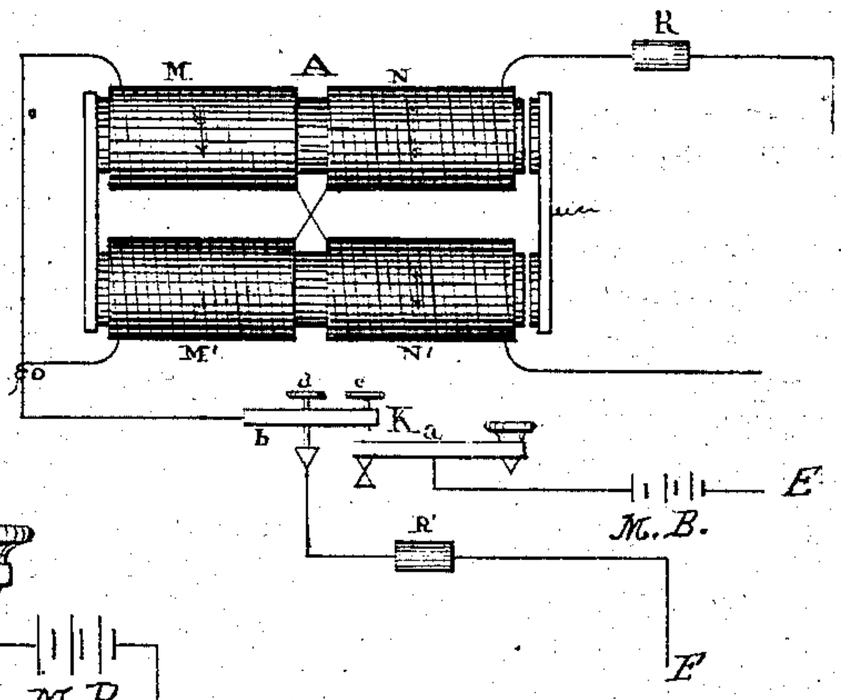


Fig: 3

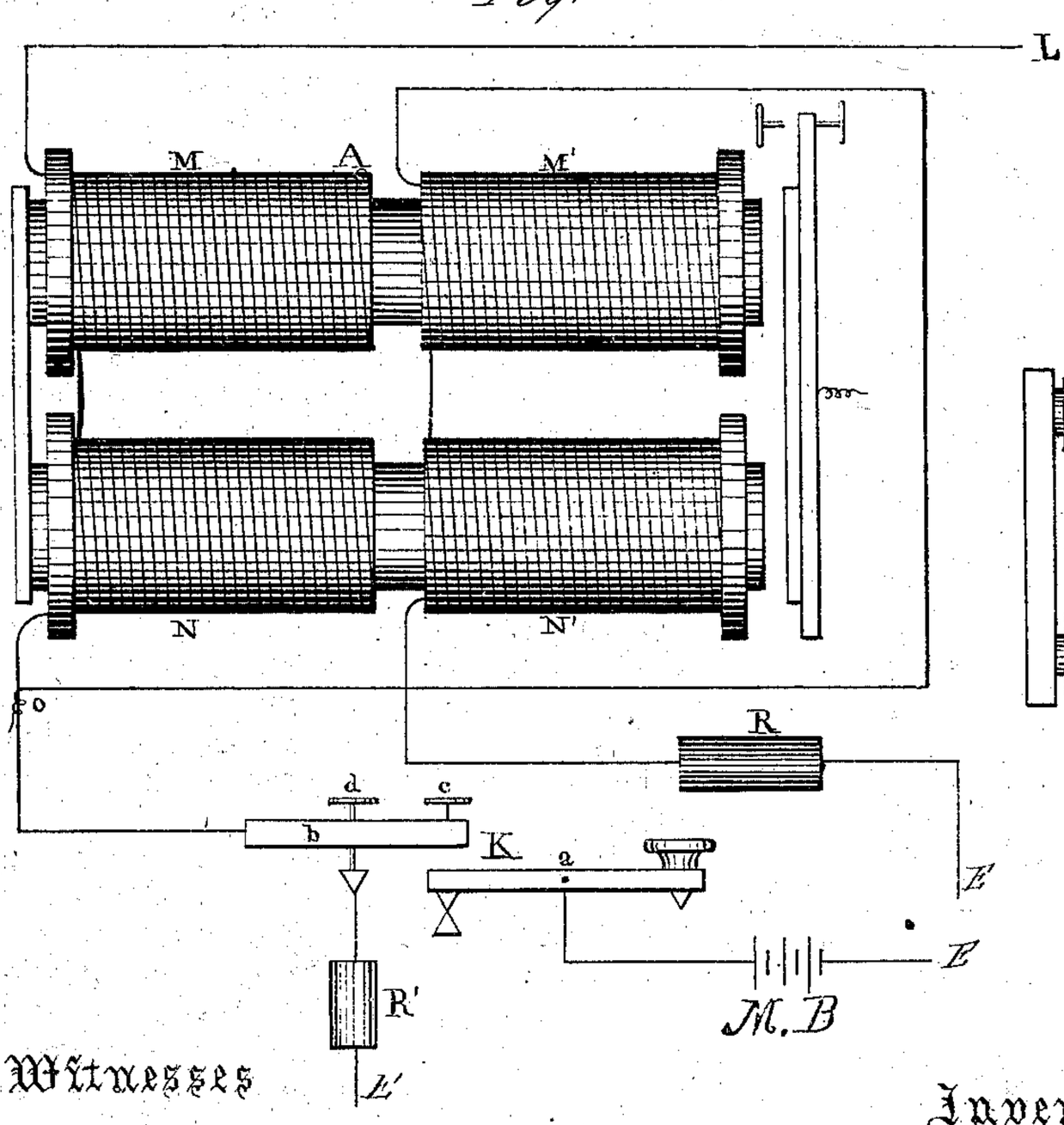
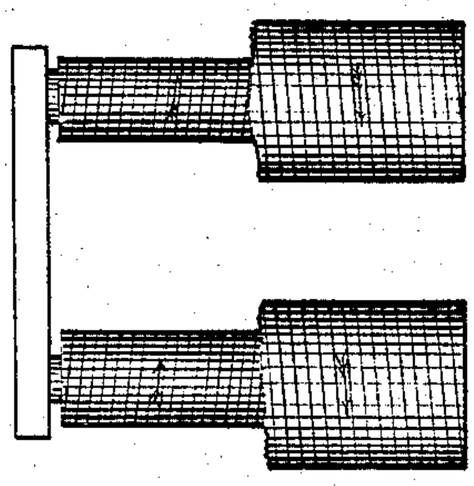


Fig: 2



Witnesses

Wm. A. Hayes jr.

A. L. Hayes.

Inventor

Joseph B. Stearns

UNITED STATES PATENT OFFICE.

JOSEPH B. STEARNS, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN DUPLEX TELEGRAPHS.

Specification forming part of Letters Patent No. **136,874**, dated March 18, 1873.

CASE B.

To all whom it may concern:

Be it known that I, JOSEPH B. STEARNS, of Boston, in the county of Suffolk, in the State of Massachusetts, have invented an Improvement in Telegraph Apparatus, of which the following is a specification:

This invention is an improvement upon the apparatus for the simultaneous transmission of two signals from opposite ends of the same line-wire, patented by me June 2, 1868, Nos. 78,547 and 78,548; and consists in the combination of the circuit-changing key described in Letters Patent No. 78,548. with the form of relay or receiving instruments and the arrange ment of resistances and circuits described in Letters Patent No. 78,547, by which means an apparatus is obtained of greater simplicity and efficiency than either of those described in the above-mentioned patents.

The form of relay or receiving instrument described in Letters Patent No. 78,547 is so constructed that two currents of equal strength entering the same neutralize each other's effect, and is called a differential relay.

The accompanying drawing forming part of this specification represents my invention, Figures 1, 2, 3, and 4 representing the construction of the circuit-changing key with various forms of differential relay.

In these figures, A is the "differential relay." This is constructed of two coils of wire on each core, through which currents are passed in opposite directions, which coils may be wound side by side throughout their whole length, so that the number of turns and lengths of wire of which the helices are formed shall be equal, as in Fig. 1, may be superimposed upon each other in the form of two concentric cylinders, as in Fig. 2, which may be wound in opposite directions, or so connected that the currents pass in opposite directions, or may be placed end to end, as in Figs. 3 and 4. K is the key, composed of two levers or springs, *a* and *b;* M B, the main battery; R, a rheostat or resistance coil, having the same or nearly the same resistance as the line; and R′, a rheostat or resistance-coil placed between the back contact of the key and the earth, and having the same or nearly the same resistance as the battery.

The conditions necessary for success in the double transmission of signals on a single line-wire are, first, having the relay or receiving magnet at each station always in the circuit on the line; second, preventing the signals transmitted from either station from affecting the relay or receiving instrument at that station; and, third, maintaining the resistance of the line always the same.

The manner in which these conditions are fulfilled by this invention is shown in the following description of its construction and mode of operation, reference being had to the accompanying drawing.

As before stated, the relay or receiving magnet has two helices on each of its arms, through which currents of opposite direction pass, and, therefore, when both of these helices are traversed at the same time by currents of the same strength, these currents neutralize each other's effect upon the cores of the magnet, owing to their difference in direction, and consequently the magnet is not excited.

The key K is composed of two levers or springs, *a* and *b*, the former being connected with the battery M B, the latter with the earth through a contact-stop, *d*. These levers or springs can be connected at their adjacent ends by depressing the lever *a*, so as to bring it in contact with the stop *c* in the lever *b*, and said stop *c* is shorter than the stop *d*, so that when connection is made with it, it is before connection is broken with *d*, as shown in the drawing, and with the earth, and, therefore, when currents from the battery are thrown on the line by the said movement of the key, the circuit with the receiving instrument or relay is not broken, and it remains always in the circuit on the line.

On the depression of the lever *a* of the key in signaling, and the connection of the battery with the line, a current passes through *a c b* to the point *o*, where it divides, one portion passing through one pair of helices in one direction to the line, the other portion passing in the other direction through the other pair of helices to the earth through a rheostat or resistance-coil, having the same or nearly the same resistance as the line. These currents, being of similar strength but of opposite di-

rection, neutralize each other's effect on the magnet, and, consequently, it does not acquire polarity, its armature is not attracted, and no indication is given by the relay that a signal has been transmitted to the distant station.

When, however, a current is received from the distant station, it passes to the earth through only the pair of helices connected to the line, and does not divide at the point *o*, so as to affect the other pair of helices, on account of the resistance of the rheostat or resistance-coil R, placed in the circuit of the other helix, and, consequently, the balance between the attractive forces of the two sets of coils is destroyed either by neutralizing the current in one set of helices when the home station is sending on account of the difference in direction, or by affecting one set of helices only when the home station is not sending, and therefore the magnet will be excited and the armature attracted.

Thus it will be seen that the relay or receiving instrument at one station is affected only by the currents transmitted from the other station, and is not affected by the currents transmitted from the station where it is situated; and therefore, as the respective relays or receiving instruments at each station, though always in the circuit, respond only to the currents transmitted from the opposite station, both stations are able to receive and transmit simultaneously on a single wire. A small rheostat or resistance-coil having the same or nearly the same resistance as the battery M B is placed between the back contact-stop *d* of the key K and the earth, and thus the resistance of the line is maintained the same, whether the battery be connected or disconnected.

Fig. 3 represents a modification or form of the differential relay, in which, instead of winding each core with wires side by side or of superimposing the helices one upon the other, they are placed end to end, as shown at M M′ N N′. In this form, however, the helices will not all exert the same attractive force, notwithstanding that the currents which traverse them are of the same strength, for the reason that two are nearer the extremities of the cores; and therefore, to prevent this inequality, I connect the helices, as shown in Fig. 4, in which the course of the current to the rheostat or resistance-coil is represented by the dotted arrows as traversing the helices M N′, and the course of the current to the line by the full arrows, as traversing the helices M′ N.

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

1. The combination of the circuit-changing key K, composed of the levers *a* and *b*, or their equivalents, the differential relay or receiving instrument, and the rheostats or resistance-coils R R′ and their connections, substantially as and for the purpose as set forth.

2. The differential relay composed of the coils M M′ N N′, connected as shown in Fig. 4 of the drawing, as and for the purpose as set forth.

JOSEPH B. STEARNS.

Witnesses:

A. L. HAYES,

WM. A. HAYES, Jr.