# M. GALLY.

## Duplex-Telegraph.

No. 163,923. Patented June 1, 1875.

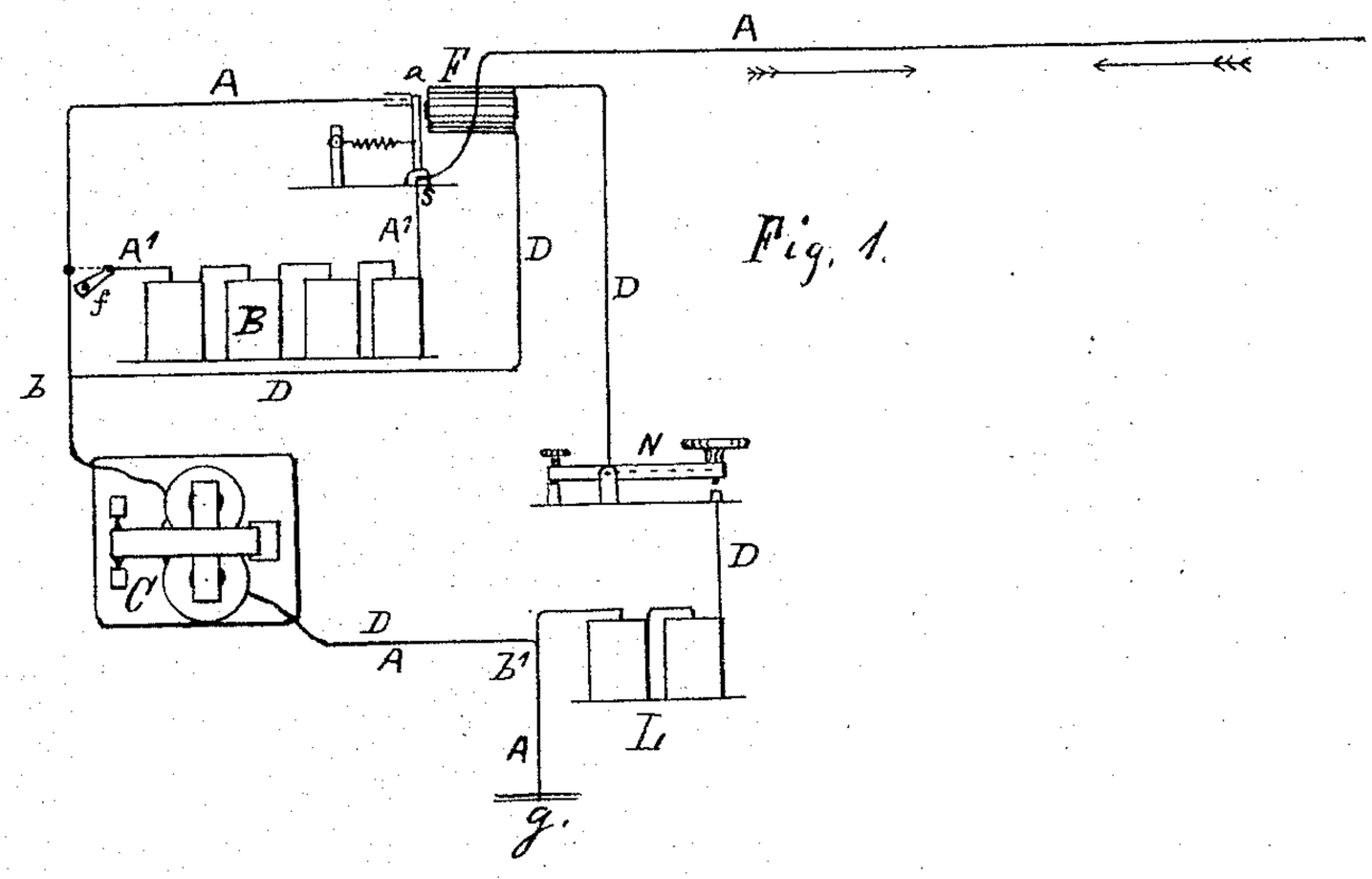


Fig. 1.

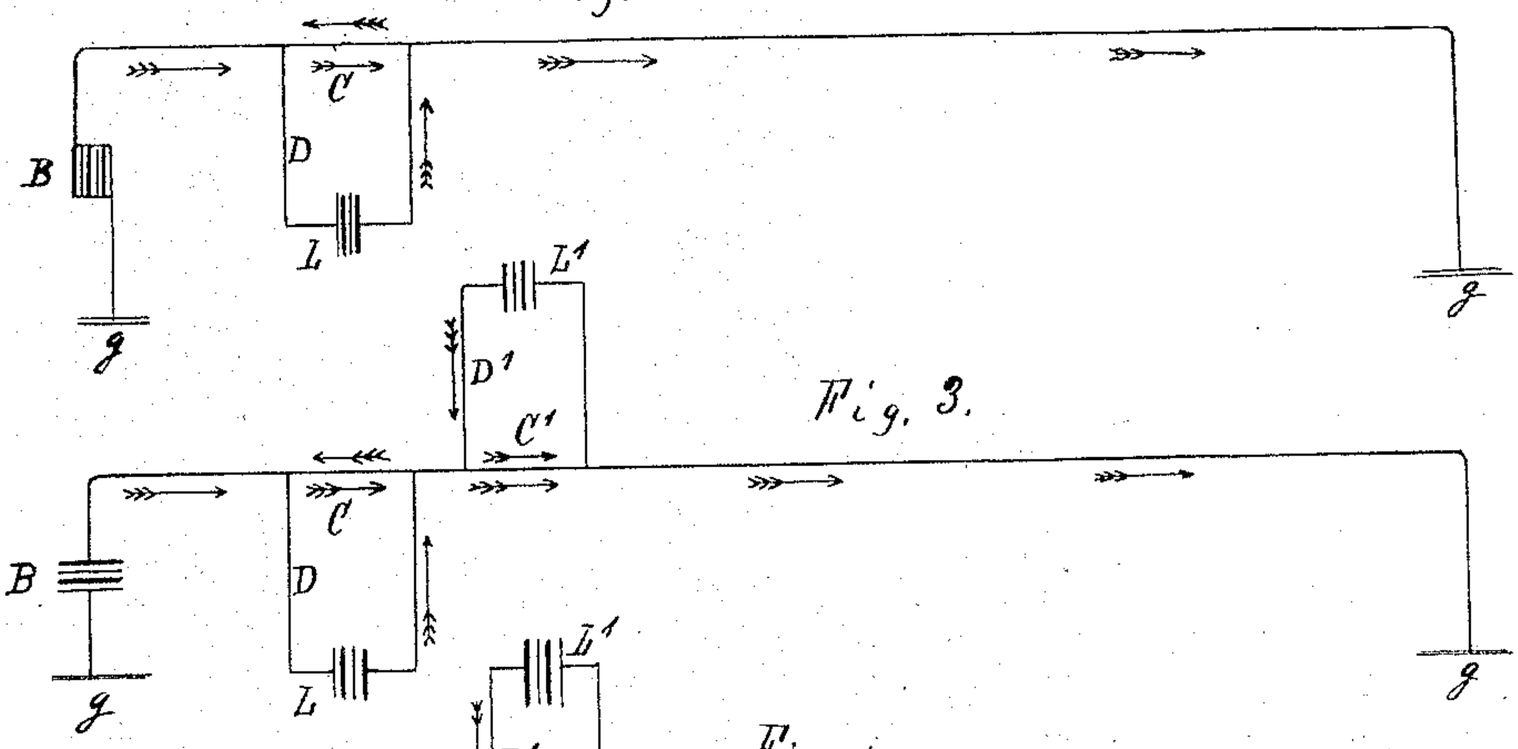


Fig. 2.

Fig. 3.

Fig. 4.

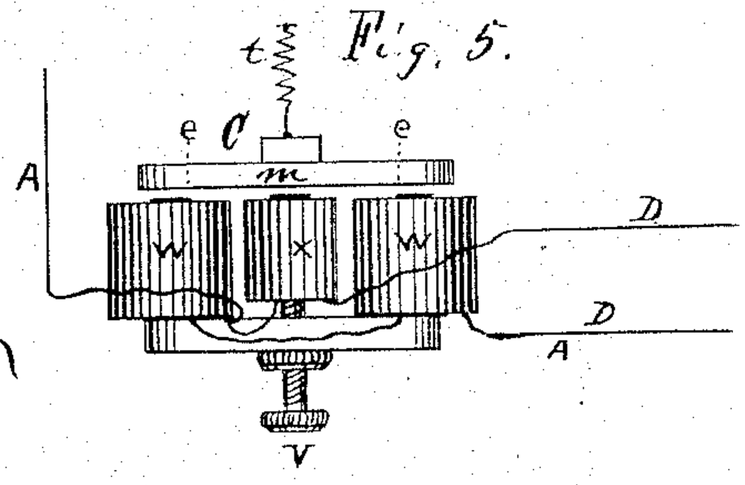


Fig. 5.

WITNESSES.

John Thomson.

W. C. Chaffee.

INVENTOR.

Merritt Gally.

THE GRAPHIC CO. PHOTO-LITH. 39 & 41 PARK PLACE, N.Y.

# UNITED STATES PATENT OFFICE.

MERRITT GALLY, OF ROCHESTER, NEW YORK.

## IMPROVEMENT IN DUPLEX TELEGRAPHS.

Specification forming part of Letters Patent No. **163,923**, dated June 1, 1875; application filed February 9, 1875.

CASE G.

*To all whom it may concern:*

Be it known that I, MERRITT GALLY, of Rochester, in Monroe county and State of New York, have invented certain new and useful Improvements in Telegraphic Apparatus; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings and to the letters of reference marked thereon.

Figure 1 represents a station with instruments, batteries, &c., together with a portion of the main line. Figs. 2, 3, and 4 are diagrams representing the main line combined with short circuits, showing different relative arrangements of currents to produce different effects. Fig. 5 represents the combination magnet, showing, also, the compound armature.

In Fig. 1, A represents a portion of the main line passing through the connector of the magnetic switch F, from thence through the receiver C, and to ground at *g*. The magnetic switch F is for breaking the line from ground through the receiver when the key N is closed, and does not differ from that of my patent dated January 19, 1875, except in the fact that its magnet is operated by means of the local battery L instead of that of the main line. The operating connections in circuit D are produced by key N, which may be substituted by any kind of a connector, whether operated automatically or by hand. The main battery is represented at B, and is connected from one of its poles to main line at S. The line from its opposite pole leads to switch *f*. The battery B, as shown, is therefore cut out, and the main line is closed to ground to receive messages at C. The circuit D, and the main line, pass through the same single wire between *b* and *b'*, which wire forms the coil of the receiving-magnet. Battery L is, however, cut out by the break in its circuit at key N. The main line and receiver are thus in the common condition for receiving messages from a distant station.

If the operator wishes not only to receive but to transmit a message at the same time he closes the switch at *f* and operates key N. Now, considering the instruments and circuits of the distant station arranged and adjusted in like manner, the results will be as follows: If the operator wishes to throw a current through the main line from battery B he closes key N. This operates the magnetic switch F, breaking the direct connection of main line with ground at *a*, and current from battery B passes to line; also through the receiver to ground. The receiver, however, remains inoperative as the current of battery L passes through the wire of the helices of C in an opposite direction to that of the main line, and prevents the main current from magnetizing the cores in proportion to the amount of current coming from battery L, taking into account the comparative resistances of the two circuits, and the comparative powers of the two batteries. It is not at all necessary that the effects of the two currents should balance each other; and, in such sense, the circuit D is not necessarily an "equating" circuit. As so far described, it is only necessary that battery L be a sufficiently disturbing force to prevent the receiver from acting at its proper adjustment. Were the effects of the batteries upon the magnets perfectly in counterpoise, other conditions requisite to perfect duplex action would not be met without the use of the compensating magnetic device which I shall hereafter explain, referring again to the point just passed over in describing the united action of the two circuits upon the receiving-magnet.

I will now speak of an important fact, the providing for which forms one of the principal features of the gist of my invention, and which I am not aware has yet been treated of or provided for by other electricians. When the current of either battery B or L is passing alone through the receiver C, it is opposed by the entire resistance of the wire in the helices, and has a certain measurement in any point of the circuit outside the wire contained between *b* and *b'*. When the battery-currents are both passing in opposite directions through the helices, the currents are not in the least neutralized in the outside parts of their circuits nor intermingled, but both remain intact, with only one difference as to their measurement. The resistance of the helices is now divided proportionately between the two cur-

rents, and, therefore, each has an increased measurement. With receiving-magnets of great resistance for long lines this increase is of considerable magnitude, and unprovided for would materially affect the successful duplex action of the line. For example, let the receiver be adjusted to act by means of the incoming main-line current alone, as in the first condition described. Now, if most favorably arranged, and the currents of the two circuits D and A in effect perfectly balance each other, the currents will be increased in power when operated together in proportion to the amount of resistance each is relieved from by their united action through the helices.

The outgoing current, when the home-key alone is depressed, therefore measures its greatest power. Now, if both keys be simultaneously struck, the two main batteries will be opposed in the main line, and, therefore, inactive. The local L of each station must now act upon its home-receiver against the entire resistances of the helices, making a much feebler stroke of the armature than that of the former condition. On long lines this would cause breaks in very rapid or short signals, and, unless provided against, would be a serious defect. I provide against such defect in the following manner: The receiving-magnet C, as shown in Fig. 5, is provided with an additional helix and core, X. The armature *m* is adjusted to the stronger current, which passes only through the helices W W. The circuit D is made first to pass through the central helix X, and then through the helices W W. The weaker current is that of the circuit D when acting alone. The magnets W W are made stationary, and adjustment of armature to them made only by the spring *t*. The magnet X, however, is in itself adjustable, in respect to the armature, and is moved nearer to or farther from it, as the case may demand after the adjustment of the spring is made. Now, when the weaker current is acting upon the receiver, the additional magnet X is moved toward the armature, until its added power makes the effect of the current upon the armature just equal to the stronger current operating only through the magnets W W. Thus the strokes of the armature-lever are perfectly equalized for all conditions. Beside this, if the battery L be comparatively light, and not in any condition balancing the effect of battery B upon the magnet C, the helix X is moved still nearer armature *m*, and the defect provided for without necessitating balancing of batteries. If, on the contrary, battery L is comparatively too heavy, the defect is provided for by withdrawing helix and core X farther from the armature. The set-screw V, passing through the connecting-bar of magnet W W, is either insulated from it, or is itself made of non-magnetic metal, so that the magnetism of the cores of W W will not affect the core of X.

It will be seen from the principles laid down that the resistance to the main-line current, when operating one of the receivers is diminished by the amount of resistance from which the helices are relieved by the current of D at the other station; and, as it is desirable to make the resistance of the main line as little as possible, I therefore increase the current of D as much as practicable, and make up for the variations in balance by adjustment of magnet X.

To further change the resistance of any of the coils, or any part or whole of the circuit-wire, I pass, if desirable, other currents through the coils or circuit-wire from independent batteries at such times as the change in resistance is to be utilized. The change of resistance of wires or coils to any given current by passing through the same, in whole or in part, other independent circuits I apply to various uses, and I do not, therefore, wish to limit myself in the use of the invention or discovery to the particular case as laid down. For example, it is often desirable at certain periods to change the resistance of a circuit, or coils of resistance in a circuit, to the current being employed. This is commonly done by cutting out certain of the resistance coils or parts thereof.

I find the method above described (of passing through certain of the coils or a part or a whole of the circuit-wire at such times independent currents) to be in many cases more advantageous, and believing myself to have been the first to have discovered this method for reducing the resistance of a circuit or coils to an operating current, I shall, therefore, broadly claim, in connection with this specification, the method as described.

If it be desirable to operate the armature with the currents of A, when passing only in one direction, for secret messages, for drop messages, or for other purposes, I make the armature of steel, and harden only its extreme ends, leaving the central portion between the dotted lines *e e* soft. I then charge the armature with permanent magnetism, when the ends become thoroughly magnetic without affecting the soft center. The ends of armature will now act in connection with cores W W, as a common polarized magnet, while the magnet X, with soft or polarized core, may, with currents differently directed through it, produce, with W W, different effects upon armature *m*, as the case may demand.

Diagram Fig. 2 represents the line and circuit D, as in Fig. 1. Fig. 3 shows two circuits, D and D′, connected with the main line, in which the batteries L and L′ are turned, as to their poles, in opposite directions. The main battery, plus to line, diminishes the magnetic effect at C, while it increases the magnetic effect at C′, as shown by the arrows. The main battery being reversed, as to its poles, produces the opposite effect, as shown in Fig. 4. These arrangements of the circuits may be used in receiving on certain direction of main current, instead of using the polarized magnet, or for alternating currents, or for op-

erating different parts of electro-mechanical receivers, as the case may be.

It will be noticed that I have represented the helices of the receiving-instrument as consisting in a single wire wound in the ordinary manner, in which the compensating current is opposed to the outgoing main-line current to prevent, when necessary, the action of the home-receiver. I shall not herein make claim to this particular feature, as I propose to more fully illustrate and broadly claim the same in another application.

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

1. The combination, with a main line, of a branch containing both the receiving-instrument and a magnetic key or switch for connecting main line with battery, or for breaking its direct connection with ground, substantially as specified.

2. The combination, with circuit D, having a magnetic switch therein, of circuit A A′, the one being open while the other is closed, and vice versa.

3. The combination, with the main line, of sub-line A′ and switch *f*, for cutting out the main battery when not in use for transmitting, substantially as specified.

4. A receiving-magnet, provided with ordinary electro magnet or magnets, and an additional magnet or magnets, all acting upon the same armature-lever for equalizing its stroke under different conditions of currents, substantially as specified.

5. A compound electro-magnet, consisting of a number of cores and helices, a part of which are stationary, the armature being adjusted to them by means of a spring, the others being in themselves adjustable, to be moved to or from the armature, substantially as specified.

6. An armature having magnetic extremes and non-magnetic center, the extremes to be affected by electro-magnets as a polarized armature, and the center as a common armature, substantially as specified.

7. The combination, with the main line passing through one or more of the magnets of the receiver, of the compensating circuit passing through the same magnet or magnets, and also through another magnet or magnets not affected by the main-line current, but all acting upon the same armature-lever, substantially as specified.

8. The combination, with a main line and its battery, of one or more circuits, each having a section of union with the main line, and an independent battery maintaining intact its own circuit-current, the magnetic or neutral condition of each section of union changing with any change of the direction of the main current, substantially as specified.

9. The method of reducing the resistance of a wire or helix to a given current, by passing through it, in whole or in part, the current of another circuit or circuits.

MERRITT GALLY.

Witnesses:

HENRY H. BURTON,

THOMAS C. CONNOLLY.