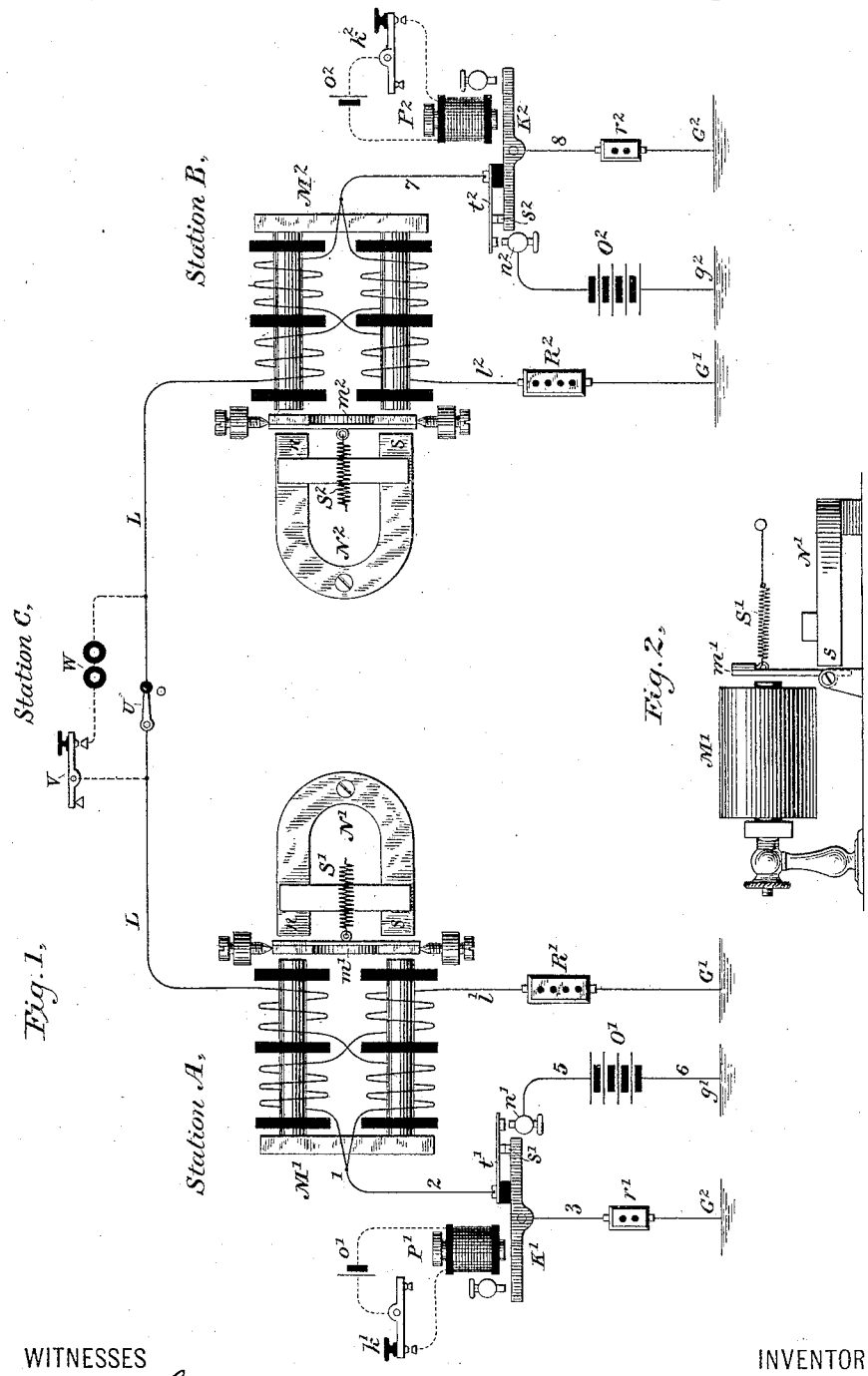
(No Model.)

W. E. ATHEARN.

TELEGRAPHY.

No. 324,799. Patented Aug. 25, 1885.



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SPECIFICATION forming part of Letters Patent No. 324,799, dated August 25, 1885.

Application filed May 5, 1884. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM E. ATHEARN, a citizen of the United States, residing in New York, in the county and State of New York, have invented certain new and useful Improvements in Duplex Telegraphs, of which the following is a specification.

My invention relates to the class of telegraphic instruments employed for the simultaneous transmission of signals in opposite directions over a single main-line conductor.

The objects of the invention are to provide means for rendering a receiving-instrument at each terminal of a line responsive to the electric impulses transmitted from the distant station, while remaining unaffected by currents caused to traverse the line through the action of the transmitting-instrument at the same station; to readily transmit to and from an intermediate station; and to cause the instruments at all stations to remain unaffected by the static discharge of the main line.

The invention consists, generally, in organizing apparatus substantially as follows: A differentially-wound electro-magnet, preferably provided with a soft-iron armature, which receives a given polarization by induction from a permanent magnet, is placed at each terminal of the line. The permanent magnet is so applied that in itself it does not tend to turn the armature upon its axis in either one direction or the other. Assisting-batteries are placed at the respective terminals of the line; but they are so connected that the currents from the battery at either station do not cause the armature of the instrument at that station to be actuated, for the reason that such currents are divided between the two branches of the differential coils with which the instruments are constructed, and the magnetization caused by the currents traversing the one branch is neutralized or counteracted by that caused by the currents traversing the other branch. The static discharge of the line does not affect the armature, for the reason that its tendency is to induce in the core magnetism of the proper character to repel the armature instead of attracting it. Currents proceeding from the distant station, however, are of the proper character for so vitalizing the electro-magnet that it will actuate the armature. At an intermediate station there is placed a receiving-instrument and a transmitting-key. This receiving-instrument responds only to the combined action of both batteries, so that by operating the key at either terminal the instrument at the intermediate station will be operated, and by operating the key at that station either terminal receiving-instrument may be operated.

Apparatus has been heretofore organized for the purpose of sending messages simultaneously in opposite directions, either between terminal or terminal and way stations, and double transmitting apparatus has been arranged at the main station of a system in such a manner that each of a series of branch stations may transmit to the line and receive simultaneously.

In Figure 1 of the drawings the organization of apparatus is illustrated at two stations, designated as Station A and Station B, and which are connected by a main line, L. Fig. 2 illustrates certain detail in the construction of the armature and its polarizing electro-magnet.

The apparatus at station A consists of a differentially-wound electro-magnet, M′, provided with a soft-iron armature, *m*′, which is normally polarized by a permanent magnet, N′. The permanent magnet is applied to the armature, as shown in Fig. 2, with its poles opposite the fulcrum of the same, and it does not therefore act to impel the same in either direction. A retractile spring, S′, is preferably employed for normally holding the armature away from the poles of the electro-magnet. This method of polarizing an armature is not in itself new, and no claim is made to it as such. The magnet N′ tends to induce in the armature a polarization of the proper character to impel it away from the poles of the electro-magnet M′ when that electro-magnet is vitalized by a current of one polarity, and to attract the same when vitalized by a current of the opposite polarity. Thus, if the poles *n* and *s* of the magnet N′ be respectively north and south, the corresponding extremities of the armature will be by induction north and south. The coils of the electro-magnet M′ are so wound with reference to the direction and polarity of the currents caused to traverse the same during the operation of transmitting from the station at which the in-

strument is located that the currents passing to the line would, were their effects not counteracted, tend to attract the armature. A current of the same polarity traversing the coils in the opposite direction would therefore have the opposite effect and tend to induce magnetism of the proper character to repel the armature. One branch of the coils of the electro-magnet M′ is connected with the main line L, while the other is connected through a conductor, *l′*, including a resistance, R′, with the earth at G′. The amount of resistance offered by the resistance R′ is preferably approximately equal to that of the main line. The remaining terminals of the differential coils are united at a point, 1, with a conductor, 2, leading to the contact-spring *t′* of a circuit-preserving transmitting-key, K′. The lever of the key K′ is connected with the earth through a conductor, 3, including a resistance, *r′*. The contact-spring *t′* normally rests against a stop, *s′*, upon the lever of the key and completes the connections of the conductor 2 with the earth through the conductor 3 and resistance *r′*. When, however, the key K′ is depressed this connection is interrupted by the contact of the spring *t′* with a stop, *n′*, which stop is connected with one pole—in this instance the positive—of a battery, O′, by means of a conductor, 5. The remaining pole of this battery is connected with the earth at *g′* through a conductor, 6. The key K′ is preferably under the control of an electro-magnet, P′, which is included in the circuit of a local battery, *o′*, provided with a circuit-closing key, *k′*. When the electro-magnet P′ is vitalized, the key K′ will be depressed and the battery O′ is placed in connection with the conductor 2 through spring *t′* of the key K′, the connection of the key K′ with the earth being at the same time interrupted. For the purpose of effecting this substitution without materially changing the amount of resistance offered to incoming currents the resistance *r′* is made approximately equal to that offered by the battery O′.

The apparatus at station B is precisely similar to that described with reference to station A, with the exception that the negative pole of the battery O^2 is connected with the line, and the positive pole is connected with the earth, and the coils of the electro-magnet M^2 are so wound that a current passing to the line from the battery O^2 would tend to attract the armature m^2, and a current of the same character in the opposite direction would tend to repel it.

The apparatus at each station is so organized that a current from the battery O′ passing over the main line to station B will actuate the receiving-instrument at that station, and a current from the battery O^2 passing to station A will actuate the receiving-instrument at station A.

The operation of the apparatus is as follows: When both keys are at rest, no current traverses the main line, both terminals being connected with the earth through the artificial resistance *r′* and r^2, respectively. When, however, the key K′, for instance, is depressed, the positive pole of the battery O′ will be connected with the conductor 2. The current upon reaching the point 1 divides, one half traversing the coils of the magnet M′, which are connected with the earth through the conductor *l′*, while the remaining portion traverses the opposing coils and passes, by way of the main-line conductor L, to station B. No effect is therefore produced upon the cores of the electro-magnet M′. At station B, however, the current passes through one system only of the coils of the differential electro-magnet M^2, reaching the earth by way of the conductors 7 and 8 and artificial resistance r^2. The electro-magnet M^2 is therefore vitalized, the magnetization being such as to attract the armature m^2. In this manner the receiving-instrument at station B will be actuated by currents from the battery O′. When the key K^2 alone is operated, the receiving-instrument at station A will be actuated in precisely the same manner.

Considering now the operation, were both keys K′ and K^2 depressed, the current from the two batteries being in the same direction will not neutralize each other, but may be considered as traversing their respective circuits independently, and each will perform precisely the same function as when the batteries are separately connected with the main line.

It is a well-known fact that upon the interruption of a current traversing a conductor an electrical disturbance occurs, which is commonly termed the "static discharge." Such a discharge, when occurring through a telegraphic line of any considerable length, is of sufficient force or strength to actuate a receiving-instrument of ordinary construction, and false signals are thus given unless its effects are provided against.

Considering now the effect produced upon the interruption of a current flowing from the battery O′ upon the main line L—that is to say, a positive current—there will be a static discharge in the form of a positive current flowing from the line through the coils of the receiving-instruments which are connected therewith.

By so winding the coils of the electro-magnet M′ and organizing the permanent magnet N′ that the tendency of a current from the battery O′ traversing these coils of the differential electro-magnet is to attract the armature *m′*, the discharge of the line will be of proper polarity for inducing in the cores of the electro-magnet M′ magnetism of the same polarity as that induced in the confronting extremities of the armature *m′* by the permanent magnet N′. The discharge will therefore tend to cause a repulsion of the armature rather than an attraction, provided the strength of the static current is not sufficient to overpower the induced magnetism in the armature. In practice the static discharge

will not be of sufficient strength to cause this last result, and the instrument will therefore not be affected by the discharge of the line.

The various parts are so adjusted that the effects of the discharge will not be sufficient to impair the operation of the apparatus in response to currents transmitted from the distant station.

At station B the static discharge following an interruption of the current from the battery O′ is in effect a slight prolongation of that current.

When transmitting from the battery O^2, the operation is precisely similar to that described with reference to station A, and will not require further description.

An intermediate station is represented at C, the circuits being shown in dotted lines. By means of a suitable switch, U, inserted in the main line L, the normal main-line connections may be interrupted, and the currents forced to traverse the conductor shown in dotted lines. A key, V, and relay W are included in this last-named conductor. The relay W is preferably so adjusted that it will not respond to currents from one battery O′ or O^2 alone; but if both keys K′ and K^2 be closed, so that the currents from the two batteries traverse the line L, then the relay W will respond. If, therefore, it is desired to transmit from one of the stations—for instance, station A to station C—then the key K^2 at station B should be closed, and the operator at station A by means of his key K′ will cause the relay W to respond accordingly. When, on the other hand, it is desired to transmit from station C to either of the other stations, then the operator at station C operates the key V in the usual manner. The armatures m' and m^2 of the instruments at both stations A and B will be drawn into their forward positions when the main-line connections are completed through the key V, as has hereinbefore been explained; but when the main-line connections are interrupted by opening the key V, then each battery O′ and O^2 will have its circuit closed only through the coils of the corresponding electro-magnet, M, which are connected with the artificial line. The effect of the magnetism produced by currents traversing these coils will be to impel the armatures *m* away from their respective electro-magnets. In this manner the relays at each of the stations A and B will respond to the movements of the key V.

I claim as my invention—

1. The combination, substantially as hereinbefore set forth, with a telegraphic main line, of two receiving-instruments, two transmitting-instruments, and two assisting-batteries, one of each of which instruments and batteries is located at each end of said main line, means, substantially such as described, for causing each of said receiving-instruments to respond only to currents from the battery at the remote terminal of the line, and a receiving-instrument located at an intermediate point in said line, and responding only to currents due to the combined action of said batteries.

2. The combination, substantially as hereinbefore set forth, with a main line, of two assisting-batteries, two transmitting-keys for respectively connecting said batteries with the respective terminals of said main line, two telegraphic receiving-instruments respectively located at the opposite terminals of said main line, and responding only to the movements of the key at the remote terminal of the line, a receiving-instrument and transmitting key included in said main line at a point between said batteries, which receiving-instrument responds when both of the first-named keys are closed.

In testimony whereof I have hereunto subscribed my name this 25th day of April, A. D. 1884.

WILLIAM E. ATHEARN.

Witnesses:
A. L. EUGENE,
CHARLES A. TERRY.