(No Model.)

F. W. JONES.

DUPLEX TELEGRAPH.

No. 260,208. Patented June 27, 1882.

Fig: 1.

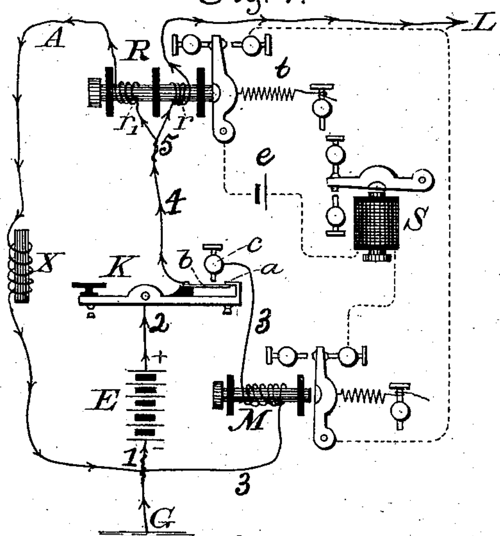


Fig: 3.

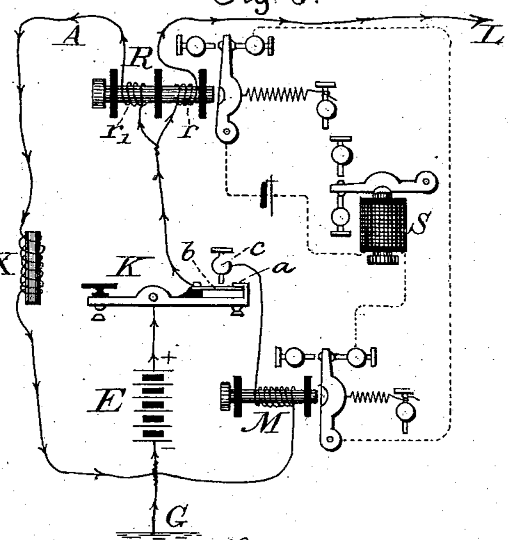


Fig: 2.

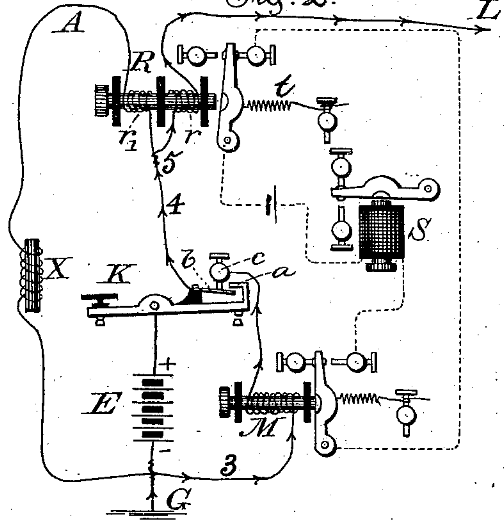


Fig: 4.

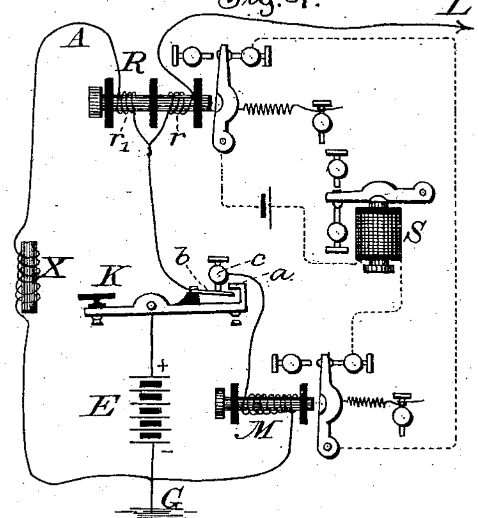


Fig: 5.

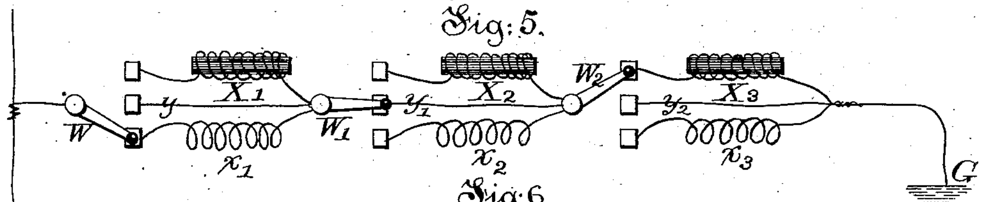
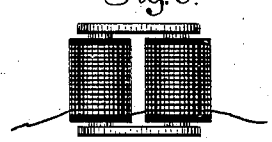


Fig: 6.



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UNITED STATES PATENT OFFICE.

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DUPLEX TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 260,208, dated June 27, 1882.

Application filed November 11, 1881. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS W. JONES, a citizen of the United States, and a resident of the city, county, and State of New York, have invented certain new and useful Improvements in Duplex Telegraphs, of which the following is a specification.

I am aware that it is not new to make use of an inductor consisting of a mass of soft iron surrounded by a magnetizing-helix for the purpose of counteracting the effects upon the instruments of a duplex telegraph produced by the electro-static action of the main line. In Letters Patent of Great Britain No. 1,044 of 1870, granted to Cromwell F. Varley, an inductor of this character is described and shown which is situated at the home station at a point between the duplex apparatus and the line, so that all currents passing to and from the main line traverse its coils. This organization, however, is objectionable for two reasons. First, the resistance of the main circuit is materially increased by the introduction of additional helices, thereby necessitating the use of a greater electro-motive force in working the line, and also increasing the difficulties encountered from leakage through imperfect insulation in wet weather; and, second, the discharges from the coils of the inductor, while they produce a beneficial effect in neutralizing the action of the static discharges at the home station, at the same time produce disturbing effects at the distant station, inasmuch as any action produced by an inductor at any point in the main circuit must necessarily extend to all parts of the circuit. In Letters Patent of the United States No. 136,873, granted to Joseph B. Stearns, an inductor of this class is applied to the so-called "artificial line," which is primarily employed for the purpose of producing a magnetic equilibrium in the receiving-relay at the home station when traversed by outgoing currents. In this organization the outgoing current divides equally at the home station between the main and artificial lines, and these respectively pass through separate coils of the receiving-instrument in opposite directions. Hence the discharge from an inductor in the artificial line (being necessarily in the same direction or having the same polarity as the exciting-current) will continue to traverse the differential magnet in the same direction, whereas the direction of the static discharge is opposite to that of the original current. Hence the static discharge and the discharge from the inductor will pass through both coils simultaneously in the same direction, and tend rather to increase than to diminish the injurious effects which the invention seeks to obviate. My invention differs from both these, in that the inductor is placed in an independent branch instead of the circuit of the main or artificial line, and this branch is so arranged with reference to the main-line circuit and to the receiving-magnet that it opposes instead of assisting the action of the electro-static discharge.

My invention relates to that class of duplex telegraphs in which two or more independent signals or series of signals are simultaneously transmitted in opposite directions over a single telegraph-wire. In the practical operation of such a system of duplex telegraphy the proper reception of signals is interfered with and obstructed by false signals, which are produced upon the home instrument by the charges and discharges of static or induced electricity, which pass to and from the line-wire at the instant the connection is established between the battery and the line or between the line and the earth by means of the key or transmitter. These effects are especially troublesome when the line (if a land-line) is of considerable lenth and well insulated, or when a submarine cable forms the whole or a considerable portion of the line.

The object of my present invention is to obviate the interference which arises from this source. I effect the desired result partly by an improved organization and arrangement of the receiving-sounder or other equivalent instrument, in combination with two independent relays, which are so connected that the receiving-sounder is actuated by the combined action of the armatures of both relays when upon their resting-contacts, but principally by an improved construction and organization of the electro-magnetic conductor at the home station, whereby its capacity for storing up and afterward giving out a certain amount of electric energy for the purpose of counteracting the electro-static action of the line may be increased or diminished at will.

In the accompanying drawings, Figures 1, 2, 3, and 4 are diagrams representing my improved apparatus at one terminal of a line under the four different conditions which may occur in actual use. Fig. 5 is a diagram showing the method of and apparatus for varying the resistance and electro-static capacity of the artificial line, and Fig. 6 illustrates the form of electro-magnetic accumulator which I prefer to employ.

Referring in the first instance to Fig. 1, which represents the apparatus at one terminal station, and which for convenience of description will hereinafter be designated as the "home station," K represents an ordinary continuity-preserving key or transmitter of well-known construction, this being provided with an insulated contact-spring, b, mounted upon it, which normally rests (by virtue of its own elasticity) against a stop, a, formed on the extremity of the key-lever, and which constitutes what is technically termed the "resting-contact" of the key. When the key is depressed the contact-spring b is pressed against the stop c and at the same time is pushed away from the stop a. The stop c is therefore termed the "working-contact."

E is the main battery, one pole of which (the positive pole in the drawings) is connected to the lever of the key K, and consequently to the resting-contact a. The other or negative pole of the battery is connected by a wire, 1, with the earth at G. The working-contact c of the key is connected by a wire, 3, with the earth at G, and in this wire is placed a relay-magnet, M. A wire, 4, extends from the insulated contact-spring b to the point 5, where it divides into two branches, one passing around the core of the relay R, as shown at r, and thence by the line L to the distant station, while the other branch passes in the same direction around the same core of the relay R, as shown at r', and thence returns by the static-compensating line A to the opposite pole of the battery E, or, what amounts to the same thing, to the earth at G. In the circuit of the equating-line A an electro-magnetic accumulator, X, is inserted, which, I here remark, may offer to the electric current a resistance approximately equal to that of the line L.

The details of construction of the accumulator X which are preferred in practice will be hereinafter more fully described.

A sounder, register, or other telegraphic receiving-instrument, S, of any suitable construction, is placed in the circuit of a local battery, e. The course of this local circuit is indicated by dotted lines. It is connected with the armature-levers and resting or back contact-stops of the two relays R and M, and hence a signal can only be produced upon the receiving-instrument S when both of said armature-levers are resting upon their back contact-stops.

In order to transmit two communications in opposite directions at the same time, it is necessary that the receiving-instrument at the home station should respond only to the movements of the transmitting-key at the distant station, and not at all to the movements of its associate key at the home station. The manner in which these conditions are fulfilled in my improved apparatus will now be explained.

In Fig. 1 the apparatus at the home station is represented as in its normal condition of rest, and the apparatus at the other terminal station is assumed to be in the same condition. In this case a current from the positive pole of the main battery passes over the wire 2 (its direction being indicated by the arrow-heads placed upon the wire) to the resting-contact a, thence through contact-spring b and wire 4 to the point 5, where it divides into two portions, one portion passing through the helix or coil r of the relay R, and thence over the line L to the distant station and earth, the other portion traversing the coil r' in the same direction, and thence passing through a short branch line, A, and inductor X to the earth or negative pole of the battery. The course of the electric currents at the distant station is precisely the same, and as the battery at that point corresponding to the battery E is placed with its negative pole to the line L it follows that the line will be traversed by a current having a strength proportionate to the combined electro-motive force of both terminal batteries, whereas the branch A at each station will be traversed by a current proportionate to the electro-motive force of one battery only. The magnetic influence of the assisting-coils r and r' upon the core of the magnet of the relay R will therefore cause its armature to be attracted, and the local circuit through the back contact-stop will consequently be interrupted. Hence when the apparatus is at rest and in its normal position the line L is at all times traversed by a current which is proportionate to the combined strength of both terminal batteries, and a corresponding static charge is accumulated upon the line. If, now, the key be depressed in order to transmit a signal to the distant station, the apparatus at the home station will assume the position shown in Fig. 2. In this case the main battery E at the home station is disconnected from the line, its circuit being interrupted between the contact-spring b and the resting-stop a. At the same time a new connection is formed between the spring b and the working-contact c. Hence the current from the battery at the distant station now traverses the route indicated by the arrow-heads upon the wires in Fig. 2—that is to say, from the earth at G, through the wire 3, relay-magnet M, working-contact c, contact-spring b, wire 4, coil r of the relay R, and line L, to the distant station, returning by the earth, as before. In this position the armature of the relay R is released and falls on its back contact, for the reason that the effective current in the coil r is no longer sufficient to overcome the force of the retracting-spring t, which is so adjusted that it can be overpowered only by the combined effect of both terminal batteries acting in concert. The current also traverses the other relay, M, which is adjusted to respond to the current from the battery of the distant station only, and causes its armature to be attracted, thus breaking the local circuit at its back contact. The effect of this operation upon the apparatus at the receiving-station will be best understood by reference to Fig. 3, in which the key at the home station is shown in its normal position of rest, while the key at the distant station is assumed to be depressed, as in Fig. 2. In this case the current of the battery E, traversing the coils r and r' of the relay R, receives no assistance from the battery at the distant station, which, as hereinbefore explained, is cut out of the circuit when its associate key is depressed or is transmitting a signal. Hence it is not able to overpower the opposing-spring t, and its armature-lever falls on the rear contact-stop and closes the circuit of the local battery e. As there is now no current traversing the relay M, this also allows its armature to fall on the back contact, and hence the local circuit is closed, and the sounder or receiving-instrument S is actuated, thus responding to the depression of the key at the distant station.

In case the keys at both terminal stations are simultaneously depressed, both batteries are removed from the circuit, and there is no current traversing any portion of the system, in which case it is obvious that the armatures of the relays R and M at both stations will be released and will fall on their back contacts, and thus close the local circuit at each station, and hence the sounders or other receiving-instruments S at both stations will be actuated.

It now remains to consider the effects produced by the action of the charges and discharges of static electricity passing to and from the line.

It is well known that when a bar or mass of soft iron is surrounded by a helix it becomes magnetic when the said helix is traversed by an electric current; and it is furthermore known that the inductive action exercised by the several convolutions of such a helix upon each other tends to set up a current of contrary direction, which tendency is assisted by the magneto-electric action of the soft iron upon the helix during the process of magnetization. The moment, however, that the current ceases or is interrupted the disappearance of the magnetism which has been induced in the iron produces a powerful magneto-electric current in the same direction—or, in other words, of the same polarity—as the original exciting-current, and which traverses the circuit of which the helix forms a part in the same direction as did that current. Thus the action of a mass of soft iron and its enveloping helix upon the electrical condition of the circuit of which said helix forms a part is to lengthen the time which is necessary either to establish or to interrupt a current—that is, to oppose and retard change of any nature. Hence it is obvious that if a device of this character be placed in the circuit of the branch line A at the home station, as shown at X, the current in said branch will not be established instantly when the connection with the battery is formed; nor will it disappear instantly when the same is interrupted, but will be prolonged for a determinate period. The effect of this action upon the duplex apparatus will now be explained. When the apparatus of both terminal stations is at rest in the position shown in Fig. 1 the line L attains its maximum electro-static charge, being traversed by the combined currents of both terminal batteries. When the key K is depressed, as shown in Fig. 2, the wire 4 is disconnected from the battery E and connected directly to the earth at G, through the relay M. At the instant this change takes place a powerful static discharge from the line traverses the apparatus through the wires 3 and 4 and the coil r, but in a direction opposite to that indicated by the arrow-heads in Fig. 2. This static discharge has a tendency to neutralize the existing magnetism in the relay R, and consequently to throw its armature upon the back contact and at the same time to oppose the magnetization of the relay M. Hence its general tendency is to produce a false signal by throwing the armature of relay R on its back stop and preventing the armature of relay M from responding to the action of its magnet, so as to break the local circuit at that point; but this tendency is counteracted by the discharge from the electro-magnetic accumulator X, which takes place in the same direction as its exciting-current, as shown by the arrow-heads in Fig. 1, and which opposes the effect of the static discharge both in the relay M and in the relay R, and hence no false signals are produced by its action upon the receiving-instrument S. When the key K is released and the connection is re-established between the battery E and the line L the charging-current passes through the coil r and draws the armature of relay R away from its back contact before the armature of relay M has time to pass from its front stop to its back contact, and thus no false signals are produced by the charge-currents upon the receiving-instrument S.

It is well known that the amount of the static accumulation upon a given line varies from time to time, in consequence of changes in the weather and in the insulation of the line, and hence the discharges will be much greater at some times than at others. The resistance of the line itself, as presented to the battery at the home station, also varies, but not necessarily in proportion to the variation of the static charge. Hence it is essential, in order to adapt the apparatus to different atmospheric and other like conditions, that means should be provided whereby the resistance of the branch line and the force and duration of the discharges from the electro-magnetic inductor may be regulated independently of each other. In order to accomplish this result, I prefer to construct the inductor in the manner shown in the diagram Fig. 5, in which the total resistance is made up of a series of artificial resistances, any required number of which may be placed in circuit. I have shown three such in the drawings; but I remark that any required number, either greater or less, may be used, as circumstances require.

At X′ is an electro-magnetic inductor, having a certain resistance in its enveloping coils. x' is a coil having a resistance equal to that of X′, but without a core, and y is a wire of inappreciable resistance, normally continuous with the branch line. By means of a switch, W, either one of these sub-branches may be placed in circuit at pleasure. The manner of effecting this will be understood by referring to the figure. For example, the switch W, Fig. 5, is placed in a position to include the resistance x' in the circuit. The switch W′ is connected with the direct wire y' of inappreciable resistance, while the inductor X^2 and the resistance x^2 are cut out. The switch W^2 is so placed as to include the inductor X^3 in the circuit, cutting out the wire y^2 and the resistance X^3.

It is obvious that the capacity of the several inductors and resistances may be graduated or graded with reference to each other, so that any required combination may be effected. The length and mass, and consequently the magnetic inertia, of the soft-iron cores of the inductors X′ X^2 X^3 should be different, in order that the time of discharge may be varied accordingly by throwing one or another into circuit.

In Fig. 6 I have shown the form of electro-magnetic inductor which I prefer to use, consisting of an ordinary electro-magnet having its poles united by a soft-iron bar, so that its cores form a closed magnetic circuit, as by this mode of construction a more powerful magneto-electric discharge may be obtained by the given strength of current.

I claim as my invention—

1. The combination, substantially as hereinbefore set forth, of a key or transmitter, a battery included in the circuit between the resting-contact of said key and the earth, an electro-magnet for actuating a relay included in a circuit between the working-contact of said key and the earth, a second electro-magnet for actuating a relay between said key and the line, and a receiving-instrument included in a local circuit which traverses the armature-levers and resting-contacts of both of said relays at one and the same time.

2. The combination, substantially as hereinbefore set forth, of a main line extending to the distant station, a branch line returning directly to the earth at the home station, a battery, a key connecting said battery simultaneously to both the main and branch lines, and a receiving-magnet wound with two assisting-coils, one of which is included in the main and the other in the said branch circuit.

3. The combination, substantially as hereinbefore set forth, of a main line extending to the distant station, a branch line returning directly to the earth at the home station, a battery, a key connecting said battery simultaneously to both the main and branch lines, a receiving-magnet wound with assisting-coils, one of which is included in the main and the other in the branch line, and an inductive core of soft iron surrounded by a coil, which is included in said brach line.

4. The combination, substantially as hereinbefore set forth, of an electric conductor, a receiving-instrument included in the circuit of said conductor, two branch conductors, an inductive core enveloped in an electro-magnetic helix and included in one of said branches, an artificial resistance approximately equal to said helix included in the other branch, and a circuit-changer whereby the first-named conductor may be connected at will with either of the branches.

5. The combination, substantially as hereinbefore set forth, of a series of independent electro-magnetic cores, each surrounded by a coil, a series of rheostats whose resistances are equal to those of the said coils, respectively, and circuit-changers for throwing either one of said coils or its equivalent resistance into an electric circuit at will.

In testimony whereof I have hereunto subscribed my name this 25th day of October, A. D. 1881.

FRANCIS W. JONES.

Witnesses:

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