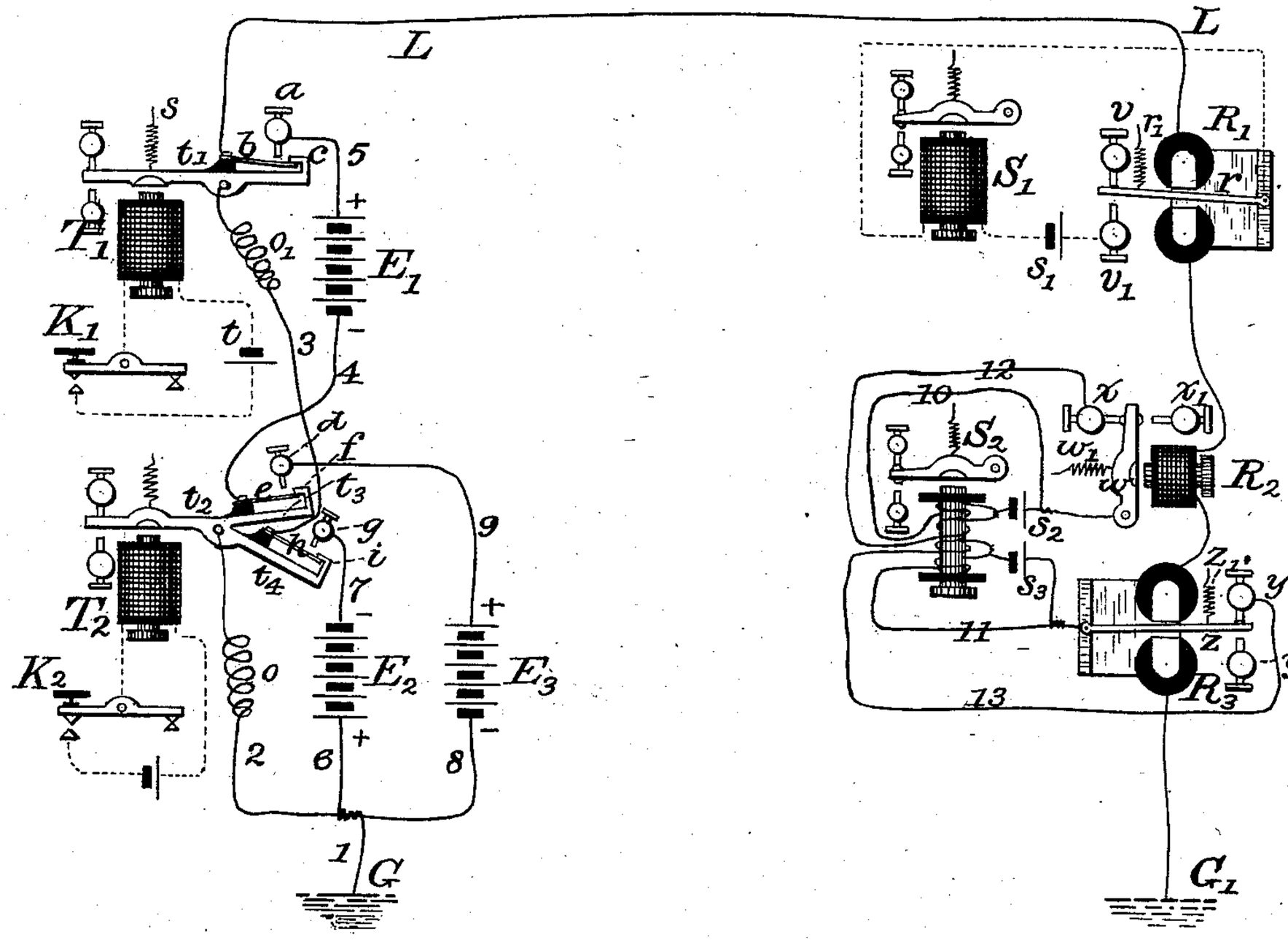
(No Model.)

F. W. JONES.

QUADRUPLEX TELEGRAPH.

No. 255,295. Patented Mar. 21, 1882.



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QUADRUPLEX TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 255,295, dated March 21, 1882.

Application filed January 16, 1882. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS W. JONES, a citizen of the United States, residing at 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.

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

My invention consists in an improved organization of transmitting apparatus with reference to the batteries, whereby the required combinations of currents are transmitted.

It further consists in an improved construction and organization of the receiving-instruments, as hereinafter fully set forth.

The accompanying drawing is a general plan or diagram illustrating my invention, showing both the transmitting and receiving instruments, with their various connections

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 the drawing, t' is a lever capable of a slight vertical movement upon its axis in one direction by the attraction of the electro-magnet T′ and in the other by the retractile force of the spring *s*. The lever t', with its appendages, constitutes the first or single-point transmitter, and is operated by means of a key, K′, 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 lever t', while its free end, by its own elasticity, presses upward against the projection *c*, formed upon the extremity of the lever t', and is therefore in electrical contact therewith. When, however, the key K′ is depressed the attraction of the electro-magnet T′ for its armature elevates the opposite end of the lever t', which carries with it the contact-spring *b* and presses the latter against the fixed stop *a*. The further movement of the lever t' 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′ 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 the lever t'. 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 form shown in the drawing, and consists of a lever, t^2, actuated by an electro-magnet, T^2, key K^2, and local battery, as hereinbefore explained. The lever t^2 is a three-armed lever, one arm carrying the armature, and the other two, which are on the opposite sides of the fulcrum, being provided with circuit-closing devices, as follows: Upon the arm t^3 is an insulated spring, *e*, which plays between the resting-contact *f* and working-contact *d*. The arm t^4 carries an insulated spring, *h*, which plays between the resting-contact *i* and the working-contact *g*.

The effect produced upon the electrical condition of the main line by the different positions of the keys at the transmitting-station will now be explained.

1. *When the first and second keys are both open.*—This is the position of the apparatus as represented in the drawing. Omitting for the present the consideration of the receiving-in-

struments and their connection with the line, the circuit may be traced as follows: from the earth at G by wires 1 and 2 to the lever t^2; thence by arm t^4, resting-contact i, contact-spring h, and wire 3 to lever t'; thence by resting-contact c and contact-spring b to the line L, which extends to the receiving-station and the earth at G'. Thus the line-wire is connected to the earth at the transmitting-station without including either battery. In this position of the keys there is therefore no current upon the line.

2. *When the first key is closed and the second key open.*—The route is the same as before, from the earth at G to the lever t^2; but at this point it diverges, going through the arm t^3, resting-contact f, contact-spring e, and wire 4 to the battery E'; thence by wire 5 to the working-contact a and contact-spring b to the line L. In this position the battery E' is placed in circuit with its positive or + pole to the line.

3. *When the second key is closed and the first key open.*—The route is as follows: from the earth at G by wires 1 and 6 to the battery E^2; thence by the wire 7 to working-contact g, contact-spring h, and wire 3 to the lever t'; thence by resting-contact c and spring b to the line L, as before. In this position the battery E^2 is placed in circuit with its negative or — pole to the line.

4. *When both the first and second keys are closed.*—The route of the circuit is as follows: from the earth at G by wires 1 and 8 to the battery E^3; thence by wire 9, working-contact d, spring e, wire 4, battery E', wire 5, contact-stop a, and contact-spring b to the line L. In this position the batteries E' and E^3 are both placed in circuit in series with their positive poles to the line.

The receiving apparatus consists of two sounders or other like instruments, S' and S^2, which are placed in local circuits, and are controlled by the action of relays in the main-line circuit, as hereinafter explained. It is essential that the sounder S' should respond to the movement of the key K' 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, upon entering the receiving-station, passes through the coils of the respective relays R', R^2, and R^3, and thence to the earth at G'. The relay R' is provided with a polarized armature, r, which vibrates between two contact-stops, v and v', being normally held in contact with the former by the tension of a retractile spring, r'. The polarized armature r operates the sounder S' by means of a local battery, s', the circuit of which is shown in dotted lines. This local circuit is completed and the sounder actuated whenever the polarized armature r is brought in contact with the stop v'.

R^2 is a relay, having a neutral armature, w, of the ordinary well-known construction, and provided with a retracting-spring, w'. This armature vibrates between two adjustable contact-stops, x and x', but is normally held against the former by the spring w'.

R^3 is a third relay, having a polarized armature, z, also provided with a retracting-spring, z', which normally holds it in contact with the stop y.

The electro-magnetic sounder S^2 is provided with four distinct helices or coils, two of which are wound in one direction and two in the opposite direction. One pair of these coils are in circuit with a local battery, s^2, and with the armature-lever of the neutral relay R^2, and the other pair are in circuit with another local battery, s^3, and the armature of the polarized relay R^3, the particular arrangement being clearly shown in the drawing. When the apparatus is in its normal position, as shown in the drawing, one coil of the sounder S^2 is included in the constantly-closed branch 10 of the local battery s^2. Another similar coil wound in the same direction is included in the constantly-closed branch 11 of the other local battery, s^3. The third coil is included in the branch 12 of the local battery s^2, which is closed through the back or working contact stop x of tlie relay R^2. The fourth coil is included in the branch 13 of the local battery s^3, which is closed upon the working-contact y of the relay R^3. Hence the electro-magnetic effect upon the sounder S^2 of the branch circuits 10 and 11 is precisely counteracted by the opposing effect of the branch circuits 12 and 13, and the sounder S^2, like the sounder S', remains normally unaffected.

The manner in which the receiving-instruments operate in accordance with each of the several electrical conditions of the line hereinbefore described is as follows:

1. *No current.* — The local circuit of the sounder S' is held open by the action of the spring r' upon the armature r, and it therefore remains inactive. In the sounder S^2 the effects of the local circuits 10 and 11 upon the sounder-magnet are neutralized by the action of the local circuits 12 and 13, which cause it also to remain inactive.

2. *Positive current from battery* E'.—The relay R', the armature of which is actuated in opposition to the spring r' by positive currents of any strength, closes the local circuit of the sounder S'. The relay R^2, which must have its retractile spring w' adjusted to a tension which the current from the battery E' alone is unable to overcome, does not respond. The relay R^3, being affected solely by negative currents, does not respond, and hence the local circuits traversing the sounder R^2 remain unchanged, and the latter is unaffected.

3. *Negative current from battery* E^2.—The relay R' does not respond to the current, which is now of the wrong polarity, and the sounder S' remains unaffected. The relay R^3, however, responds to the negative current, and its armature z is brought in contact with the stop y',

thus breaking the local circuit 13 at the stop *y*. The sounder S^2 is actuated by the current in the local circuit 11, which is no longer opposed by the current in the branch 13.

4. *Positive current from batteries* E′ *and* E^3 *combined*.—In this case the relay R and sounder S′ are operated as in the first case. The relay R^3 remains unaffected, the current now being of the wrong polarity. The increase of the strength of the current arising from the union of the two batteries E′ and E^3 is sufficient to overcome the tension of the retracting-spring *w*′. Hence the relay R^2 breaks the local circuit 12 at the stop *x*, and the sounder S^2 is actuated by the local current traversing the wire 10, which is no longer opposed by that in the wire 12. Thus the combined positive current of both main batteries causes both sounders to be actuated.

In order to adapt the hereinbefore-described apparatus to the simultaneous transmission of four communications upon the same conductor—two in each direction—it is only necessary to employ it in connection with some suitable known method of duplex telegraphy. In order to more perfectly adapt the apparatus to this use, it is necessary that the total resistance at the transmitting-station should always be the same, whatever the position of the keys or transmitters may chance to occupy. To this end it has been usual to place a rheostat, *o*, in the wire 2, which forms a connection between the lever of the transmitter and the earth, the resistance of which is equal to that of the battery E^2 or E^3. In order to provide for the resistance of the additional battery E′, I also insert a rheostat, *o*′, having a resistance equal to that of said battery, in the wire 3, between the two transmitters. Under this arrangement it will be observed that no change is made in the resistance at the transmitting-station between the line L and the earth G, whatever may be the position of the respective transmitters.

It is very essential that the direction of the current in the wire 12, which is interrupted by the action of the relay R^2, should be the same as that in the wire 13, which is interrupted by the action of the relay R^3, and that both should pass around the core of the sounder S^2 in the same direction; for in this case, when the direction of the current in the main line is reversed, no reversal will take place in the core of the electro-magnet of the sounder S^2, and consequently its armature will not have time to fall off after the circuit in the wire 12 is interrupted, before that in the wire 13 is established, and vice versa.

My improved system hereinbefore described, unlike those heretofore in use, requires no condenser between the main and artificial lines when employed in combination with the duplex system, and less electro-motive force is required in any case to operate it satisfactorily than in other systems heretofore in use.

I do not herein specifically claim the combination of an electro-magnet having two pairs of differential or neutralizing coils, each included in an independent local circuit, with two independent local batteries, as this forms the subject-matter of a claim in another pending application.

I claim as my invention—

1. The combination, substantially as hereinbefore set forth, of a key or transmitter, two insulated contact-springs mounted thereon, two insulated contact-stops with which said springs are simultaneously brought in contact when said key is depressed, two independent main batteries of like electro-motive force but unlike polarity inserted between the earth and said insulated contact-stops, respectively, and a second key or transmitter having an insulated contact-stop, said key and contact-stop being respectively connected with the two contact-springs of the first key, whereby said contact-springs are alternately placed in connection with the main line.

2. The combination, substantially as hereinbefore set forth, of a key or transmitter, two insulated contact-springs mounted thereon, two insulated contact-stops with which said springs are simultaneously brought in contact when said key is depressed, two independent main batteries of like electro-motive force but unlike polarity inserted between the earth and said insulated contact-stops, respectively, a second key or transmitter having an insulated contact-spring mounted thereupon, a line-wire extending from said spring to the distant station, a third main battery having one of its poles connected with that insulated contact-spring upon the first key, which, when said key is depressed, unites it with another battery of coincident polarity, and its other pole with the working-contact of the second key, and a conductor uniting the remaining contact-spring of the first key with the resting-contact of the second.

3. The combination, substantially as hereinbefore set forth, of a key or transmitter, two insulated contact-springs mounted thereon, two insulated contact-stops with which said springs are simultaneously brought in contact when said key is depressed, two independent main batteries of like electro-motive force but unlike polarity inserted between the earth and said insulated contact-stops, respectively, a second key or transmitter having an insulated contact-spring mounted thereupon, a line-wire extending from said spring to the distant station, a third main battery having one of its poles connected with that insulated contact-spring upon the first key, which, when said key is depressed, unites it with another battery of coincident polarity, and its other pole with the working-contact of the second key, a conductor uniting the remaining contact-spring of the first key with the resting-contact of the second, and an artificial resistance inserted in said conductor equal to the resistance of the last-named battery.

4. The combination, substantially as herein-

before set forth, of an electro-magnet provided with two pairs of differential or neutralizing coils with two independent batteries and two independent relays, one having a polarized and the other a neutral armature.

5. The combination, substantially as hereinbefore set forth, of two independent relays included in the same main circuit, one having a polarized and the other a neutral armature, two independent local circuits controlled by the respective armatures of said relays, and an electro-magnet having two independent magnetizing-coils, one included in each of said local circuits.

6. The combination, substantially as hereinbefore set forth, of an electro-magnet provided with two pairs of differential or neutralizing coils with two independent batteries and two independent relays, one having a polarized and the other a neutral armature, which respectively open and close local circuits traversing two coils, both having a like magnetic effect upon the core of the electro-magnet.

In testimony whereof I have hereunto subscribed my name this 11th day of January, A. D. 1882.

FRANCIS W. JONES.

Witnesses:

MILLER C. EARL,

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