(No Model.) 2 Sheets—Sheet 1.

F. W. JONES.

QUADRUPLEX TELEGRAPH.

No. 302,410. Patented July 22, 1884.

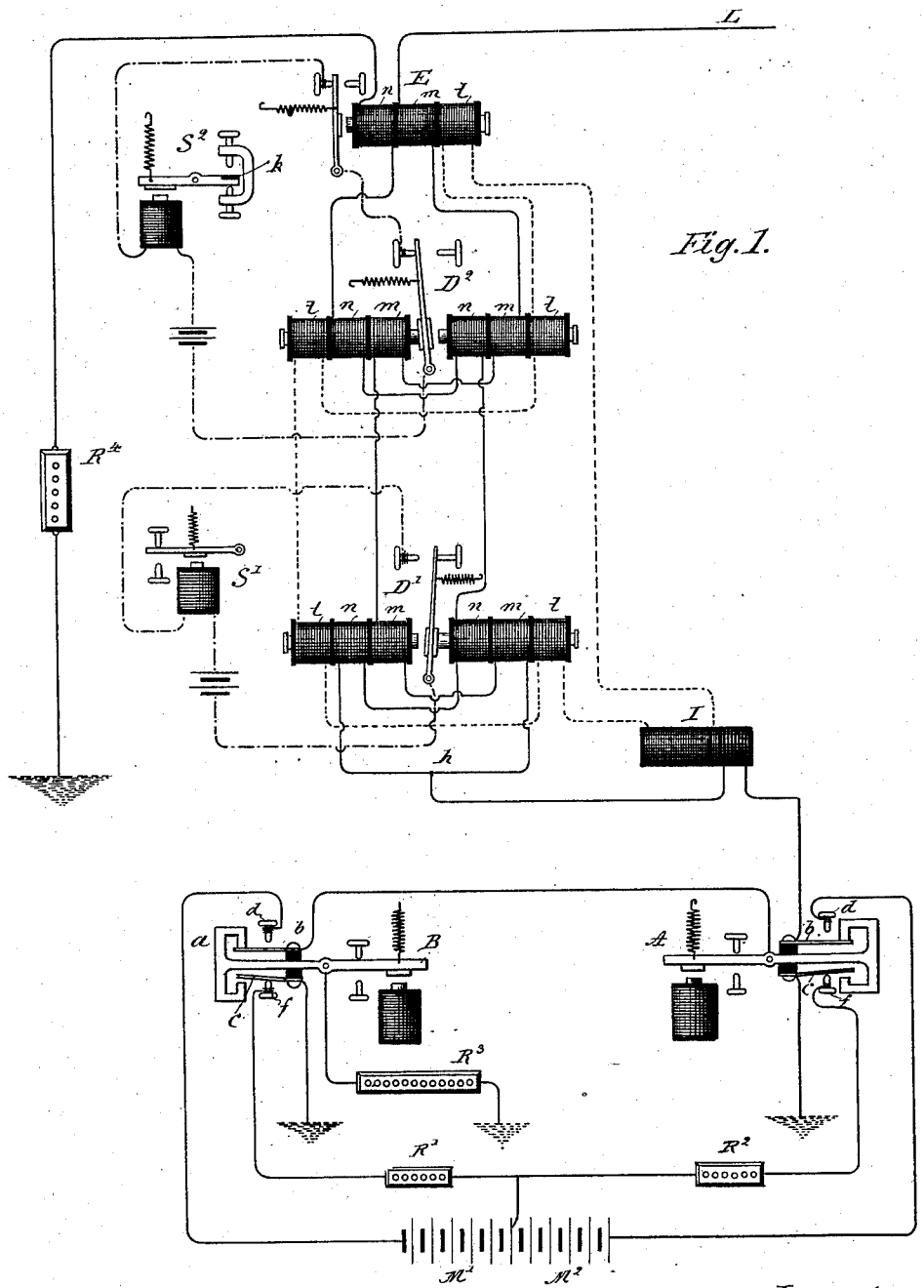


Fig. 1.

Witnesses:
Ernst Abshagen
Thos. Dorney.

Inventor:
F. W. Jones,
By his Attorney: H. B. Tunnicliff

(No Model.) 2 Sheets—Sheet 2.

F. W. JONES.

QUADRUPLEX TELEGRAPH.

No. 302,410. Patented July 22, 1884.

Fig. 2.

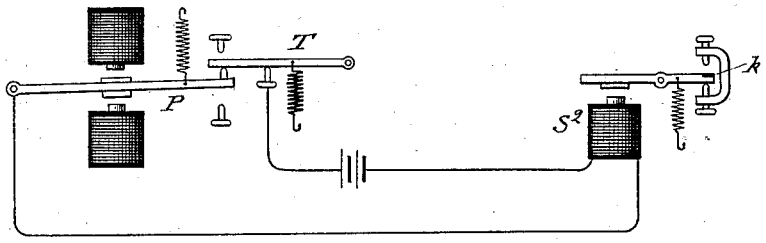


Fig. 3.

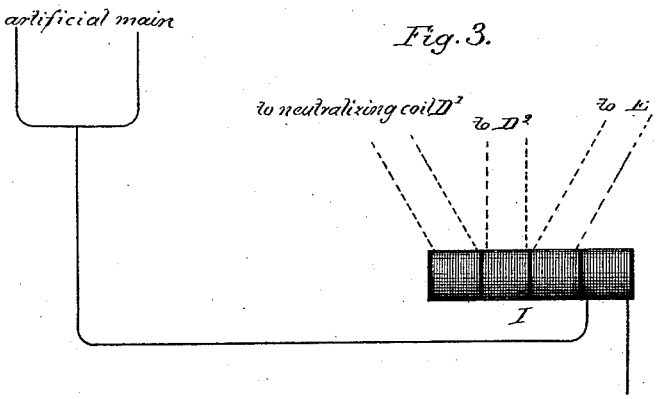
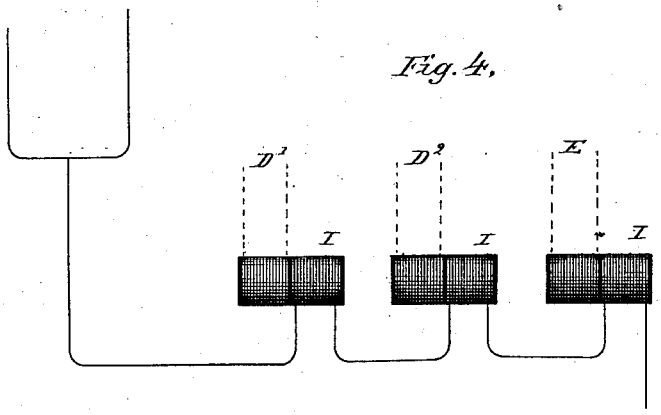


Fig. 4.



Witnesses:
Ernest Abshagen
Thos. Toomey

Inventor:
F. W. Jones
By his Attorney: H. C. Townsend

UNITED STATES PATENT OFFICE.

FRANCIS W. JONES, OF NEW YORK, N. Y.

QUADRUPLEX TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 302,410, dated July 22, 1884.

Application filed December 17, 1883. (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 New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Multiplex Telegraphs, of which the following is a specification.

My invention relates to apparatus whereby messages may be sent independently and over the same circuit without confusion.

My invention is designed, primarily, to furnish a novel and improved combination of transmitters and receivers whereby two such messages may be sent in the same direction, which combination may be utilized in connection with the well-known differential or bridge arrangement for rendering outgoing signals inoperative upon the home instruments, so that four messages may be sent over the same circuit, two in one and two in the opposite direction.

My invention is designed, more especially, to economize in the use of transmitting-battery; and to this end it consists in a novel combination of transmitters with two sections of main-line battery, the distinguishing features of which will be hereinafter described, and then pointed out in the claims.

My invention consists, also, in certain details of construction and combinations of relays and sounders, that will be readily understood from the following description, and will be specified in the claims.

Figure 1 is a diagram of circuits and apparatus illustrating the general principles of my invention. Fig. 2 illustrates a modified arrangement of the receiving-relays. Figs. 3 and 4 illustrate modified arrangements of induction-coil apparatus, whereby the disturbing effects of static charge and discharge current upon the relays at the home or transmitting station may be avoided.

I will first describe the arrangement of transmitters and batteries, whereby waste of battery is avoided, and the employment of the smallest number of cells consistent with the combination of currents to be sent is rendered possible. The transmitters are designed to send the following combination of currents: both transmitters open, no current to line; transmitter A closed, positive current to line; transmitter B closed, negative current of approximately the same strength to line; both transmitters closed, an increased positive current equal to the combined current of both transmitters. This combination is simply expressed as follows: both open, = 0; A closed, = + 1; B closed, = — 1; A and B closed, = + 2. It is of course to be understood that the order or polarity may be reversed, A sending —, B +, and both together increased negative. This combination of currents, having been well known in the art for many years, is not herein claimed, my invention consisting in the construction and arrangement whereby this combination of currents may be sent to influence properly constructed and arranged receiving-relays.

Referring to Fig. 1, A and B indicate, respectively, two transmitters, each worked by an electro-magnet and key in a local circuit, as usual. Each transmitter is provided, as indicated, with a double hook, *a*, and two insulated contact-springs, *b c*, one of which, *b*, I shall call the "front contact-spring," and the other, *c*, the "back contact-spring." The contact-stops with which said springs *b c* come into contact, and by which they are removed from contact with the hook, are indicated, respectively, at *d* and *f*, and are so arranged that when the transmitter is at rest or in normal position the back contact-spring, *c*, is in contact with *f*, and therefore out of connection with the hook *a*, while at the same time the front contact-spring, *b*, is out of connection with the stop *d*, and is therefore in contact with the hook. The latter—viz., the hook *a*—is in electrical connection with the body of the transmitter-lever.

$M' M^2$ indicate two sections of a transmitting-battery, which, at or near its center, is connected with the contact-stops *f* of the two transmitters, against which stops the insulated back contact-springs, *c*, normally bear. The springs *c* being connected to ground, as indicated, the center of the battery is normally grounded in such way that when one transmitter is operated (the other remaining at rest) one or the other half of the battery, according to the trans-

mitter operated, may find a ground through the back contact-spring, *c*, and stop *f* of the other transmitter.

R′ is an artificial resistance interposed between the middle of the battery and the back contact-connections of B, and approximately equal in resistance to the resistance of the section M′ of battery.

R² is a similar resistance between the center of the battery and back contacts of A, and equal to the resistance of section M² of battery. The extremities of the whole main battery are connected as indicated—the positive pole to the contact-stop *d* of A, and the negative to the contact-stop *d* of B. The front contact-spring, *b*, of transmitter B is connected to the transmitter-lever A, while the front contact-spring, *b*, of the latter is connected to line, so that a connection from front contact, *d*, of transmitter B to line may be made when transmitter B is operated and transmitter A is at rest. Transmitter B is connected to earth through an artificial resistance, R³, equal to the combined resistance of the two sections of battery M′ M². When the transmitters are at rest, the circuit to line is from ground through R³, transmitter-lever B, spring *b* of the same, transmitter-lever A, hook *a*, and front contact-spring of transmitter A. Both poles of the battery are open-circuited at the contact-stops *d*, and therefore no current flows to line. If transmitter A be operated, the connection of line to earth through R³ is broken by the impingement of spring *b* for A against stop *d*, and the consequent disconnection of *b* from its hook *a*. At the same time, by the closure of connection between *b* and *d* on A, the section M² of battery is placed to line, the circuit from earth being through back contact-stop and spring of B, (which is at rest,) resistance R′, and section M² of main battery, thus sending a positive current from M² to line. As will be observed, the connection to earth from center of battery, through R², is at this time broken, owing to the disconnection of *c* and *f* on transmitter A, which is produced simultaneously with the connection of *b* and *d*. If transmitter B is operated, A being at such time at rest, section M′ of main battery is put to line with a negative polarity, the circuit from earth being then through *f* and *c* on A, resistance R², battery M′, contact-stop *d* of B, spring *b*, lever A, hook *a* on the latter, and spring *b*. In this operation the normal connection to ground through resistance R³ is broken by the disconnection of spring *b* on B from the hook *a* on the latter, just as it was broken on the operation of A by the disconnection of the spring *b* and hook *a* on transmitter A. The operation of B also breaks the connection of the center of the battery with ground, through R′ and *c* and *f* on B; but section M′ finds ground through the same parts on A. No effect is produced on section M² of battery, as it is at such time disconnected at the front contacts of A. When both transmitters A and B are closed together, both sections of battery flow to line with a positive polarity. Both grounds through R′ and R² are at such time broken by the operation of the transmitters and the disconnection of their back contact-spring, *c*, from the back contact-stops, *f*, constantly connected with the middle of the battery. In this case a ground for the battery is furnished by the contact of spring *c* on A with the double hook *a* of the latter, and the connection of the front contact-spring on B with the stop *d*. The operation of B having broken the ground through R³, the circuit from ground is then through *c* and *a* on transmitter A, spring *b* on B, stop *d* of the latter, both sections of main battery M′ M² in series, stop *d* of A, spring *b* of the latter, and to line. A positive current from the whole battery is thus transmitted. The resistances R³ R′ R² serve to equalize the resistance of the circuit in the transmitting system to incoming currents no matter what the condition of the system. If the whole battery M′ M² have a resistance of two hundred ohms, R³ is equal to that resistance, so that the resistance when both keys are open is the same as when both keys are closed. If M′ and M² are equal, R′ and R² are each one hundred ohms resistance, so that if A be closed alone the resistance is that of M², + that of R′ = 200, while, similarly, if B is alone closed, the resistance is still two hundred—viz., M′ + R². It will thus be seen that, no matter what the position of the transmitters, the resistance in the key system to incoming currents which should affect the home instruments is the same, and no derangement can result from changes of resistance by operation of the transmitters. The relay system which I employ is herein shown at the transmitting end of the line, the diagram illustrating a differential winding of the apparatus to adapt it for quadruplex working. The operation of the apparatus at the distant end will, however, be precisely the same as that of the apparatus shown, and will be affected by the same kinds of currents, as is well understood in the art.

D′ D² indicate polarized relays of any desired construction, and E, a third relay, which may, if desired, be also a polarized relay, but is adjusted to respond only to an increased current sent by the operation of both transmitters. The main-line coils on the relays are indicated by the letter *m*, and the artificial-line coils by the letter *n*. The latter coils are placed in the ordinary manner in the artificial-line circuit to earth through a resistance, R⁴, approximately equal to that of the main line. The point of divergence of the main and artificial line circuits is indicated at *h*.

The manner of connecting and winding the coils, being well understood in the art, need not be described in detail. Relay D′ is polarized to respond to positive currents, or those sent by A singly or by A and B combined. Its armature is provided with a re-

tractor, which normally tends to hold it against a dead-stop, and is adjusted to permit the relay to respond to a current from one section only of the battery, or from both sections when positive pole is to line and its armature-lever to close on front contact the circuit of an ordinary sounder, S′. The local circuit of this relay, as will be observed, is normally open.

S^2 is a sounder whose local circuit is normally closed, and is controlled conjointly by the relays D^2 E. Relay D^2 is polarized to respond to a negative current from M′, while the retractor of E is adjusted so that only when the current from both sections of battery flows to line at the distant station will its armature-lever be drawn forward, and thus break the circuit of S^2. The circuit of S^2 is, as will be seen, through the back contact-stops of D^2 and E, so that the movement forward of the armature-lever for either away from its back stop and toward its front or dead-stop will break the circuit and operate the sounder. The retractor of D^2 is adjusted to permit the armature-lever to be drawn forward by the action of one section of the battery. The local circuit controlled by the latter relays is, as will be observed, a normally-closed one.

In order that the normally-energized sounder S^2 may produce sounds of the same character as those produced by an ordinary sounder—such as S′ on normally-open circuit, that is sharp or loud on the forward movement of the relay-lever in response to a signal, and light or soft on the backward movement when the signaling-current is withdrawn—I arrange and construct it as shown, with its sounding-stops on the opposite side of the fulcrum from the armature, and with a deadening cushion or contact for that stop against which the lever impinges when the magnet is energized by the falling back of the relay-lever. The deadening-cushion may be a small piece of soft rubber, *k*, interposed between the lever and the upper stop, or may be otherwise constructed to deaden the sound when the sounder-magnet pulls down its armature in response to the falling back of the relay-lever of D^2 or E. By this arrangement, when the lever of the sounder is drawn back by its spring the sound is louder than when it is drawn down by its magnet; but as the latter is normally energized the same quality of signal is heard from S^2 as from S′ in response to the closing and opening of the transmitters.

The general operation is as follows: When the transmitters are at rest, no current flows to line, and the receiving apparatus is in the the position shown, the local of D′ open, and that of D^2 and E closed. If transmitter A closes, section M^2 only of battery flows to line with a positive polarity, thus operating sounder S′. Sounder S^2 is not affected, because the current is not of the proper polarity to operate D^2, and is not strong enough to operate E. If, now, while A is closed B is operated, section M′ of battery is added to M^2, and the current is of sufficient strength to operate E, thus breaking the circuit of the sounder S^2 and giving a signal. D^2 is not, however, as yet, affected, being polarized to respond only to a negative current. If, now, both A and B being closed, transmitter A be opened, section M^2 of battery is cut off, and M′ alone flows to line, but with an opposite or negative polarity, and lever of D′ returns to its normal position, (since D′ responds only to positive currents.) At the same time the lever of E recedes toward its back or closing stop, since the current of M′ only is not strong enough to hold the lever of E up; but at the same time, and before lever of E reaches its contact, relay D^2 is operated by the negative current now flowing, and leaves its back stop, thus keeping the local circuit open and preventing mutilation of the signal from B. When B returns to normal position, D^2 closes the local of S^2, and the signal on the latter is completed. If B is alone operated, a negative current is sent from section M′ of battery, and the sounder S^2 is operated by the action of relay D^2 only, the other relays being unaffected, for the reasons before explained.

Instead of employing a second relay, E, I may use a supplemental armature-lever to be worked by D^2, as indicated in Fig. 2. In this case P indicates the ordinary armature-lever of a polarized relay, and T a supplemental lever, whose armature is to be placed in suitable proximity to the relay-magnet, as is well understood in the art, and is provided with a retractor, adjusted like that of E, Fig. 1. The retractors being applied as indicated, the local circuit is closed normally through the contact of the levers with one another and the contact of T with its stop. The movement of P alone will break the circuit; or the same effect is produced by the movement of T and P together, as in such case they move in opposite directions. Normally T remains in contact with its stop, as the retractor for P is weaker than that for T.

In order to neutralize the disturbing effects of the static charge and discharge, due to differences of static capacity between the main and artificial lines, I combine with the relays an induction-coil, I, the primary of which is in the main circuit through which the signaling-battery flows when placed to line, while its secondary is connected to neutralizing-coils *t* on the relays, said coils being wound or connected in such way that the magnetizing effect of the secondary current, which flows in them when the signaling-current flows in the primary, will neutralize the momentary tendency of the current flowing in the main-line coils on the relays to produce a false signal, owing to the greater static capacity of the line, and similarly the reverse current set up in the secondary by the opening of the transmitting key or keys will neutralize the disturbing tendencies of the static-discharge current from the

line, flowing in a reverse direction in the main-line coils. In the example shown in Fig. 1 a single secondary supplies all the neutralizing-current for the relays, the circuit being led through the auxiliary coils in series.

I do not limit myself to this arrangement, but may employ arrangements such as are shown in Figs. 3 and 4. In Fig. 3 one primary and core are employed, and independent secondary coils are used for the various relays, said coils being wound beside or over the primary, but on the same core, in a manner well understood in the art. In Fig. 4 independent induction-coils are used for the relays, the main circuit being through the primaries in series, and each primary having its own core and secondary.

Other arrangements will readily occur to those skilled in the art.

I am aware that it is old to arrange two reading-sounders in independent local circuits—one normally open and the other normally closed—and to control one by a polarized and the other by a polarized and a tension relay; and I do not wish, therefore, to be understood as claiming such arrangement, broadly.

I am also aware that it is not new to send currents in the order or combination described by two transmitters—one with three and the other with two sets of transmitting-points—as I have described such an arrangement in a prior patent granted to me. In the present arrangement, however, each transmitter has but two sets of transmitting-points, as contra-distinguished from the arrangement in which one has two and the other three; and it is to be understood that this distinction forms one of the leading features of my present sixth and eighth claims.

What I claim as my invention is—

1. In a multiplex-telegraph system, the combination of two transmitters which send singly currents of opposite polarity, but of approximately the same tension, and together a current of increased tension, and two receiving-sounders in locally independent circuits, one controlled by a relay which is polarized to respond to a current of one polarity, and closes a local when acted upon by the proper signaling-current, the other a normally-closed circuit, the sounder in which has a deadened front stop, and which circuit is controlled by two relays or relay-armature levers, one of which is polarized to respond to a current of the opposite polarity, but of same tension, while the other responds only to an increased current.

2. The combination, in a multiplex telegraph, of a polarized receiver and normally-open local or sounder circuit controlled thereby, and a second independent normally-closed circuit containing a sounder with a deadened front stop, and closed through the back contacts of two armature-levers, one or both of which are polarized, but one oppositely to the first-named relay.

3. In a multiplex-telegraph system, the combination of a polarized relay responding to a current of one polarity and given tension, a normally-open sounder-circuit controlled thereby, a second polarized relay responding to a current of the opposite polarity, but of approximately the same tension, a third relay-armature lever responding only to a current of increased tension, and a locally independent sounder-circuit normally closed through the back contacts of the two latter relays, and having a sounder with a deadened front stop.

4. The combination, with a receiving-instrument in normally-open circuit, of a reading-sounder placed on normally-closed local circuit, and having a muffled front stop, whereby the sounder may be made to give the same character of sound as the ordinary sounder worked on normally-open local circuit.

5. In a transmitter system for multiplex telegraphy, the combination of a main battery, two transmitters, each of which, when operated, puts one section of said battery to line, a normally-closed circuit to ground containing a resistance equal to the combined resistance of both sections of battery, and a ground from the middle of the battery through the back contact of each transmitter, said ground-circuit from each transmitter containing a resistance equal to the resistance of the section of battery put to line by the closing of the other transmitter.

6. The combination of two transmitters, each having two sets of transmitting-points—one set a line-connection and the other an earth-connection—and a main battery connected at its terminals, respectively, to the normally-open line-connecting set of points on the two transmitters, and separate ground-connections from the center of the battery—one through the normally-closed ground-connecting points of one transmitter and the other through the normally-closed ground-connecting points of the other—whereby when either transmitter is operated its line-connecting points complete the circuit to line for one section of battery, while the earth-connecting points of the other furnish ground for said section of battery.

7. The combination of two transmitters, a main battery grounded at its middle through the back contacts of said transmitters, and connected at its terminals to the front contacts of the same, a normally-closed connection from line to earth through a resistance equal to that of the whole battery, and resistances in the two grounds from the middle of the battery equal, respectively, to the resistances of the two sections of battery, as and for the purpose described.

8. The combination, with two double-hook transmitters, of a main battery whose terminals are normally open, but are put to line by the closing of the front or line contacts of either transmitter, connections from the center of the battery to the back contact-stop of each transmitter, two back contact-springs—

one for each transmitter normally grounded—and a front contact-spring of one transmitter connected to line, while the front contact-spring of the other transmitter is electrically connected with the double hook of the first, whereby either transmitter separately may place a section of battery to line, while both may put both sections to line by connecting one terminal directly to line and the other to ground through the front contact-spring of one transmitter and the hook and back contact-spring of the other.

9. The combination of the two double-hook transmitters, the main battery connected at its terminals to the normally-open front contact-stops of the same and at its middle to ground through the normally-closed back contacts, a resistance in each ground-connection equal to that of one section of the battery, a normally-closed earth-connection from line through the front contact-springs of the transmitters, and a resistance in the same equal to the resistance of the whole battery.

10. The combination, with the transmitters, of the battery having a ground-connection at its middle through the back contacts of each transmitter, and artificial resistances interposed between the center of the battery and the contacts, as and for the purpose described.

Signed at New York, in the county of New York and State of New York, this 13th day of December, A. D. 1883.

FRANCIS W. JONES.

Witnesses:

THOS. TOOMEY,

GEO. C. COFFIN.