

(No Model.)

W. L. RICHARDS.
TELEPHONE RELAY APPARATUS.

No. 542,657.

Patented July 16, 1895.

Fig. 1.

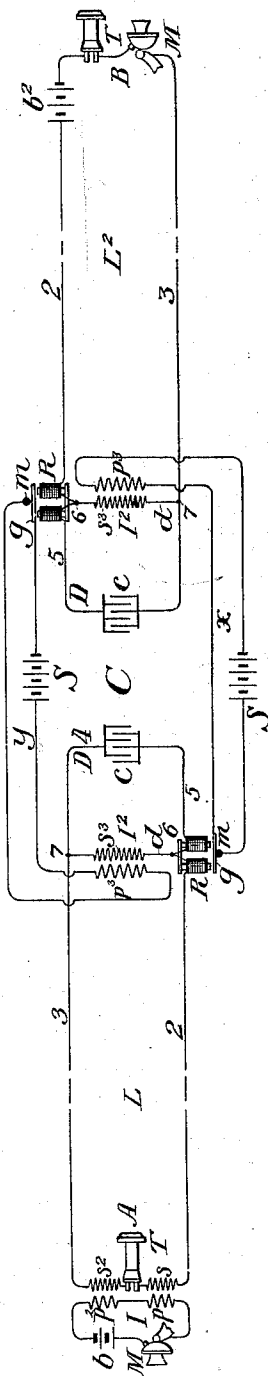


Fig. 2.

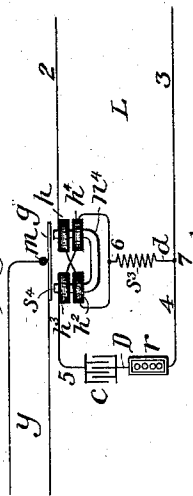


Fig. 3.

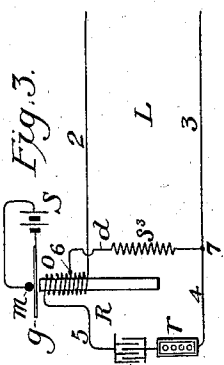
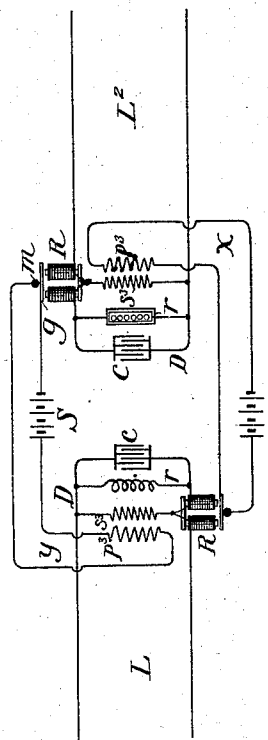


Fig. 4.



Witnesses.
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UNITED STATES PATENT OFFICE.

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TELEPHONE RELAY APPARATUS.

SPECIFICATION forming part of Letters Patent No. 542,657, dated July 16, 1895.

Application filed March 16, 1895. Serial No. 542,030. (No model.)

To all whom it may concern:

Be it known that I, WILTON L. RICHARDS, residing at Malden, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Telephone Relay Apparatus, of which the following is a specification.

When telephone-lines are of extreme length it is convenient to divide them at an intermediate station and to interpose some form of relay apparatus between the two sections or circuits, whereby the voice-currents developed by the transmitter at either end station, instead of being necessitated to travel the entire line and ultimately in an enfeebled condition to operate the receiver at the other end station directly, are enabled to put in operation a fresh source of electrical energy located at the intermediate or central station, the comparatively-strong current of which may then traverse the remaining portion of the said long line for the operation of the said telephone at the receiving-station.

My present invention relates to such an organization, and particularly to the mode adopted for rendering the relay-magnet of each of the two lines concerned null with respect to any currents developed by its own action in the other, which currents otherwise are prone to react on the said relay and to produce and perpetuate musical sounds manifesting themselves in and by means of the several receivers in circuit.

Telephonic relays have frequently been devised which act in one direction, but this invention permits of reciprocal transmission and accomplishes the change of direction automatically—that is to say, without the aid of switches of any kind.

My invention consists in combining a reciprocal telephone-relay with artificial balancing-circuits in such manner that when either line is transmitting the receiving-magnet thereof, while remaining fully responsive to such transmission, is made null or irresponsive to the relayed transmission of the receiving-line, so that its operation is not confused by reactionary effects.

It further consists in associating with the two main circuits at the central or intermediate station two artificial balancing-circuits

of suitable resistance and capacity, one for each main circuit; a relay electromagnet or receiving-magnet for each line, having its coils partly in the main circuit and partly in the balancing-circuit; an induction coil for each main circuit, having its secondary winding in a section of conductor common to both main and artificial circuits, so that it is enabled to supply current to both in different directions through the said relay, which thereby is made neutral to outgoing-currents; and two local transmitting or relay circuits, including each a suitable source of current, such as a battery, a variable resistance medium, and the primary winding of an induction-coil, these two last appliances being so relatively disposed that the primary winding of the induction-coil of each circuit is connected up with a variable resistance or transmitting medium controlled or operated by the relay or receiving magnet of the other circuit.

In the drawings, Figure 1 is a diagram of two complete telephone-circuits fitted at an intermediate station with a repeating apparatus. Figs. 2 and 3 are diagrams illustrating modified arrangements of receiving magnet-windings, all, however, based upon the same principles; and Fig. 4 shows an arrangement in which the artificial balancing-circuit has its resistance and capacity in parallel branches.

Referring in the first place to Fig. 1, A and B are the outlying or distant stations of the main telephone-circuits I. and I², which both converge to or enter the intermediate central station C, where they may be united to constitute a through line of communication between the stations A and B. At the said stations A and B the telephones may be connected in the customary way, as shown at A, where the transmitting-instrument M is included in the circuit of a local generator, as a battery *b*, and adapted to act upon the main circuit through the intermediation of an induction-coil I, whose primary winding *p* is also in the said local circuit, and whose secondary *s* is in the main circuit. Both secondary and primary windings are shown as being divided into two sections *p p*² and *s s*², and the receiving-telephone T is connected in the main circuit between the two sections *s s*² of

the said secondary; or, if desired and convenient, the telephones may be connected, as at B, where the battery b^2 , transmitter M, and receiver T are all included in the main circuit L^2 .

5 At the central station C the two line-circuits concerned L and L^2 have similar connections. Each has a repeating or relay magnet R responsive to currents coming in from the distant transmitter of its own line, and
10 an induction-coil I^2 to serve as an intermediary for receiving the relayed currents originating in the other line. Each main circuit is also associated with an artificial balancing-circuit D containing a condenser, as in Fig.
15 1, a condenser and resistance (preferably adjustable) in series, as in Figs. 2 and 3, or a condenser and resistance-coils in parallel, as in Fig. 4.

Referring again exclusively for the present
20 to Fig. 1, it will be seen that at the station C the line-conductors 2 and 3 of the main circuits L L^2 are united at the points 6 and 7 by a cross-conductor d , in which is connected the secondary wire s^3 of the associated induction-coil I^2 , and that one bobbin of the
25 relay-magnet R of the said circuits, respectively, (forming one section or half of its winding,) is contained in such closed circuit. The cross-conductor d of each main circuit also
30 forms a part of the artificial balancing or equating circuit associated with such main circuit, which may be traced from the point 6, through the second spool of the relay-magnet R, to the wire 5, condenser c , wire 4, and
35 cross-wire d , including the secondary winding s^3 , back to the said point 6.

Two local repeating-circuits x and y , one for each main circuit, are provided. They
40 respectively include a source of current S, ordinarily a battery, a variable-resistance medium m , organized to serve as a relay-transmitter, and the primary windings p^3 of the two induction-coils respectively. The variable-
45 resistance medium m of the repeating-circuit x is mounted in operative relation to the relay-magnet R of main circuit L and is actuated by the varying attraction exercised by the said magnet upon its diaphragm or armature g , and the primary winding p^3 of the
50 same circuit x is that of the induction-coil I^2 of main circuit L^2 . In the same manner the primary winding p^3 , included in the local repeating-circuit y , is that of the induction-coil
55 belonging to main circuit L, and the variable-resistance medium m , connected together with it in the said local-circuit wire, is placed in juxtaposition to the relay-magnet R of main
60 circuit L^2 to be operated thereby. Thus when messages are being transmitted from either of the stations A or B the relay-magnet of the transmitting-circuit for the time being—say
65 L—exercises such a variable attraction upon its armature or diaphragm g that if, instead of being organized to repeat the message into a second circuit, it should be arranged simply as an ordinary sound-reproducing telephone-receiver it would emit a copy of the original

sounds uttered at station A. The armature-vibration thus effectuated operates the variable-resistance medium of the local circuit x ,
70 throwing the current of its battery S into fluctuations corresponding in character to those originally produced in main circuit L; but the new variations are, as it were, reinforced
75 by the introduction of a fresh battery and are stronger than those delivered by the main circuit L at the relay-station C. By means of the induction-coil I^2 , whose primary winding is contained in the local circuit x , the
80 voice-currents of this second series are impressed upon the receiving-circuit L^2 , traversing the same, for the operation of the receiving-telephone T at the distant station B. Of course when B transmits a corresponding but
85 reversed operation is performed.

When the currents of one circuit are repeated into the other by the action of the induction-coil I^2 of the latter it is evident that they must circulate in the relay-magnet coils
90 of the latter, so that, unless some means of prevention be adopted, the said relay-magnet will be responsive to the relayed current as well as to the currents of its own circuit, and the efficient transmission of speech will be
95 much impaired by the consequent confusion. To obviate this liability I divide the relay-magnet winding into two equal portions, and placing one half, as described, in the working-
100 circuit, I place the other half in the balancing-circuit D, and as the induction-coil bridge connects with the main and balancing circuits at the point 6, between the two spools
105 of the relay-magnet, the currents flowing outward from the said induction-coil split between the circuits and exercise a differential effect on the relay. The said relay is null to
110 outgoing currents, while it remains fully responsive to currents due to the operation of the transmitter of its own line.

It is convenient and advisable to include a
110 rheostat or adjustable resistance in the artificial balancing-circuit D, as shown in Figs. 2 and 3, so that the resistance to voice-currents between its points of junction 6 and 7 with the main line may be varied within wide
115 limits.

It is also desirable in practice to perfectly balance the magnetizing value of the two relay-sections, and to that end I prefer the split-coil arrangement of Fig. 2, in which the two
120 poles of the bipolar magnet n are each provided with two like coils. Then both the main and balancing circuits are led successively through two of the said coils, one on each polar arm. The main circuit is traceable from the
125 conductor 2 through the front coil h on pole n^4 , then through the back coil h^3 on pole s^4 , and thence to the point 6, while the balancing-circuit may be traced from wire 5 through coil h^3 on pole s^4 , and thence through the coil
130 h^4 to the point 6, such an arrangement aiding materially in securing a satisfactory balance.

Another and similar plan for the relay-magnet connection, which has been successfully

tried, is that shown in Fig. 3, which discloses a unipolar magnet having a single winding *o* with the line-conductor 2, connected at one end, the balancing-circuit conductor 5 at the other, and the cross-conductor *d* to a point 6 at the middle.

The circuit arrangement of Fig. 4 differs from that of Fig. 1 only in that the artificial balancing-circuit D is shown with its adjustable resistance *r* and its condenser *c* in parallel branches—that is to say, the resistance is directly in the circuit and is shunted by the condenser, which supplies the required capacity.

Having now fully described my invention, I claim—

1. An automatic reciprocal telephone repeater or relay system, comprising two main line circuits; each being associated with the following instrumentalities; a transmitter induction coil having its secondary winding connected therein; a branch circuit including a condenser shunting the said secondary winding; a relay magnet having a portion of its winding included in the main, and the remaining portion thereof in the said branch circuit; and a repeating or local transmitter circuit containing a source of current, a variable resistance medium, and the primary winding of the said induction coil, the variable resistance connected with the induction coil of each main circuit, being placed in juxtaposition or operative relation to the relay magnet of the other main circuit, to be controlled by the varying attractive power thereof; substantially as described.

2. An automatic reciprocal telephone relay or repeater, consisting of two main line circuits extending to outlying stations; and an artificial line or balancing circuit including a condenser, for each; a transmitting induction coil for each, having its secondary winding connected in parallel with the said main and balancing lines, so that it forms a section of conductor common, and supplying current to both; a relay magnet for each, having a split or differential winding, the two sections thereof being included in the main and balancing circuits respectively; and two relay or local transmitting circuits, each containing a source of current, a variable resistance medium, and the primary winding of one of the said induction coils, the variable resistance of each relay circuit being associated with and controlled by the relay magnet of one of the said main circuits, while its primary winding is associated with the secondary of the induction coil of the other main circuit; substantially as described.

3. In a telephonic repeater apparatus, the combination of a relay system at a central station, in which the receiving magnets of both main circuits, are arranged in juxtaposition to the variable resistance transmitting medium of the other, and adapted to actuate the same; with an artificial balancing circuit associated with each main circuit, and

connected with the receiving magnet thereof, in such manner that the relayed currents are balanced in its coils, and prevented thereby from exercising reactive effects.

4. The combination of two telephone main circuits converging from distant stations to a common terminal station; a relay magnet, and a transmitting induction coil connected with each, the relay magnet of each being adapted to operate a variable resistance medium in circuit with a battery, and the primary winding of the induction coil of the other, thereby transferring messages from one to the other; and an artificial balancing circuit of suitable resistance and capacity for each main circuit, in which a section of the relay of such main circuit is connected, whereby the said relay is prevented from responding to the currents impressed by its operation upon the second circuit.

5. In a telephone repeater system and apparatus, the combination of two main telephone circuits entering a central station, and extending therefrom to different outlying and distant stations, both closed at said central station through the secondary winding of their respective induction coils; and telephones at the said distant stations included in the said main circuits; with an artificial balancing circuit for each main circuit connected in parallel therewith, in respect to the said induction coil windings, and containing suitable resistance, and a condenser; a split coil of differential relay magnet for each telephone circuit, having the two sections of said coil included in its associated main and artificial circuits respectively, whereby the effect on said relay magnet of relayed currents is balanced and nullified, while the said magnet is left fully responsive to the distant transmitter of its own circuit; and two local battery circuits, each including a variable resistance medium operated by the relay magnet of one of the main circuits, and a primary winding acting upon the secondary winding of the induction coil of the other main circuit substantially as specified.

6. The combination in an automatic and reciprocal telephone relay apparatus, of two main telephone line circuits; and two independent artificial lines or balancing circuits associated with the said main circuits respectively; with repeating or relay electro-magnets, one for each set of circuits, each magnet having one half of its winding in the main line circuit, and one half in the associated artificial line or balancing circuit; substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 7th day of March, 1895.

WILTON L. RICHARDS.

Witnesses:

GEO. WILLIS PIERCE,
FRANK C. LOCKWOOD.