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TELEPHONIC REPEATING CIRCUIT AND APPARATUS.

APPLICATION FILED JUNE 26, 1906.

2 SHEETS—SHEET 1.

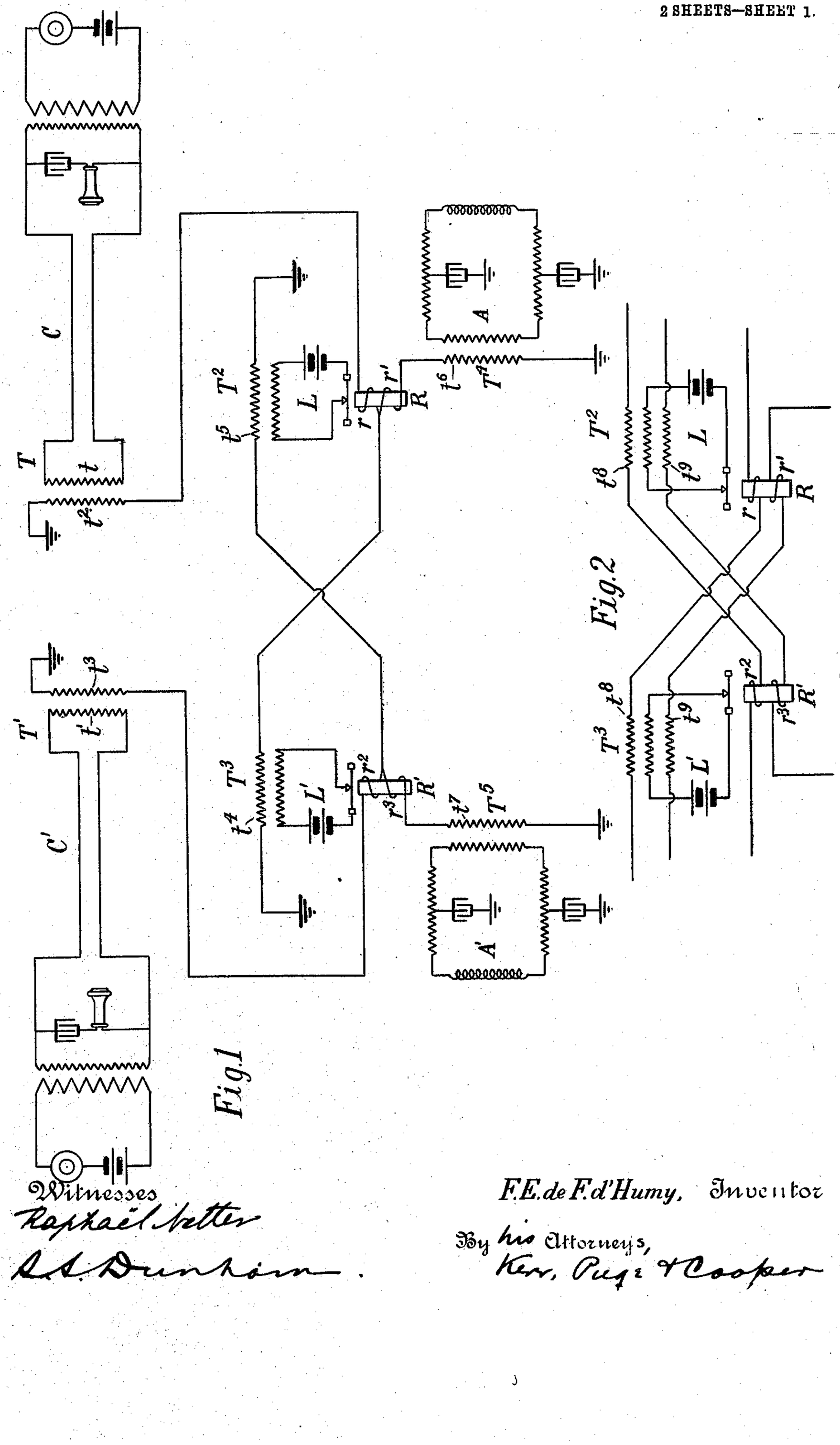

Fig. 2

Fig. 1

Witnesses
Raphael Netter
R. A. Dunham.

F. E. de F. d'Humy, Inventor

By his Attorneys,
Kerr, Page & Cooper

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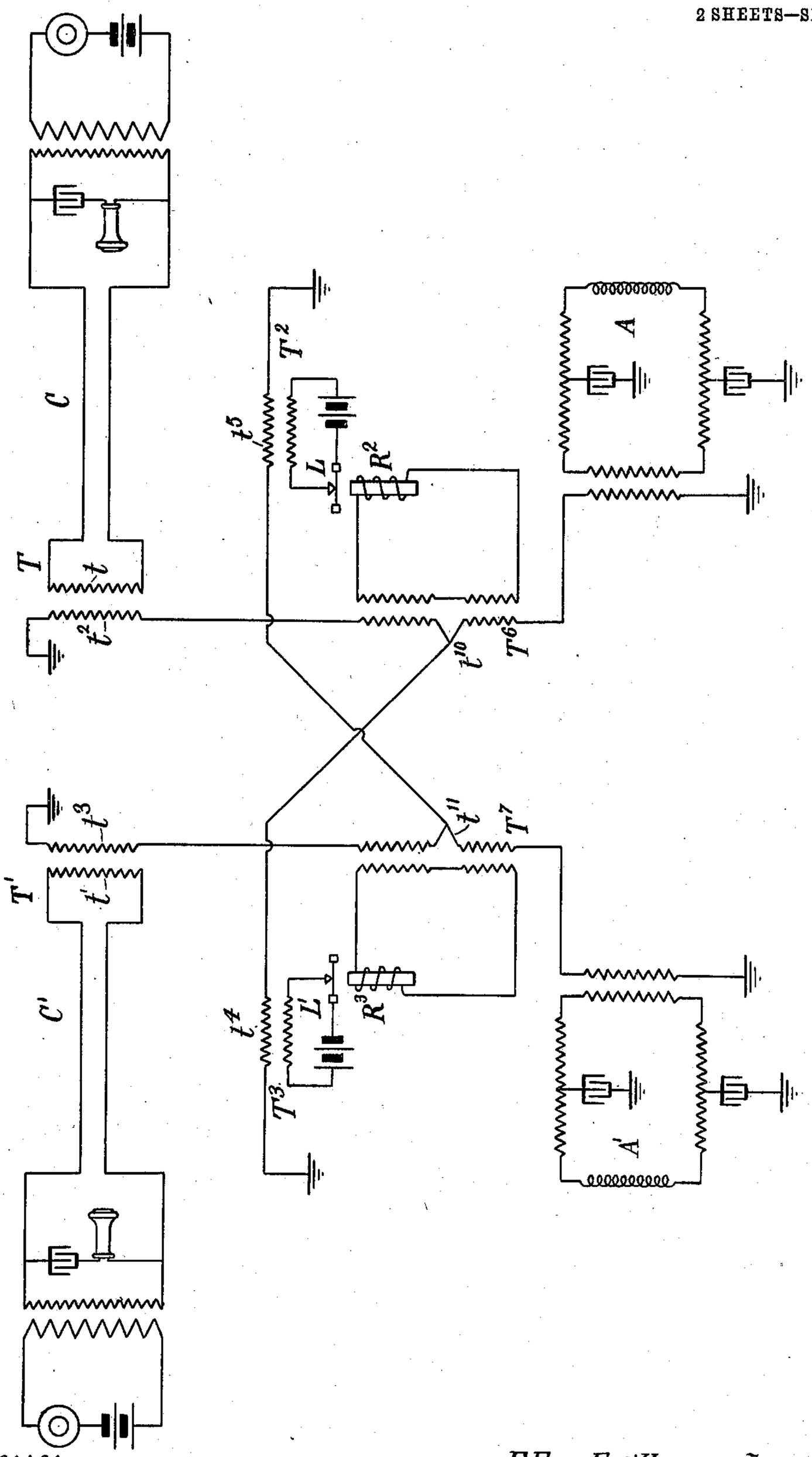
Fig. 3



Witnesses
Raphael Fetter
A. S. Dunham

F. E. de F. d'Humy, Inventor

By his Attorneys,
Kerr, Page & Cooper

UNITED STATES PATENT OFFICE.

FERNAND EMILE DE FAUCHEUX D'HUMY, OF ENGLEWOOD, NEW JERSEY.

TELEPHONIC REPEATING CIRCUIT AND APPARATUS.

No. 847,777. Specification of Letters Patent. Patented March 19, 1907.

Application filed June 26, 1906. Serial No. 323,482.

To all whom it may concern:

Be it known that I, FERNAND EMILE DE FAUCHEUX D'HUMY, a citizen of the United States, residing at Englewood, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in Telephonic Repeating Circuits and Apparatus, of which the following is a specification, reference being had to the drawings accompanying and forming part of the same.

One of the most serious difficulties met with in telephonic transmission over long circuits is the unavoidable attenuation of the current, due to well-known causes, thereby rendering the action on the distant receiving instruments correspondingly weak. To remedy this drawback, it has been proposed to divide the circuit into comparatively short sections and to "repeat" or reproduce the current-waves in one section after another from the transmitting end of the system to the receiving end with a fresh source of current and correspondingly amplified waves in each section. It is of course desirable—in fact, it is practically essential—that such a system be reciprocal—that is, operative for transmission in either direction at the will of the parties using the line and not in one direction only. Numerous systems based on this plan have been proposed; but so far as I am aware none of these numerous attempts has been productive of practical results. The use of relays with two line-circuits, as commonly employed, is productive only of a sustained hum or shriek in the instrument, due to the fact that waves relayed from one line into the other are relayed back into the first, then again into the second, and back into the first, and are thus tossed back and forth at the rate of the vibrating attunement of the relays. Furthermore, any reciprocal repeater which sends waves back into the originating or sending circuit causes distortion of the original waves to a greater or less degree, for the reason that the relay armature or diaphragm possesses a certain inertia which causes it to lag slightly behind the waves which actuate it. Consequently any waves which the relay sends into the originating-circuit will be slightly in arrear of the original waves, producing resultant distorted waves, which are carried to the second line-circuit and reach the receiving end thereof in their distorted form, thereby seriously impairing the distinctness or clearness of the articulation from the receiver. Attempts have been made to avoid this difficulty by using one-way relays and automatic switches to bring about the necessary circuit changes when the receiving-station desires to become the transmitting-station, and vice versa; but the net results have not been satisfactory.

A reciprocal repeating system without automatic switches, but using instead relays with differentialized coils, has also been proposed, each relay-magnet being thus made responsive to currents from the transmitter in its own section and not to currents set up by it in the other section; but in order to properly balance the differential windings which are in series with their appropriate line-circuits the other differential windings are put in series with artificial-line loads having resistance, capacity, and inductance equal to the transmission-circuit. Hence although the system referred to is actually reciprocal in operation it fails to produce the results for which a repeating system is intended, for the addition of the artificial lines, through which the new currents must flow, brings each circuit, in effect, up to the original total length of the line before it was divided.

I have therefore been led to devise my present invention, which has for its chief object to provide, first, a reciprocal repeating system in which the direction of transmission is changed at the will of the parties using the line by the mere act of speaking into the transmitter without the use of automatic switches; second, a system in which amplified current-waves are sent into the second or receiving line circuit, but not in the first or originating line circuit also; third, a system in which reciprocal operation may be obtained with or without differentially-wound relays, but without attenuating the current by an artificial line in series with the receiving-line.

The nature of the invention by which these objects are attained will be more readily understood from a description of the preferred embodiments, which are illustrated in the annexed drawings, wherein—

Figure 1 is a diagram showing the preferred form. Figs. 2 and 3 are diagrams showing modifications.

Referring now to Fig. 1, R and R′ indicate two microphone relays of any suitable type, with the usual local circuits L L′, but having their receiving magnets wound differentially, as indicated at r r' and r^2 r^3, respec-

tively. C C′ are the east and west telephone-circuits, respectively, in which are the windings t t' of transformers T T′. The other windings t^2 t^3 of these transformers are in series with the differential windings r r^2, respectively, of the relays R R′ and are connected thence to ground by way of the windings t^4 t^5 of transformers T^3 T^2. In the circuits of the differential windings r' r^3 of the relays R R′ are the windings t^6 t^7 of transformers T^4 T^5 of the same electrical dimensions as the transformers T T′ in the circuits C C′. The secondary windings of transformers T^4 T^5 are in closed circuits or artificial lines A A′, each having resistance, inductance, and capacity equal to its respective line-circuit C or C′.

The operation of the system will now be readily understood. If a voice-current be produced in the telephone-circuit C, corresponding current will be induced in the transformer T, in the winding t^2 thereof, flowing through the differential winding r of the relay R, and thence dividing to the ground through windings t^4 and t^5 of transformers T^3 and T^4, respectively. The diaphragm of the relay is thereby actuated in correspondence with the current-waves in the telephone-circuit and causes fresh, stronger, and independent but exactly similar current-waves to be set up in the winding t^5 of transformer T^2. These current-waves flow to the relay-magnet R′, where the current divides and flows in opposite or neutralizing directions on account of the equal loads on the two branches of the magnet-winding. Part of the current thus divided flows to transformer T^5 and artificial line A′ and thence to ground, while the other part flows to ground through the winding t^3 (which now becomes a primary) of the transformer T′. The fresh strong current in the primary t^3 induces similar current with corresponding waves in the other winding t', (now the secondary,) which current-waves are propagated to the telephone in circuit C′. At the same time no effect is produced on the relay local circuit L′ and telephone-circuit C, since the relay R′ is not affected. Consequently the voice-waves originating in line C are reproduced in line C′, inductively through transformer T, electromechanically and inductively through relay R, and inductively through transformer T′, and that without affecting in any way the original waves in circuit C. Conversely, by an exactly similar operation voice-waves in circuit C′ are reproduced in circuit C.

Fig. 2 shows a slightly-different arrangement in regard to the differential relays. In this case the relay-transformers are each provided with two secondaries t^8 and t^9, which are connected to the appropriate differential windings of the other relay instead of a single secondary connected at the neutral point of the other relay-magnet winding.

The embodiment shown in Fig. 3 is like that of Fig. 1; but the magnets of relays R^2 R^3 are not differentially wound, results equivalent to those produced by differential relays being secured by means of the transformers T^6 T^7, whose windings t^{10} t^{11} are connected at their middle points with the windings t^4 t^5, respectively, of transformers T^3 T^4. In this case current induced in transformer-winding t^2, for example, flows to the middle point of transformer-winding t^{10}, where it divides, half flowing to ground through the transformer T^3 and the other half flowing to ground by way of the artificial line A. The current induced in the other winding of transformer T^6 actuates the relay R^2. The current thereby induced in the latter's transformer-winding t^5 flows to the middle point of the winding t^{11} of the transformer T^7 and dividing there flows equally through the two halves, one of which includes the transformer T′, and causes the current to be induced or repeated in line-circuit C′, while the other half includes (inductively) the balancing-circuit or artificial line A′. The currents in the two halves of winding t^{11}, however, are in opposite directions, and hence neutralize each other so far as any effect on the other winding of the transformer is concerned. Consequently the relay R^3, although not differentially wound, is nevertheless unaffected, and likewise the originating-circuit C. In the same way currents originating in line-circuit C′ will be reproduced in the other without affecting the relay R^2.

From the foregoing description it will be seen that the system in both forms is fully reciprocal without the use of automatic switches, the direction of transmission being changed at will by the act of speaking into the transmitter of the receiving-station, and that the amplified current-waves are produced only in the receiving-circuit C or C′, as the case may be, and not in the originating-circuit. There can therefore be no deforming of the original waves, with consequent impairment of clearness at the receiving end of the system, nor can current-waves be thrown back and forth between the two circuits, with the objectionable humming or singing. It will also be seen that the currents produced in the transformers T^2 T^3 divide at the differential devices, which, as explained above, may be either relays or transformers, half of the current influencing inductively the transmission line-circuit through transformer T or T′, as the case may be, and the other half inductively influencing the respective artificial line, thereby bringing the two influencing-circuits into multiple relation with each other. The consequent attenuation of the current in such an arrangement is only that due to the natural loss or straightening effect in the transmission-cir-

cuits, which loss is much less than would result in a series relation.

It is to be understood, of course, that the arrangements herein described are merely typical of the invention, which may be embodied in a great variety of forms without departure from its proper scope as defined by the following claims.

What I claim is—

1. In a reciprocal telephonic repeating system, in combination, a divided telephone-line, differential repeating devices, and artificial-line loads, the said artificial-line loads and the sections of the telephone-line being in multiple inductive relation to respective differential repeating devices, as set forth.

2. In a reciprocal telephonic repeating system, in combination, a telephone-line consisting of independent sections, repeating devices having differential windings, portions of their windings being in inductive relation to respective sections of the telephone-line, and artificial-line loads in inductive relation to other portions of the windings of the repeating devices, as set forth.

3. In a telephonic repeating system, in combination, a telephone-line consisting of independent sections, a device having differential windings, one of the differential windings being connected inductively with one of the line-sections, means for producing in the said differential device currents corresponding to currents in the other line-section, and an artificial-line load connected inductively with another winding of the differential device, as set forth.

4. In a telephone repeating system, in combination, a telephone-line consisting of independent sections, a device having differential windings, one of the differential windings being connected inductively with one of the line-sections, an artificial-line load connected inductively with another winding of the differential device, and a circuit in inductive relation to the other line-section and connected to the neutral point of the winding of the differential device, as set forth.

5. In a telephonic repeating system, in combination, a telephone-line consisting of independent sections, a relay having a differentially-wound receiving-magnet, one of the differential windings being connected inductively with one of the line-sections, an artificial-line load connected inductively with the other differential winding of the relay receiving-magnet, and a circuit in inductive relation to the other line-section and adapted to produce currents in the relay corresponding to currents in the said line-section as set forth.

6. In a telephonic repeating system, in combination, a telephone-line consisting of independent sections, a relay having a differentially-wound receiving-magnet, one of the differential windings being connected inductively with one of the line-sections, an artificial-line load connected inductively with the other differential winding of the relay receiving-magnet, and a circuit in inductive relation to the other line-section and connected to the neutral point of the windings of the relay receiving-magnet, as set forth.

7. In a telephonic repeating system, in combination, a telephone-line consisting of independent sections, a relay having a differentially-wound receiving-magnet, one of the differential windings being connected inductively with the one of the line-sections, means for producing in the said differential device currents corresponding to currents in the other line-section, and an artificial-line load connected inductively with another differential winding of the relay receiving-magnet, as set forth.

8. In a reciprocal telephonic repeating system, in combination, a telephone-line consisting of independent sections, repeating-relays having differentially-wound receiving-magnets, portions of the differential windings being in inductive relation to respective sections of the telephone-line, and artificial-line loads in inductive relation to other portions of the differential windings of the relay receiving-magnets, as set forth.

9. In a reciprocal telephonic repeating system, a divided telephone-line, repeating-relays having differentially-wound receiving-magnets, and artificial-line loads, the said artificial-line loads and the sections of the telephone-line being in multiple inductive relation to respective relays, as set forth.

10. In a telephonic repeating system, in combination, a telephone-line, a differentially-wound relay having one of its differential windings inductively connected with the telephone-line, and an artificial line inductively connected with the other differential winding of the relay and in multiple inductive relation to the telephone-line, as set forth.

11. In a reciprocal telephonic repeating system, the combination with telephone-line sections, of repeating-relays, each inductively responsive to currents originated in its respective line-section and unresponsive to currents produced by it in the other line-section, as set forth.

12. In a telephonic repeating system, a relay having a differentially-wound receiving-magnet inductively connected with a transmission-line and an artificial line, as set forth.

FERNAND EMILE DE FAUCHEUX D'HUMY.

Witnesses:

STURGES S. DUNHAM,

THOS. J. BYRNES.