No. 706,319. Patented Aug. 5, 1902.

M. H. HOWELL.

TELEPHONE CIRCUIT.

(Application filed June 19, 1901.)

(No Model.

3 Sheets—Sheet 1.

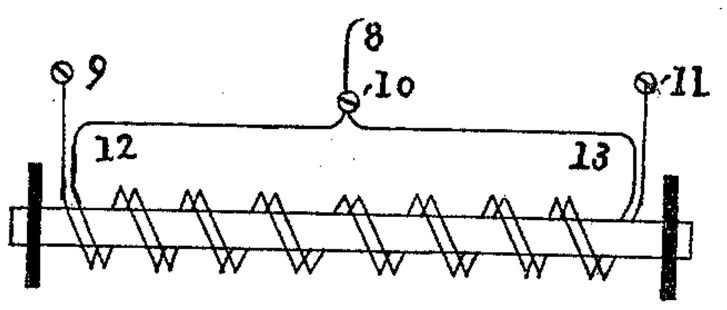

Fig. 1.

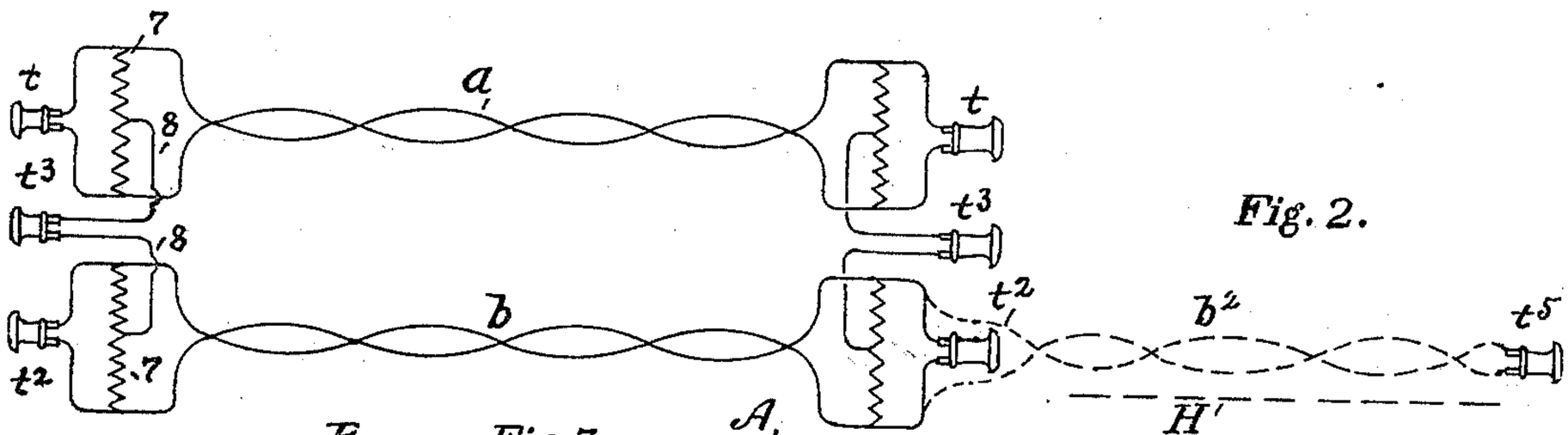

Fig. 2.

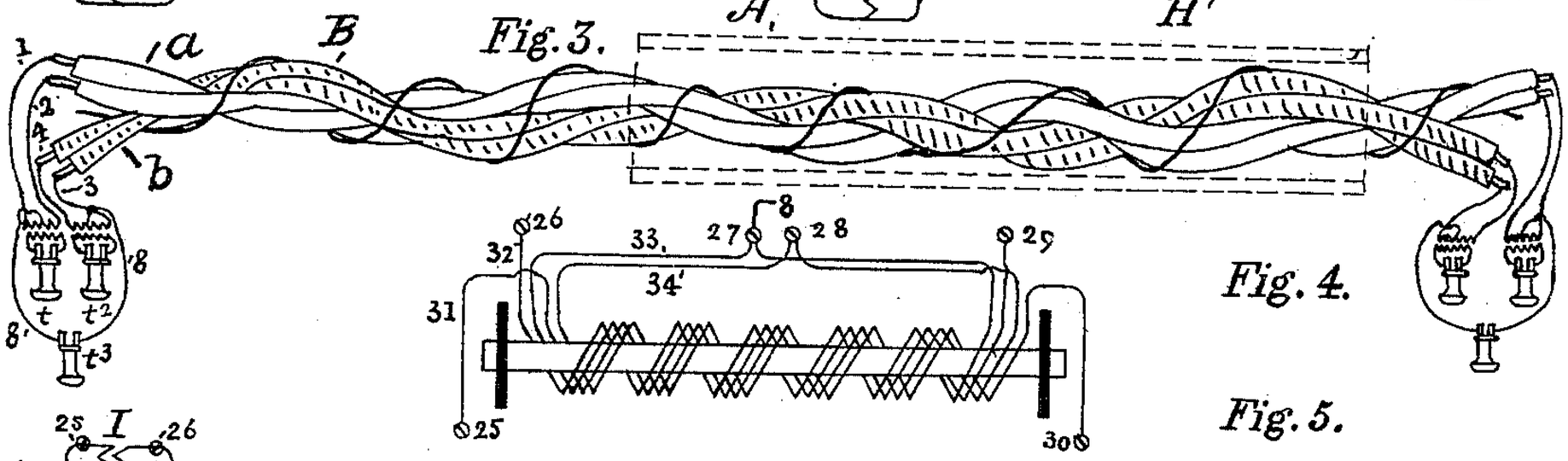

Fig. 3.

Fig. 4.

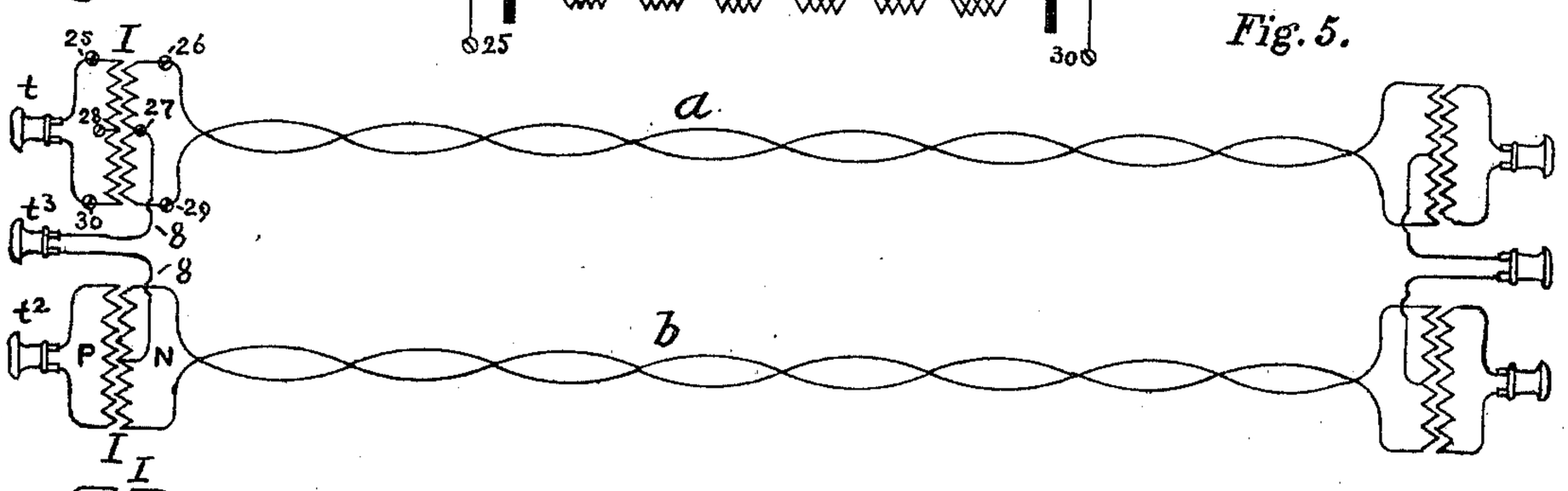

Fig. 5.

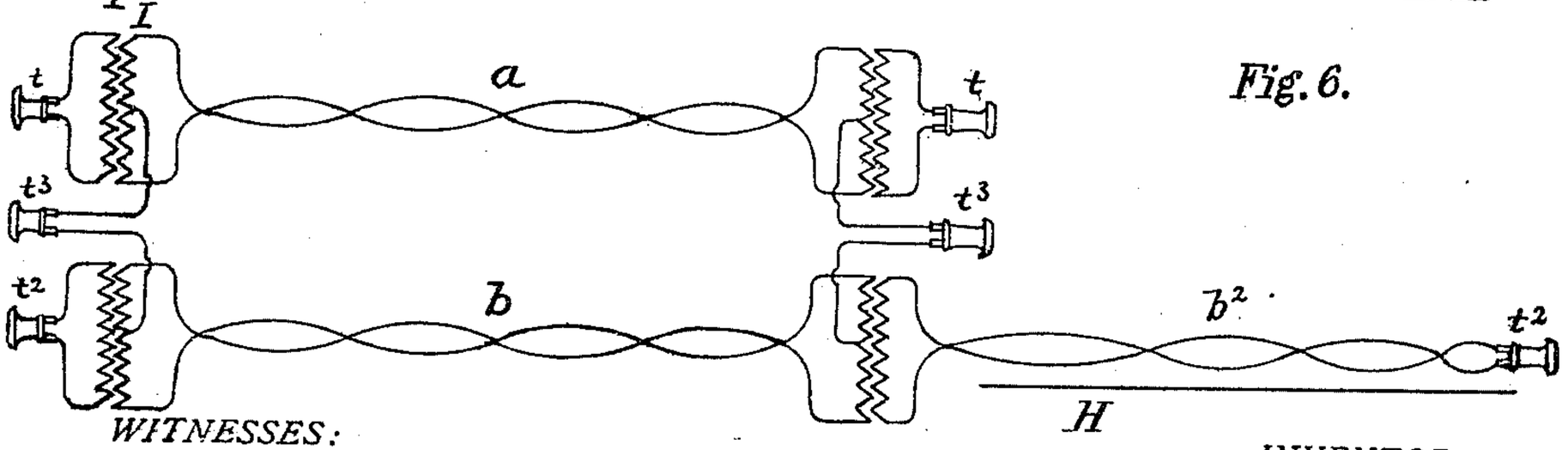

Fig. 6.

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TELEPHONE CIRCUIT.

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(No Model.) 3 Sheets—Sheet 2.

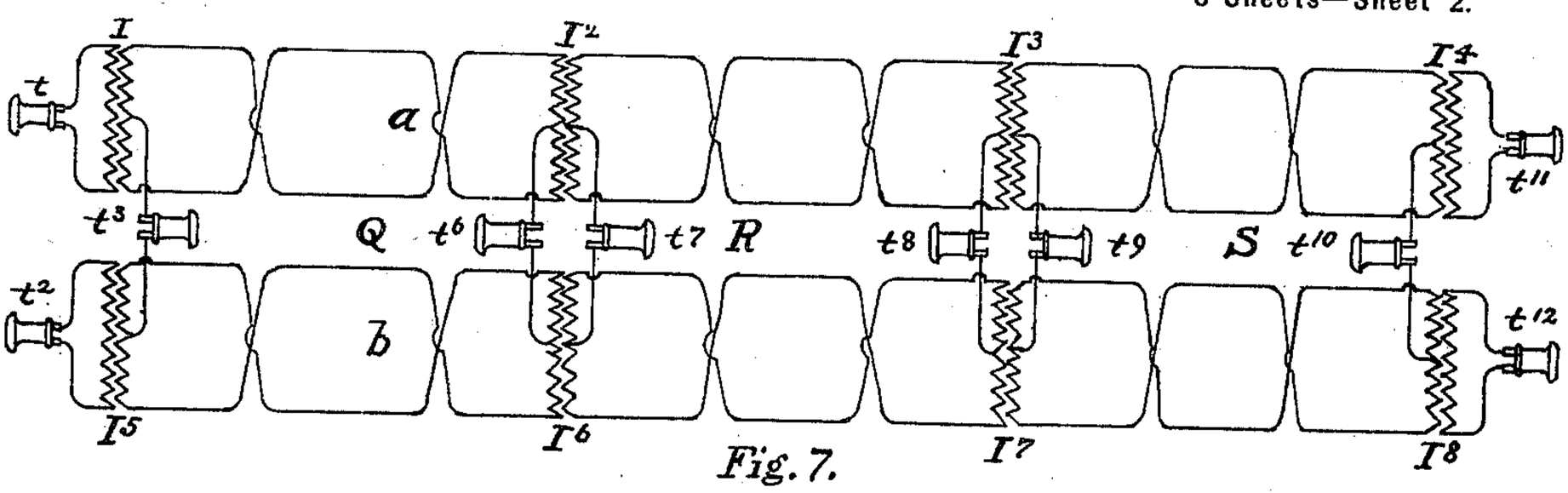


Fig. 7.

Fig. 8.

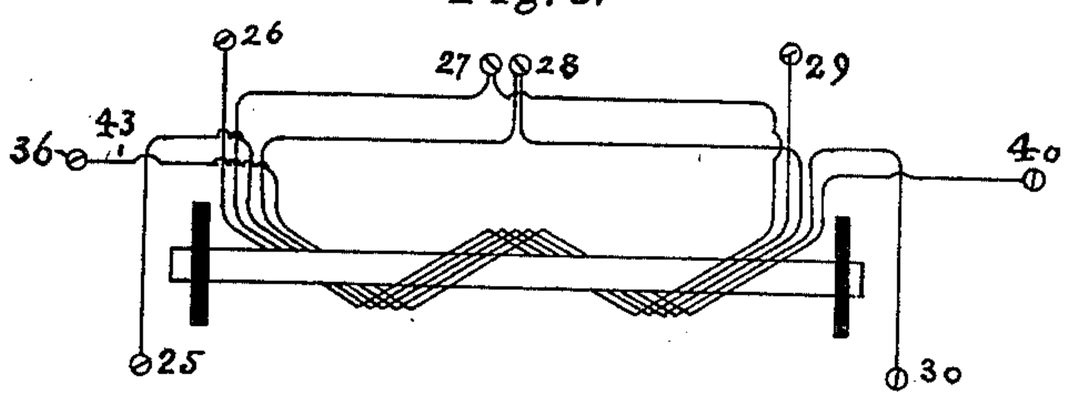
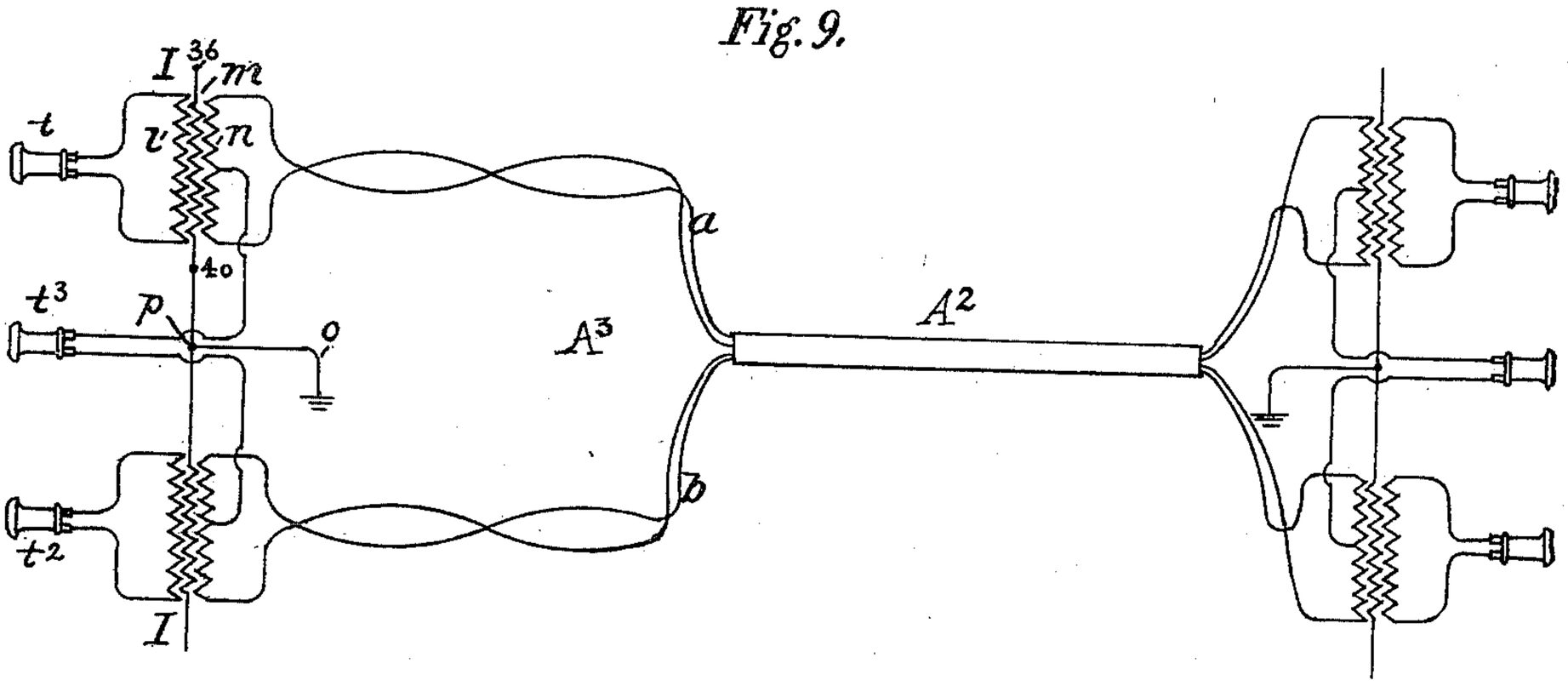


Fig. 9.



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TELEPHONE CIRCUIT.

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(No Model.)

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Fig. 10.

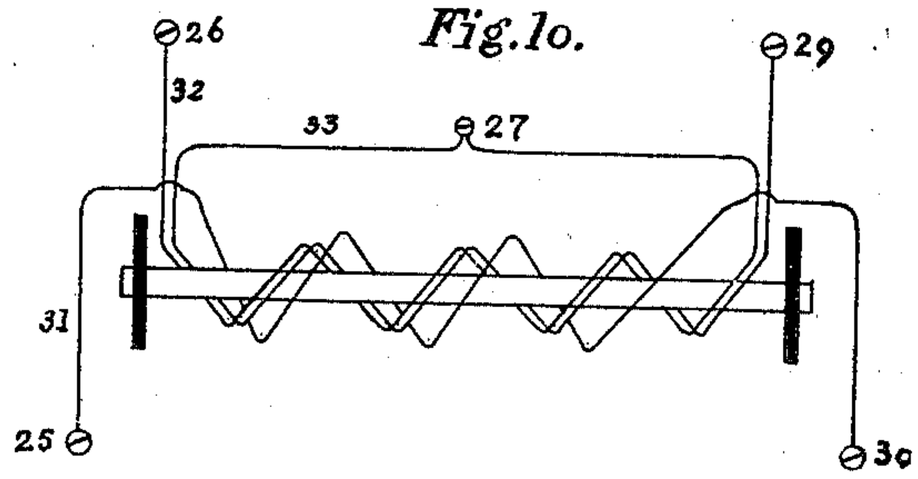


Fig. 11.

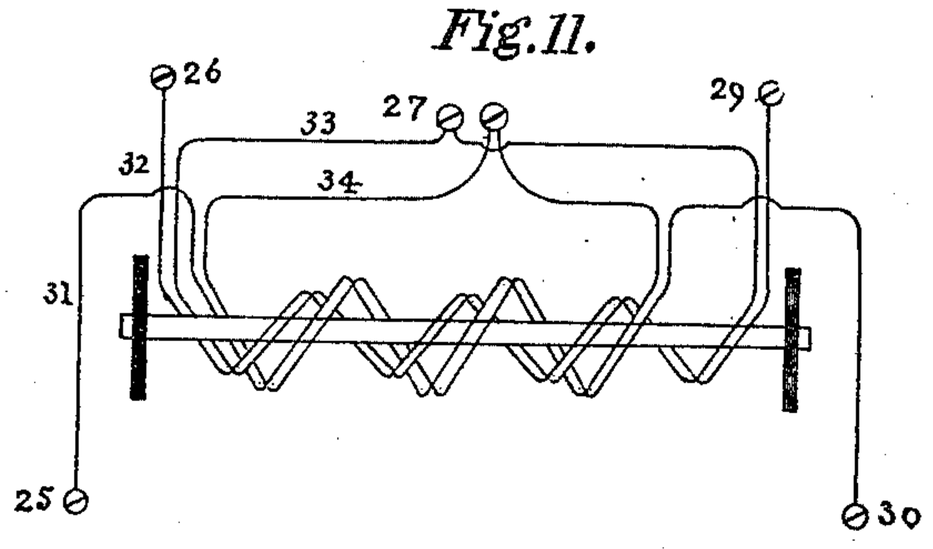


Fig. 12.

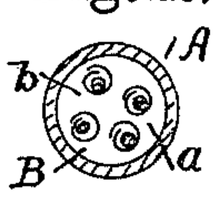
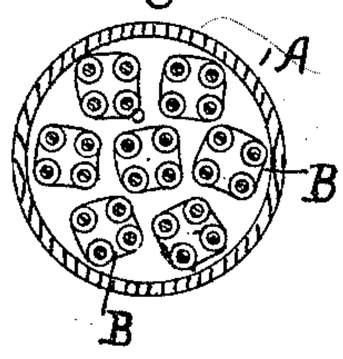


Fig. 13.



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MARTIN H. HOWELL, OF MELROSE, MASSACHUSETTS, ASSIGNOR TO NEW ENGLAND TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 706,319, dated August 5, 1902.

Application filed June 19, 1901. Serial No. 65,137. (No model.)

To all whom it may concern:

Be it known that I, MARTIN H. HOWELL, residing at Melrose, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Telephone-Circuits, of which the following is a specification.

The present invention concerns telephone-circuits, and has especial reference to circuits whose conductors are transposed, whether carried upon poles or inclosed in cables, which form so large a portion of the telephone-lines at the present time, and is an improvement upon the invention described in the application of Marcia J. Farnham, administratrix for estate of I. H. Farnham, Serial No. 66,932. In the said application two pairs of insulated conductors are twisted together and the four conductors are termed a "unit," and a plurality of such units are inclosed in a sheath to form a cable. Each pair of conductors constitutes a telephone-circuit, and a third or phantom circuit is formed by bridging an impedance-coil between the two conductors of each circuit at their terminals and including signaling instruments or telephones in a deviation from the center of the impedance-coils of two such circuits.

In the present invention such impedance-coils as have been referred to are discarded and repeating-coils having the required impedance of a new and novel kind are employed in their place; and the invention has especial reference to the construction of such repeating-coils and their combination in the line-circuit by means of which the third or phantom circuits may be established.

The repeating-coils consist, essentially, of two separate windings upon a soft-iron core. The helices of one winding are in series from one terminal to the other and are inductive to alternating currents circulating through the second winding of the coil, and the helices are provided with two end terminals and also with a third central terminal, the use of which will be explained hereinafter. The helices of the second winding are provided with two end terminals and with a third central terminal, and the helices are inductive to alternating currents entering or circulating from an end terminal and continuing through the helices in series, but are non-inductive to currents which enter the central terminal, divide, and pass to the helices at either end of the said winding.

Impedance or inductance coils, such as are indicated in the application referred to, whose windings are in conductive relation with both the local instrument-circuit and the main circuit work well under ordinary conditions; but when one of the metallic circuits, formed as referred to, is much longer than the others and is in proximity to a high-potential current the circuits associated with said metallic circuit become unbalanced, especially the third or phantom circuit, which becomes a noisy telephone-circuit; but when coils of the character of the invention about to be described are employed the proximity of high-potential power-currents has no appreciable effect upon the phantom circuit, all of which I will now proceed to describe in detail.

Of the drawings illustrating the invention, Figure 1 represents an impedance-coil such as is employed in said application. Fig. 2 illustrates the use of such impedance-coils in the circuits constituting the invention of said application, and Fig. 3 represents the impedance-coils associated with the cabled conductors of the application. Figs. 4, 8, 10, and 11 are repeating-coils embodying the invention; and Figs. 5, 6, 7, and 9 are diagrams to illustrate the use of the repeating-coils. Fig. 12 is a section of a cable, showing two pairs of conductors, constituting a unit, inclosed in a protective sheath; and Fig. 13 is a section of a cable, showing a plurality of such units within a sheath.

Fig. 3 of the drawings illustrates two pairs of conductors *a* and *b*, twisted together, (after the manner described in the application referred to and forms a unit B,) having at their ends repeating-coils, the combination of which constitutes a portion of my invention. The conductors are shown as first twisted together in pairs and then the pairs twisted together in a direction opposite to the twist of the said pairs; but I may employ a unit in which four conductors are all twisted together in one direction, as referred to in said application. A represents in dotted lines the protective sheath of the cable.

Figs. 1 and 2 represent an impedance-coil

and a circuit in which the coil forms a part. *a* and *b* are the respective pairs of the unit B. The coils are in bridges 7 at each end of the pairs at which are the telephones *t*. An extension 8 from the center of each coil includes the telephones t^3, and the arrangment represents two metallic circuits and a third or phantom circuit whose conductors or limbs are the pairs *a* and *b*, respectively. When the circuits *a* and *b* are substantially of the same length, there will be obtained a quiet phantom circuit; but should one circuit—say *b*—be excessively longer than the other, *a*, as indicated at dotted lines, and be in the neighborhood of a power-circuit H of high potential the phantom circuit will be very noisy and unfit for commercial use as a telephone-circuit.

If the conductors of the circuits *a* and *b* b^2 are equally transposed, there will be no noise in the telephones at their terminals by the proximity of the power-wire H; but the telephones t^3 at the terminals of the phantom circuit will indicate a disturbed condition, owing to the fact that the conductors of circuit *a* are very much shorter than the conductors of circuit *b* b^2 and that the extension b^2 is subject to inductive disturbances to which the circuit *a* is not.

There are many ways known in the art for securing the beneficial results of line-conductor transposition, such as the method employed in foreign countries of rotating one conductor around the other with more or less frequency—the method shown in Patent No. 392,775, to J. A. Barrett, &c.—and I may employ sections of cables, the conductors of one section being more frequently twisted than its companion.

Fig. 4 shows a repeating-coil I, which is very effective in operation when used as illustrated in Figs. 5, 6, and 7 and exercises no retarding effect to the passage of telephone-currents entering at split or point 27, where the phantom circuit is introduced. The helices of the coil are composed of four conductors 31, 34, 32, and 33, which are preferably twisted together, and their right-hand ends are respectively brought to the screw-posts 28, 30, 27, and 29, and the left-hand ends are brought to the screw-posts 25, 28, 26, and 27, respectively, so that each conductor passes through the coil in two windings in series with one another, the points 27 and 28 being in the center of each of the two windings. Both sides of the coil are balanced and are symmetrical. The extensions or conductor 8 from the point 27 on the side N of the coils I at each end of each circuit connects with the telephone t^3, and the conductors of the circuit *a* terminate at the screw-posts 26 and 29, respectively, and the terminals of the local telephone-circuit are secured in the screw-posts 25 and 30 of the side P of the coils, so that the circuit *a* is one side or limb and the circuit *b* the secoud side or limb of a phantom circuit having the instruments t^3 at each terminal.

It will be understood that the telephones shown are merely symbolical and simply represent regular telephone outfits. In the operation of the phantom circuit current passes from the telephone t^3 to the point 27 of the winding N of one of the coils I associated with the circuits *a* and *b*—say *a*—where it divides, a portion going through the helices of the coils in opposite directions, coming out at the points 26 and 29, and then continues over the conductors of the circuit to the corresponding points 26 and 29 of the winding N of the coil I at the opposite end of the circuit and traversing the helices in opposite directions comes to the point 27 and to the telephones t^3, from which it continues by a similar route of that just described over the circuit *b* to the home end of the circuit. As the current splits at the point 27 and goes in opposite directions through the helices, as described, one side neutralizes the other, and therefore no inductive effect is produced in the core, and consequently there is no disturbance in the telephone *t* or t^2 at either end of the circuits, and when the telephone *t* or t^2 is used the generated currents enter the P winding of the coils I and traverse the same in series, and an inductive effect is produced in the core of the coil, and similar currents are induced in the winding N of the coil which circulate in the helices thereof in series and are propagated over the conductors 1 and 2 of the circuit and pass through the helices of the winding N of the coil I at the opposite end of the circuit and are inductively transferred to the winding P, through whose helices they circulate in series, and are received by the telephone in the local circuit of the winding.

For convenient description I prefer to represent the end circuits P, which include one winding of the repeating-coil, in series with the telephones *t* and t^2 as local circuits, but the said circuits may be of any extension, and also to refer to the intervening circuit as the "main" circuit.

Fig. 6 illustrates what frequently happens in telephone construction—the combination of a short circuit *a* and a comparatively longer circuit *b* b^2, located in the vicinity of a power-circuit. In the figure the power-circuit H is shown in proximity with a portion of the extension b^2, and if the conductors of the circuits are properly transposed all of the circuits, including the phantom circuit, will be free from inductive disturbances and quiet because of the perfect balance secured by the repeating-coils.

Fig. 7 shows the pairs of twisted conductors *a* and *b* divided by the repeating-coils I, I^2, I^3, I^4, I^5, I^6, I^7, and I^8, with extensions 8 from the points 27 of the end coils and the points 27 and 28 of the intermediate coils, so that from the four twisted conductors there are produced the metallic circuits *a* and *b* with telephone-stations *t* and t^{11}, t^2 and t^{12}, between which are the phantom circuits Q, R, and S, having the telephone-stations t^3 t^6, t^7 t^8,

and t^9 t^{10}, and all of the circuits will be independent of each other and free from extraneous disturbances.

Fig. 8 indicates a repeating-coil similar to the coil shown in Fig. 4, having a third winding, which has a grounded branch by means of which static line changes detrimental to good telephone-work are provided with ground-escapes. All five wires are preferably twisted together before being wound upon the bobbin, and their ends are brought out as indicated.

Fig. 9 is a diagram to indicate the use of the coil shown in Fig. 8 and also to indicate that a portion A^3 of the circuits *a* and *b* is transposed on pole-lines, and another portion A^2 is twisted in a cable. The third winding *m* is shown as grounded by branch *o*.

Fig. 10 shows a repeating-coil in which the two wires 32 and 33 are twisted together before they are wound on the bobbin, but for sake of clearness are not so represented in the drawings, and the single wire 31 is then wound over them, and in Fig. 11 the two wires 32 and 33 are twisted together and then wound upon the bobbin, after which the wires 31 and 34, which are twisted with one another, are wound on the said wires. The connections of the windings of these two coils will be understood, as the binding-posts are numbered to correspond with the figures previously described.

I claim as my invention—

1. The combination of a plurality of insulated conductors inclosed in a protective sheath, twisted together in pairs to form independent metallic circuits, each pair twisted with a second pair; with a repeating-coil at the terminal of each pair of conductors and provided with an extension from the center of the main-circuit windings to constitute a third instrument-circuit.

2. The combination of a plurality of insulated conductors inclosed in a protective sheath, twisted together in pairs to form independent metallic circuits, each pair twisted with a second pair in a direction reverse to their own twist, with a repeating-coil at the terminals of each pair of conductors whose windings are twisted together and provided with an extension from the center of the main-circuit windings to constitute a third instrument-circuit.

3. The combination of a plurality of insulated conductors inclosed in a protective sheath, twisted together in pairs to form independent metallic circuits each pair twisted with a second pair; with a repeating-coil at the terminals of each pair of conductors whose windings are twisted together and are in inductive relation respectively to the main circuits and to their local instrument-circuits, and provided with an extension from the center of the main-circuit windings to constitute a third instrument-circuit.

4. The combination of a plurality of insulated conductors inclosed in a protective sheath, twisted together in pairs to form independent metallic circuits, each pair twisted with a second pair in a direction reverse to their own twist; with a repeating-coil at the terminals of each pair of conductors whose windings are twisted together and provided with an extension from the center of the main-circuit windings to constitute a third instrument-circuit.

5. The combination of a plurality of insulated conductors inclosed in a protective sheath, twisted together in pairs to form independent main circuits having telephones at each terminal thereof, a repeating-coil at the said terminals of each pair, the said windings being twisted together and having an extension from the center of the main-circuit windings to include telephones and to form a third circuit, each pair of conductors constituting a metallic circuit and twisted with a second pair, as set forth.

6. The combination of four insulated conductors twisted together in pairs to form independent main metallic circuits, each pair twisted with the other pair; with a repeating-coil at the terminals of the pairs of conductors and provided with an extension from the center of the main-circuit windings to constitute a third instrument-circuit, as set forth.

7. The combination of four insulated conductors twisted together in pairs to form independent main metallic circuits, each pair twisted with the other pair; with a repeating-coil at the terminals of the pairs of conductors, and provided with an extension from the center of the main-circuit winding, to constitute a third circuit including telephones, as set forth.

8. The combination of a plurality of conductors transposed in pairs to form independent metallic circuits; with a repeating-coil at the terminal of each pair of conductors and provided with an extension from the center of the main-circuit windings to constitute a third instrument-circuit.

9. The combination of a plurality of telephone-circuits extending between terminal stations, two or more of which circuits are insulated and contained in a protective sheath for a portion of their length, and for the remainder of the distance are non-insulated and supported upon pins in the air; the said insulated portions of the circuits being twisted in pairs to form independent metallic circuits, each pair twisted with a second pair, and the non-insulated continuations of said pairs are transposed upon said pins; with a repeating-coil at the terminal of each pair of conductors and to their local instrument-circuits and provided with an extension from the center of the main-circuit windings to constitute a third instrument-circuit.

10. A repeating-coil for electric circuits, one or both of whose inductive windings consist of twisted conductors both of the windings provided with end terminals and one winding having a central terminal.

11. A repeating-coil for electric circuits, one or both of whose inductive windings consist of twisted conductors whose terminals are so connected that the circuit therethrough continues through the conductors twice in series, with an extension from the center of the windings.

12. A repeating-coil for electric circuits whose inductive windings consist of double-twisted conductors, the circuits through each winding continuing through the helices twice in series, with an extension or terminal from the center of one of the windings.

13. A repeating-coil for composite electric circuits consisting of three windings composed of several conductors wound together, the helices of one winding in series from one terminal to the other and inductive to alternating or telephone currents, the helices of the second winding provided with end terminals and a third terminal from the center thereof, the said winding inductive to alternating or telephone currents traversing its helices in series, and non-inductive to such currents circulating therein differentially, and the third winding consisting of one or more helices adapted to be grounded at one terminal and open at the other.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 8th day of June, 1901.

MARTIN H. HOWELL.

Witnesses:
GEORGE S. MOYNAHAN,
ALBERT C. DADUM.