(No Model.) 3 Sheets—Sheet 1.

A. M. & T. R. ROSEBRUGH.

MULTIPLE TELEPHONE.

No. 417,511. Patented Dec. 17, 1889.

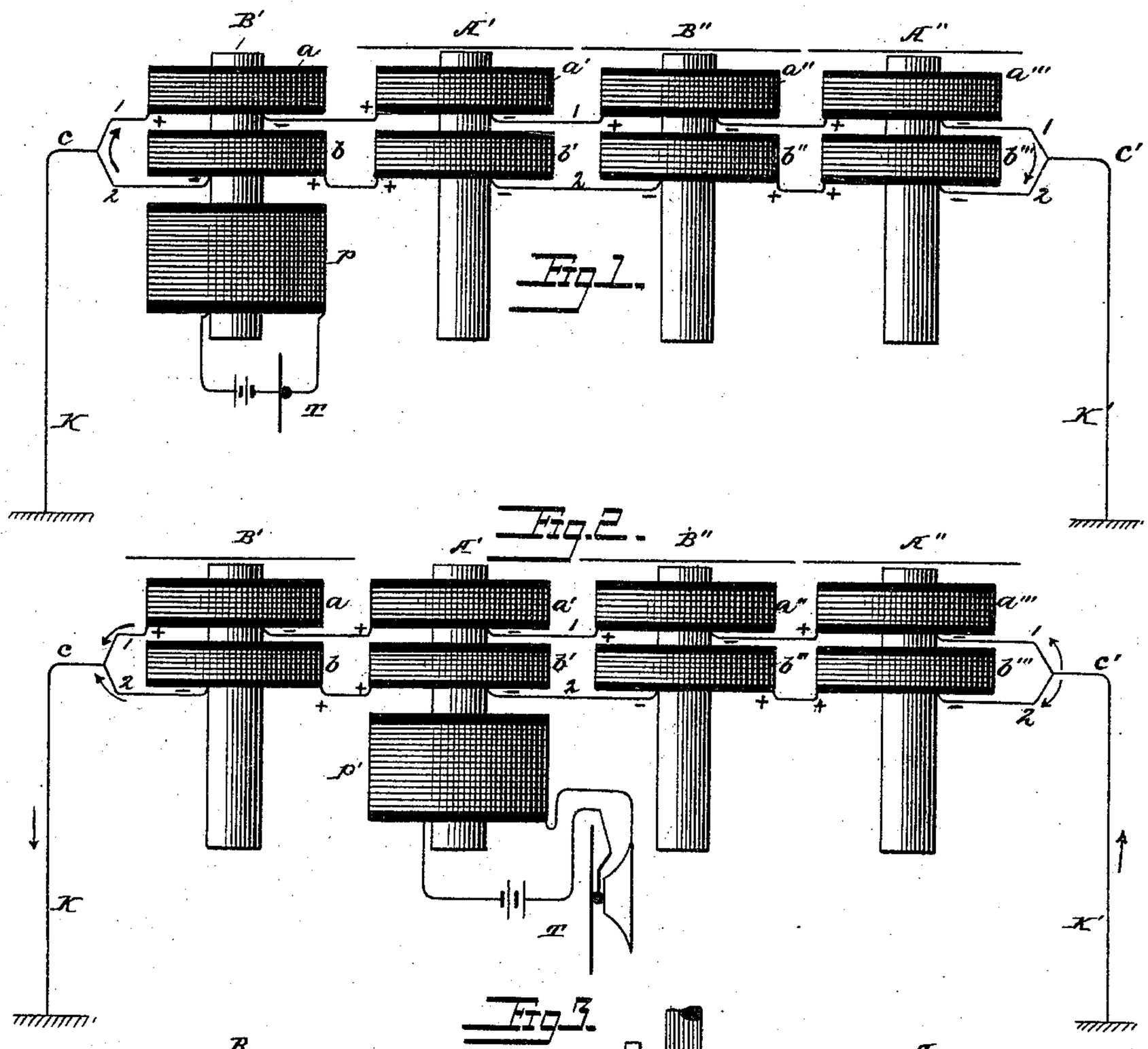

Fig. 1.

Fig. 2.

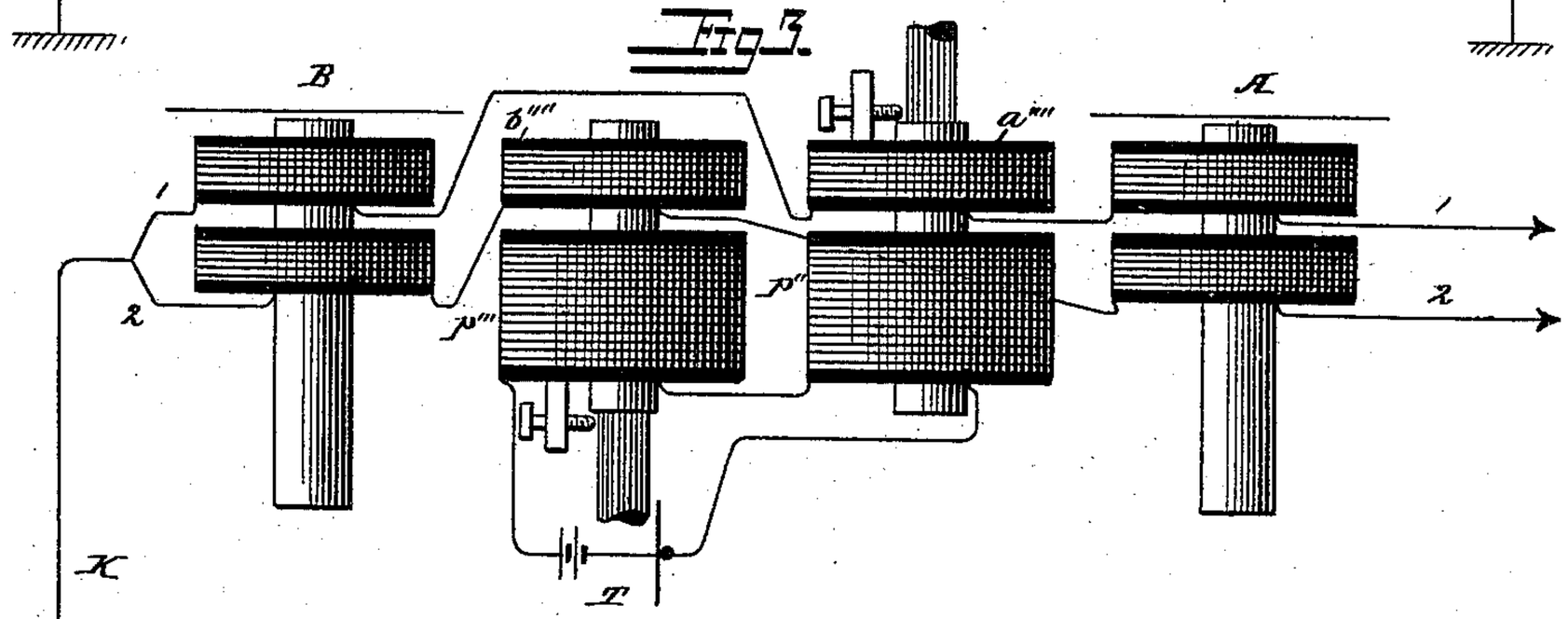

Fig. 3.

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A. M. & T. R. ROSEBRUGH.

MULTIPLE TELEPHONE.

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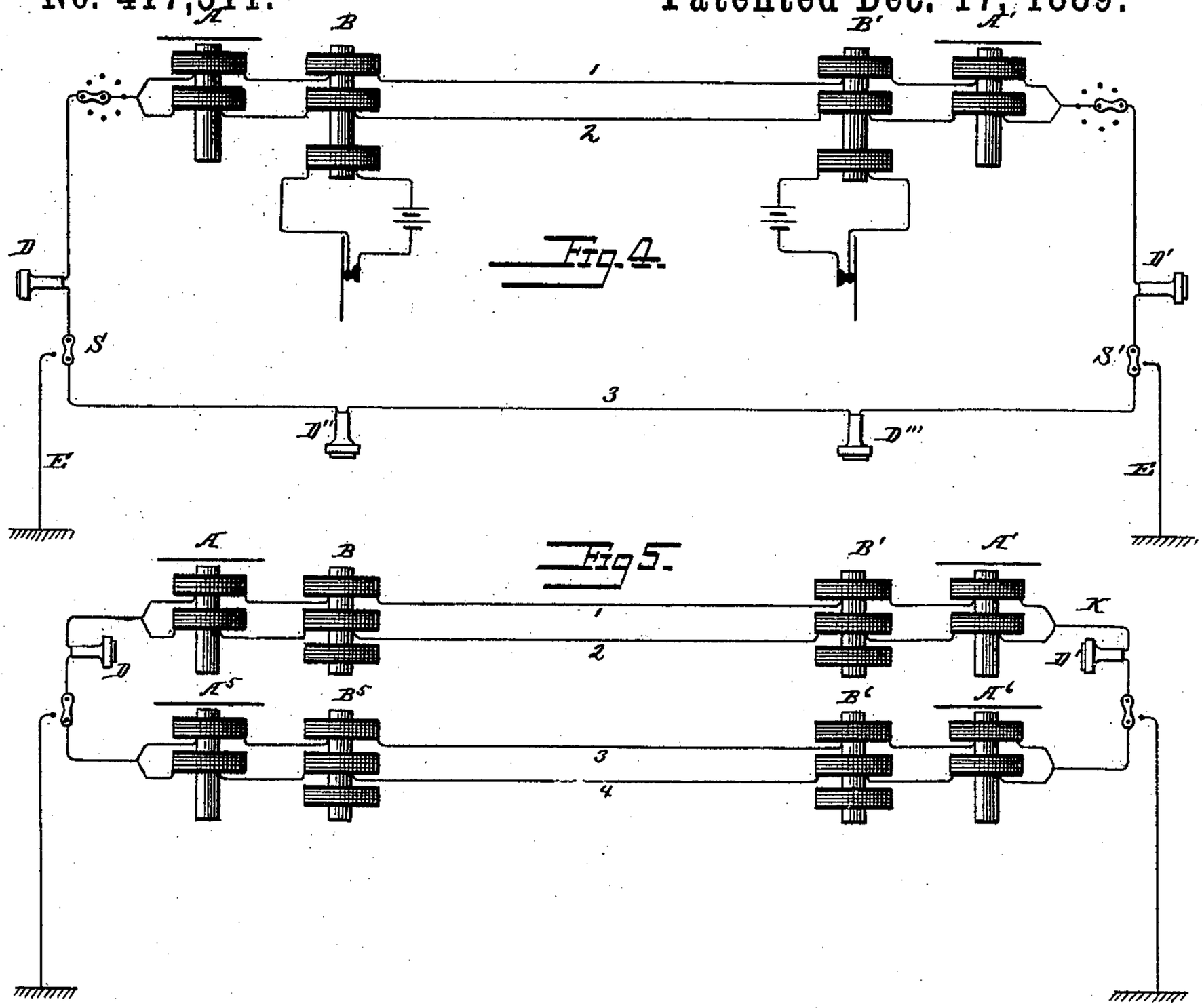

Fig. 4.

Fig. 5.

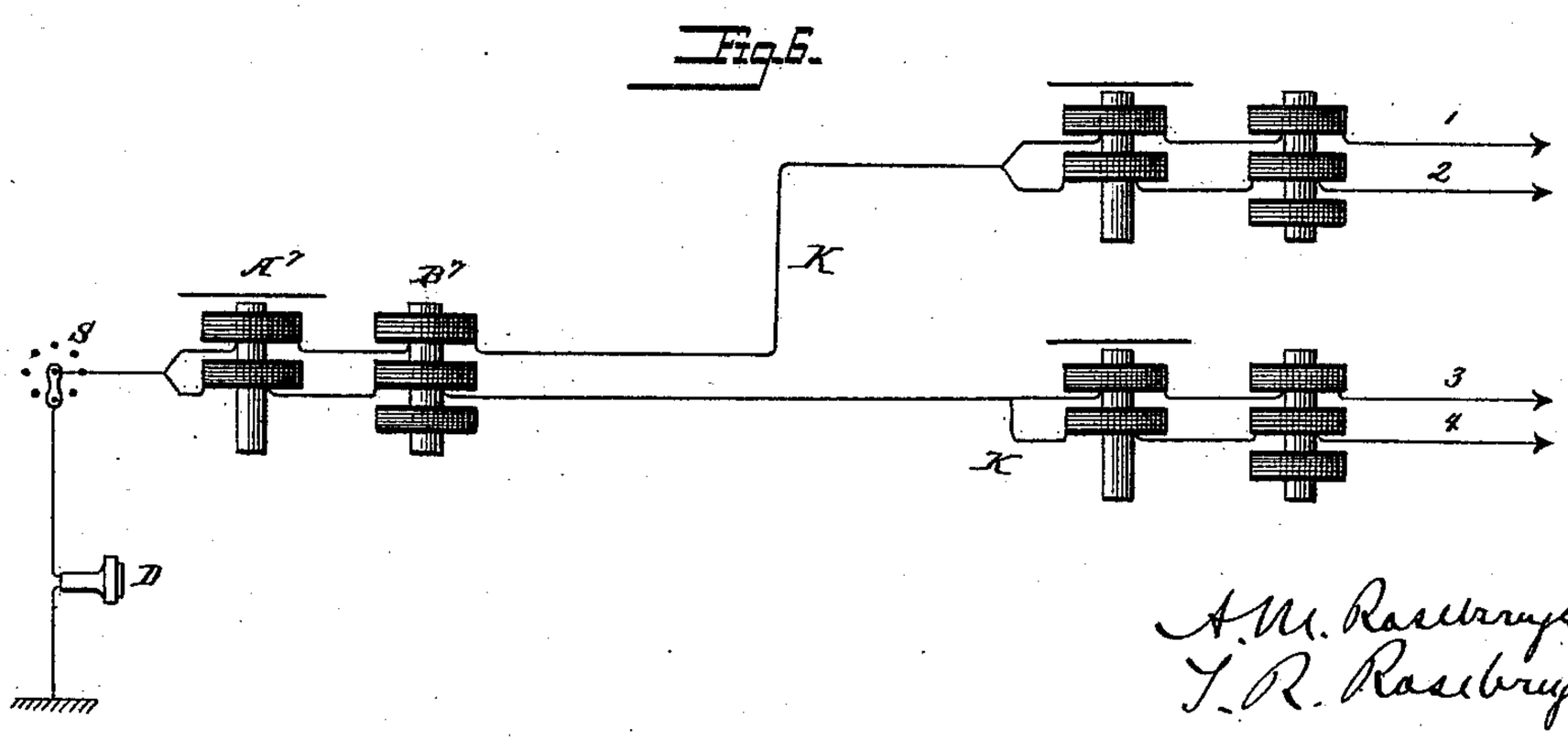

Fig. 6.

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Fig. 7.

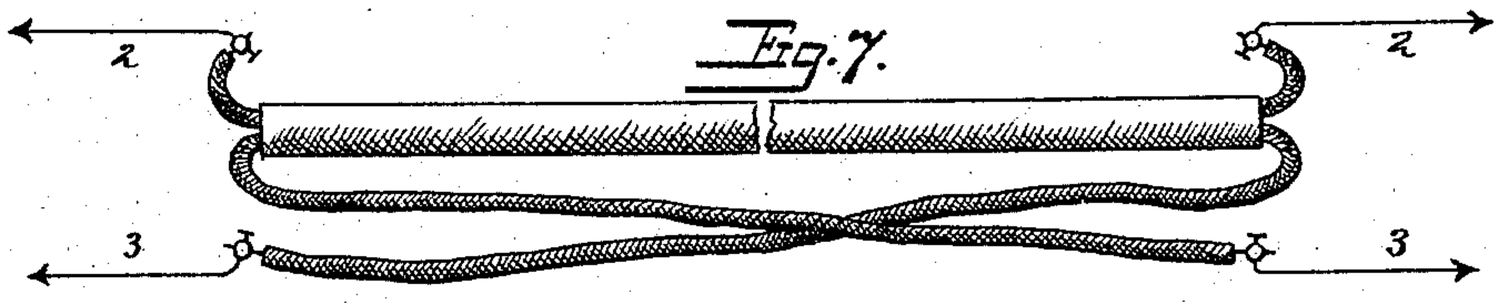
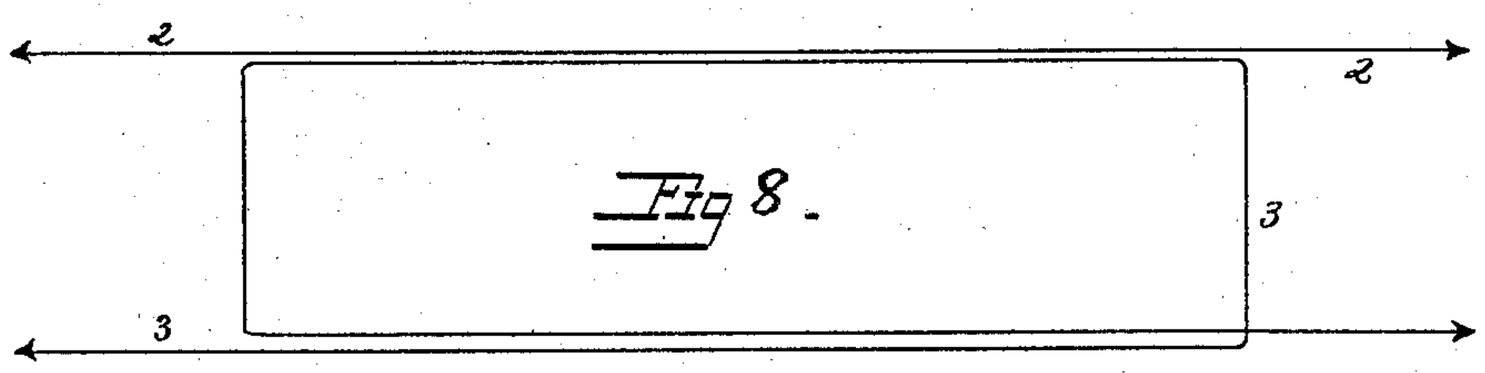


Fig 8.



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UNITED STATES PATENT OFFICE.

ABNER M. ROSEBRUGH AND THOMAS R. ROSEBRUGH, OF TORONTO, ONTARIO, CANADA.

MULTIPLE TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 417,511, dated December 17, 1889.

Application filed November 27, 1886. Serial No. 220,072. (No model.) Patented in England August 15, 1885, No. 4,231.

To all whom it may concern:

Be it known that we, ABNER M. ROSEBRUGH and THOMAS R. ROSEBRUGH, subjects of the Queen of Great Britain, and residing at Toronto, Province of Ontario, Canada, have invented certain new and useful Improvements in Multiple Telephones, of which the following is a specification.

The subject-matter of this case has been patented to us in British Letters Patent No. 4,231 and dated August 15, 1885.

The object of this invention is to increase the working capacity of metallic telephone-circuits, so that long-distance telephony may be facilitated, and so that either two telephone-subscribers or a telephone-subscriber and a telephone-operator at each end of a metallic circuit may communicate with each other simultaneously. This we accomplish by using the following interdependent means and devices: first, by connecting a branch line with each end of the metallic circuit and connecting said branch line to either a ground-wire or to a return wire or wires and using differentially-wound telephone apparatus in the metallic circuit; secondly, by using a compensating device between parallel metallic circuits or between a metallic circuit and a grounded circuit.

It is evident that when a metallic telegraph or telephone circuit is grounded at both ends and electrical impulses are generated in either branch of said metallic circuit the currents so generated will divide at the points where the metallic circuit is grounded, and a large percentage of said currents, instead of continuing in the circuit, will escape to earth through said ground-wires. We have, however, made the important discovery that when electrical impulses of equal strength are generated in both branches of the metallic circuit simultaneously and in opposite directions the currents so generated may be made to continue in the metallic circuit without affecting or being affected by the two ground-wires. We also discovered, after much experimenting, that this can be accomplished in several ways—as, for instance, first, by using a transmitter with a doubly-wound secondary coil, one coil for each branch of the metallic circuit; secondly, using a transmitter with two induction-coils, the primaries being connected either in series or in multiple arc. We also find that it is not essential that the two branches of the metallic circuit shall have the same resistance, as we have discovered that a practical balance may be effected by using adjustable cores in the transmitter-coils or by varying the inductive capacity of the two sides of the double repeaters. We also found that we could use two sets of duplex or doubly-wound transmitters simultaneously in the metallic circuit, one set for generating electrical currents in the two branches of the metallic circuit in opposite directions and the other set for generating currents in the two branches in the same direction. The latter actuates the receivers in the ground-lines; the former does not. Of course duplex receivers can easily be arranged in the metallic circuit so as to respond to one set of duplex transmitters and be neutral to the other set, and also so as to respond to or be neutral to the singly-wound transmitters in the ground-wires.

In the accompanying drawings, Figures 1, 2, and 3 represent the first part of our invention, namely: the combination of a metallic circuit, two ground-wires, and differentially-wound telephonic apparatus. Figs. 4, 5, and 6 represent the combination of metallic circuits with differentially-wound telephonic apparatus, and Figs. 7 and 8 the compensating device for parallel circuits.

The principle involved in the first part of our invention is illustrated in Figs. 1, 2, and 3, it being understood that we do not limit ourselves to the particular construction of apparatus therein represented.

B′ and A′ are duplex or differentially-wound telephonic transmitters, and B″ and A″ are duplex or differentially-wound telephone-receivers. In Fig. 1, B′ is transmitting and B″ is receiving, and in Fig. 2, A′ is transmitting and A″ receiving.

No. 1 and No. 2 are the two wires of the metallic circuit, and K and K′ are ground-wires.

The transmitters B′ and A′ are provided with a primary wire and with two secondary coils on a soft-iron core, while the receivers

B″ and A″ have two coils, preferably on a soft-iron core magnetized by a permanent magnet. The coils a, a', a'', and a''' are in circuit with No. 1 wire, while the coils b, b', b'', and b''' are in circuit with No. 2 wire. The coils p and p' are primary coils, and are in circuit with a local battery and a microphone T. Following No. 1 wire from the point c in the direction of the arrows from left to right, it will be seen that the wire enters the coil a by the outside terminal, marked +, and makes its exit by the inside terminal, marked —. The connection is the same with a', a'', and a''', and on tracing the connection of the wire No. 2 from the point c' to c it will be seen that the coils b'' and b are connected from the outside to the inside, (+ to —,) while the coils b''' and b', on the contrary, are connected from the inside to the outside, (— to +.)

Referring to Fig. 1, it will be seen that upon operating the microphone T the soft-iron core will generate secondary currents in the coils a and b, presumably of equal strength, and as the outside or + wire of coil a is connected with the inside or — wire of coil b and on corresponding ends the current from a will re-enforce the current from b, and a current will be generated in the metallic circuit in the direction indicated by the arrows, the current in No. 1 wire moving in one direction and the current in No. 2 wire moving in the opposite direction. It will also be seen that from the peculiarity of the connection of the coils at A′ and A″ the currents in coil a' will neutralize the currents in b' and the currents in coil a''' will neutralize the currents in b''', whereas, on the contrary, the currents in coils a'' and b'' will re-enforce each other; hence the receiver B″ will respond to the transmitter B′, while the receiver A″ will be neutral thereto.

Again, reference being made to Fig. 2, it will be seen that by operating the microphone T independent secondary currents will be generated in coils a' and b', and will move toward the point c on wires 1 and 2 and in the same direction as indicated by the arrows. At the point c these currents meet, and were it not for the ground-wire K they would neutralize each other, whereas, on the contrary, they re-enforce each other on wire K, and proceed to "ground," and from ground to K′ and to c', where they redivide and return to a' and b' by the wires 1 and 2. As the coils a''' and b''' are similarly connected and the currents traverse the two wires in the same direction, receiver A″ will respond, and, as the coils a' and b' are similarly connected, A′, were it a receiver, would also respond. On the contrary, as the coils of B′ and B″ are dissimilarly connected, these receivers will remain neutral; hence, when B′ transmits to B″, A′ and A″ are neutral, and when A′ transmits to A″, B′ and B″ are neutral. In the former case the currents traverse the two wires of the metallic circuit in opposite directions, and in the latter case the currents move on the two wires in the same direction, the circuit being completed by means of the ground or by a return-wire. It is to be understood, of course, that the transmitters need not necessarily be of the form represented at B′ and A′. It will be obvious, also, that an ordinary transmitter inserted in wire K would operate the coils of A′ and A″ in a manner similar to that of transmitter T.

In Fig. 3 is represented another form of duplex transmitter. T is a microphone which operates the two induction-coils a'''' and b'''', the former being in circuit with No. 1 wire and the latter with No. 2 wire. The two primary coils p'' p''' are connected with a local battery and microphone, and may be connected in any suitable way, being shown as in series. By keeping the connections of the primary coils and the connections of one of the secondary coils permanent it is obvious that the direction of the currents by the two secondary coils combined will depend upon the manner in which the terminals of the other secondary coil are "connected up." Thus if the currents generated in coil a'''' move to the left the currents generated in coil b'''' would move to the right; whereas, if the connections of, say, coil b'''' were reversed, the currents from both coils would then move in the same direction. In the former case receiver B would respond, while receiver A would be neutral, and in the latter case A would respond, while B would be neutral. By this arrangement either two operators or an operator and a subscriber may both receive and transmit independently at each end of the line without interference. It will be seen that a current generated in only one of the wires of the metallic circuit would divide at the terminal points and a portion of the current would escape through the grounded receiving-instruments. When, however, the electric currents are generated in both wires of the metallic circuit simultaneously, as in the case where the two coils, one in each circuit, are charged by one battery and one microphone and the coils are connected so as to re-enforce each other, the tendency is for these currents to circulate only in the metallic circuit; consequently there is little tendency for these currents to escape to a grounded wire. Hence it will be obvious that two duplex transmitters and two duplex receivers and a ground-wire at each end of a metallic circuit can be connected in such a manner, and as described, that either two operators or an operator and a subscriber at one end may communicate with either two operators or an operator and a subscriber at the other end without interference.

The switches H and H represent diagrammatically the trunk-line switches.

G and L are the subscribers' switches, and I and J supplemental switches for facilitating the use of the duplex repeater.

The trunk-line switches H and H are con-

nected with the subscribers' switches G and L by a wire or wires not shown in the drawings. By means of the switches H and H the duplex repeater may be switched into or out of circuit at pleasure, and by means of the supplemental switches I and J either telephonic apparatus or signaling apparatus may be inserted in the branch line at pleasure.

In Fig. 4, 1 and 2 are the two wires of a metallic circuit, and 3 is a return-wire. By means of the switches S and S′ the two subscribers D and D′ may either use a ground-wire or a metallic circuit return-wire at pleasure. To this end the subscriber is supplied with either a special return-wire to the telephone office or with its practical equivalent—such, for instance, as a common ungrounded wire extending from the central office to the different subscribers in addition to the grounded line of each subscriber. A B and A′ B′ represent the duplex or differentially-wound telephonic apparatus in the metallic circuit. In this arrangement No. 3 return-wire or trunk-line may be used as a "way" wire, and intermediate stations may be connected therewith, as indicated at D″ D‴.

In Fig. 5 the arrangement is the same as in Fig. 4; but the two wires 3 and 4 are used as a common return-wire. A B and A′ B′ are duplex telephonic apparatus in No. 1 and No. 2 metallic circuit, and A^5 B^5 and A^6 B^6 are duplex apparatus in Nos. 3 and 4 metallic circuit.

In Fig. 6 the branch line K K is also represented as being duplexed, A^7 B^7 representing duplex telephonic apparatus in said branch lines. In this latter arrangement it will be seen that with two metallic circuits three operators and a subscriber at each end of a line may communicate with each other simultaneously without interference. In this arrangement two or more wires are used as a single conductor. This increases the area or cross-section of the conductor and necessarily facilitates long-distance telephony.

When telephone-wires are conducted parallel to each other, particularly on long lines, they affect each other by induction. Various ways may be used to overcome these effects when one or both of said wires forms part of a metallic circuit—as, for instance, a section of one wire may be brought within close proximity with the other, but the direction reversed. To accomplish this we used, preferably, a cable with two insulated wires, the terminals of which are connected, the one with wire No. 2 direct and the other with wire No. 3 reversed, as shown at Fig. 7, or the wires may be connected, as indicated in Fig. 8, respectively, which needs no special description.

Our invention is susceptible to a great variety of changes by those skilled in the art, and without attempting to recite all those we have tried we wish it distinctly understood that we do not limit ourselves to the details of construction set forth above, but intend to cover by this specification all well-known equivalent means of accomplishing the results of our invention.

A convenient form of induction-coil core for balancing the two branches of the metallic circuit is made of a tube of sheet-iron and inclosing soft-iron wire. The core may be maintained in any desired position by means of a set-screw, as described in our Patent No. 329,956.

In this application we do not claim the anti-induction device herein described, we do not claim the cable-inductors, and we do not claim the supplemental switch as herein described.

The objects attained by this telephone system are as follows: first, rendering duplex or multiplex telephony practical; second, in using two or more conductors the resistance of the line is reduced and long-distance telephony is facilitated; third, in using metallic circuits foreign induction is neutralized.

We claim—

1. The combination of two main lines, a transmitting device connected with both main lines and consisting of an inductorium for establishing electrical impulses upon said main lines, a receiving-instrument having coils included in both said main lines, and a conductor or conductors uniting said main lines with the earth or a return-conductor.

2. The combination, as hereinbefore set forth, of a transmitter and a receiving-instrument, coils in each of said instruments, two main lines, each including one of the coils in each instrument, conductors uniting said main lines with the earth or with each other, a third coil in one of said instruments, and means for establishing currents therein, substantially as described.

3. The combination, substantially as hereinbefore set forth, of two cores, opposing coils upon each of said cores, two main lines, each including one of the coils upon each core, conductors uniting said main lines with the earth or with each other, a third coil upon one of said cores, and means for establishing currents therein, substantially as described.

4. The combination, substantially as hereinbefore set forth, of two pairs of coils, two main lines, each including one of the coils of each pair, substantially as described, two inductoriums having primary and secondary coils, the secondary coils being respectively included in said main lines, conductors uniting said main lines with a common return-conductor or the earth, and signaling-instruments included in the first-named conductors.

5. The combination, substantially as hereinbefore set forth, of two pairs of opposing coils, two main lines, each including one of the coils of each pair, substantially as described, two differentially-wound inductoriums, the opposing coils of each of which are respectively included in said main lines, a transmitter for establishing impulses in the

primary coils, conductors uniting said main lines with a common return-conductor or the earth, and signaling-instruments included in the first-named conductors.

6. The combination, substantially as hereinbefore set forth, with two main lines, of a magnetizable core at one station, opposing coils upon said core and respectively included in said main lines, a third coil upon said core, a circuit including said third coil, means for establishing a variable current in said third coil and thereby varying the magnetization of said core, a conductor uniting both said main lines with the earth, a second core located at a distant station, opposing coils upon said core respectively included in the main lines, and a conductor uniting both of said lines with the earth or return-conductor at the distant station.

7. The combination, substantially as hereinbefore set forth, of a transmitting-instrument, a soft-iron core, a coil upon said core, connected in circuit with said transmitting-instrument, two coils wound in opposite directions, also mounted upon said core, two main lines respectively including the last-named coils, a conductor connecting the two lines with the earth, and a receiving-instrument responding to currents simultaneously transmitted in opposite directions upon said lines but silent to currents in the same direction.

8. The combination of two main lines, a transmitting device consisting of a differentially-wound inductorium for sending currents of opposite character upon said lines, a receiving-instrument included in said main lines and responding only to currents transmitted in opposite directions upon said main lines, and conductors leading from said main lines at points respectively beyond said transmitting-instrument and said receiving-instrument and connecting with apparatus designed to be operated by currents transmitted in the same direction through said main lines.

9. The combination of two main lines, a transmitting device consisting of a differentially-wound inductorium for sending currents of opposite character upon said lines, a receiving-instrument responding only to currents of opposite character upon said lines, a transmitting device for sending currents of the same character upon said lines, and a receiving-instrument responding only to currents of the same character upon said lines.

10. The combination, substantially as hereinbefore set forth, of two or more pairs of main lines, electrical instruments included in said main lines for sending and responding to opposing currents upon each pair of main lines, conductors uniting the respective pairs of main lines with each other, and an instrument having opposing coils respectively included in the last-named conductors, substantially as described.

11. The combination, in a telephonic instrument, of two opposing coils respectively included in different main lines, a transmitter, and a circuit therefor extending into inductive proximity to said opposing coils and acting inductively upon the same when traversed by currents.

12. In a telephonic system, opposing coils, a core carrying the same, a transmitter, a circuit for the same, and coils included in said circuit and mounted upon said core.

13. The combination of two main lines, coils included in said main lines respectively, a transmitting device, a circuit for the same, and coils included in said circuit and located in inductive proximity to the first-named coils, whereby opposing currents are established in the two lines through the instrumentality of the first-named coils by variations in the current caused by the transmitter.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

A. M. ROSEBRUGH.
T. R. ROSEBRUGH.

Witnesses:
ELLEN ROSEBRUGH,
NELLE ROSEBRUGH.