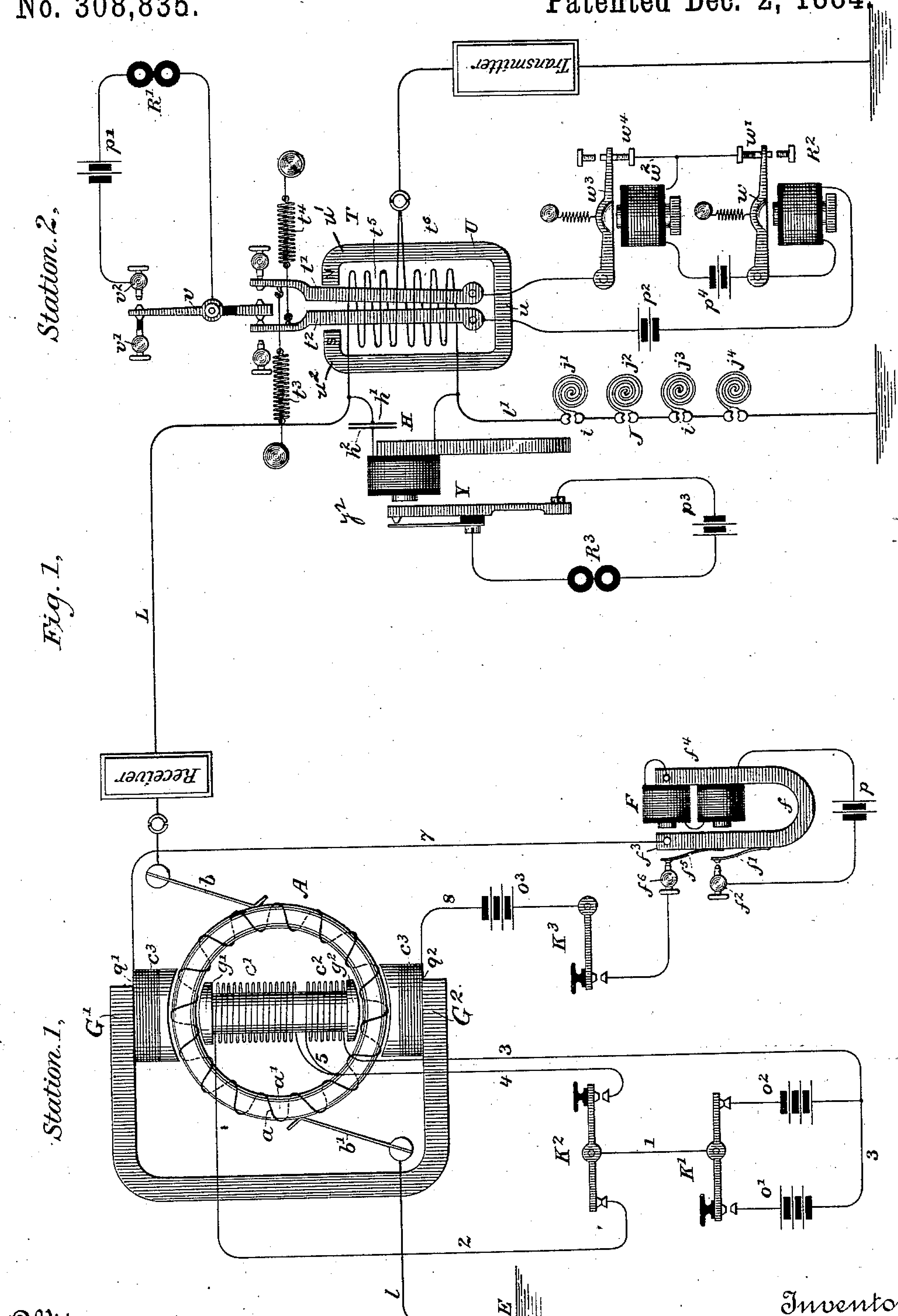
(No Model.) 2 Sheets—Sheet 1.

S. D. FIELD.

DYNAMO MULTIPLEX TELEGRAPHY.

No. 308,835. Patented Dec. 2, 1884.



Witnesses
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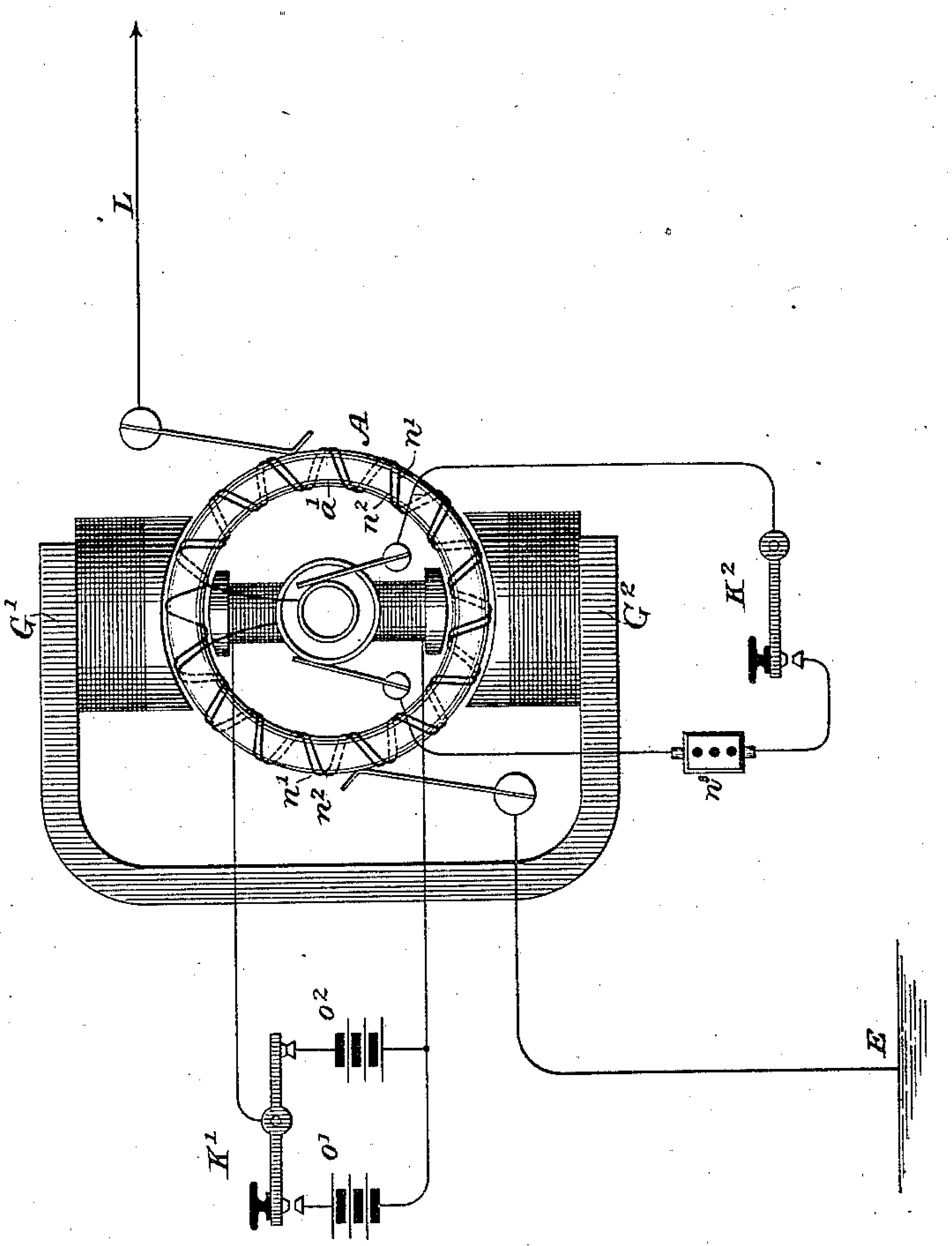

Fig. 2.

Witnesses

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UNITED STATES PATENT OFFICE.

STEPHEN DUDLEY FIELD, OF NEW YORK, N. Y.

DYNAMO MULTIPLEX TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 308,835, dated December 2, 1884.

Application filed May 20, 1884. (No model.)

To all whom it may concern:

Be it known that I, STEPHEN D. FIELD, a citizen of the United States, residing in New York, in the county and State of New York, have invented certain new and useful Improvements in Dynamo Multiple Telegraphs, of which the following is a specification.

My invention relates to the construction and organization of apparatus employed for transmitting several communications telegraphically over a single conductor simultaneously.

It has been customary in organizing apparatus for multiple telegraphy to provide at each station transmitting-keys for sending to the main line currents having different characteristics, the character of each current being dependent upon the particular key or combination of keys which may at any time be employed. Receiving-instruments adapted to respond to the currents coming from the distant stations have been included in the main line in such manner that each current having traversed any or all of the instruments reached the earth by way of the transmitting-keys and the battery-connections. For the purpose of insuring the successful operation of the receiving-instruments in response to their respective classes of currents, it is essential that the comparative resistances of the different branch circuits, which the incoming currents are compelled at different times to traverse, shall be accurately adjusted or equated, and that the balance of the line be at all times correctly maintained. Owing to the several facts that, in the usual form of apparatus the path by which an incoming current reaches the earth changes in accordance with the relative positions of the respective keys at the receiving-station, that more or less battery-power, and consequent resistance, is included in the earth-circuit, according to these positions, and that the contact-points of the keys forming a portion of the earth-circuit at any given moment offer more or less resistance accordingly as they chance to form poor or good electrical connections, it is found exceedingly difficult to maintain the balance of the line with sufficient accuracy to render such system entirely successful.

In Letters Patent No. 288,786, issued to me November 20, 1883, I have described an invention whereby means are provided for sending to the line currents or impulses of any required character without varying the resistance offered to the incoming currents—that is to say, those currents which are designed to actuate the receiving-instruments at the home-station. This end is accomplished by placing an armature adapted to be rotated at any required velocity within the field of force of one or more solenoids electrically independent thereof, but capable of being traversed by currents of electricity of determinate strength and polarity, thereby creating a field of magnetic force within or through which the armature moves. Corresponding currents are thereby generated in the coils of the armature, and the currents thus generated are transmitted to the main line. Suitable methods are also described of organizing the transmitting and receiving apparatus for the purpose of multiple telegraphy.

My present invention relates, particularly, to certain improvements in the organization of the class of apparatus described in the patent referred to; and the object of the invention is to provide more efficient means for generating and transmitting the currents having the different characteristics required, and for organizing the receiving-instruments designed to respond to the currents having these different characteristics.

In the accompanying drawings, Figure 1 is a diagram illustrating my invention in an organization of apparatus designed to be employed in sextuplex telegraphy. Fig. 2 illustrates a modified form of transmitter.

Referring to Fig. 1, L represents the main line uniting two telegraphic stations, which, for convenience, will be hereinafter termed "station I" and "station II."

At station I there are represented three independent keys or transmitting devices, one of which, K′, is adapted to send currents of determinate strength and polarity, while the second, K^2, is designed to transmit currents of decreased strength and of either polarity, and the third, K^3, is designed to transmit rhythmic pulsations.

At station II, I have shown three receiving-instruments, R′ R^2 R^3, adapted to respond, respectively, to currents of a given strength and polarity, currents of decreased strength without reference to their polarity, and rhythmic pulsations.

Considering, first, the transmitting apparatus, A represents an armature having the same general characteristics as the armatures commonly employed in dynamo-electric generators. In this instance an armature of the type known as the "Gramme ring" is indicated in diagram, consisting of coils of insulated wire *a* wound upon a soft-iron ring, *a'*, in a manner well understood. This armature is designed to be rotated by means of any suitable motor-power. Two commutator-brushes or systems of brushes, *b* and *b'*, are so arranged with reference to the circuit-connections of the coils that currents of one polarity generated within the coils of the armature will be received upon the brush *b* and transmitted to the line L, with which it is connected, while currents of the opposite polarity will be received upon the brush *b'*, and will reach the earth at E through the conductor 1. Contrary, however, to the method adopted in dynamo-electric machines, no portion of the current generated in the coils of the armature is employed for intensifying the field of magnetic force; but the latter is established by two electro-magnets. Variations in the strength of these magnets are produced by means of currents transmitted from three local batteries, o' o^2 o^3, through coils of wire c' c^2 c^3. The coils c' and c^2 surround a soft-iron core, g' g^2, which is placed within the interior of the armature A, or in such position with reference thereto that changes in its magnetic intensity will occasion changes in the field of force of the armature. The coils c^3 are preferably applied to the respective extremities of a second core, G' G^2, or to soft-iron extensions of the same, as indicated at q' and q^2. The battery o', which is applied to the key K', is so disposed that one pole—say its positive pole—will be connected, when the key is actuated, through the key-lever, conductor 1, the resting contact-point of the key K^2, and a conductor, 2, to the coil of insulated wire c', thence through the coil c^2, and a conductor, 3, to the negative pole of the battery. When, therefore, the key K' is closed, a positive current of a given strength will be transmitted through the coils c' and c^2, and a current will be generated in the armature having a strength dependent upon the number of convolutions contained in these coils, the two coils being wound in the same direction. This current we will, for convenience, consider as a positive current transmitted to line.

Applied to the back contact-stop or resting-stop of the key K' is a second battery, o^2, having the same electro-motive force as the battery o', but so disposed that its negative pole will be connected with the key-lever of the key K' when that key is at rest. The negative pole, therefore, of the battery o^2 will so long as the key K' is at rest be connected with the lever of the key K^2, and, although the circuit of this battery is completed in the same manner as described with reference to the battery o', so long as the key K^2 is at rest, yet the current generated in the armature A will be of the opposite polarity from that described with reference to the battery o', and it will not therefore be of the proper polarity to actuate the particular receiving-instrument which is designed to respond to the key K', as will hereinafter appear. The front contact-point of the key K^2 is connected, through a conductor, 4, with the conductor 5, leading from the coil c' to the coil c^2. The remaining terminal of this coil is connected, through the conductor 3, not only with the battery o', but also with the positive pole of the battery o^2, by means of the conductor 6. It will be seen therefore that when the key K^2 is depressed, the key K' being at rest, a negative current from the battery o^2 will be transmitted through the coil c^2, and there will therefore be generated a current of the opposite polarity from that caused to be generated by the action of the key K'—that is to say, negative. This current will, however, be of less strength than that which is caused to be generated by the action of the key K', for the reason that the number of convolutions traversed by the current is reduced. Should, however, both keys K' and K^2 be simultaneously depressed, then the battery o' will be substituted for the battery o^2, and a current of the same strength as that last considered, but of opposite polarity—that is to say, positive—will be generated in the coils of the armature A. It will be understood, therefore, that by the action of the key K' positive currents are caused to be transmitted to the line, and by the action of the key K^2 currents of decreased strength, which are either negative or positive accordingly as the key K' is at rest or is in operation, will be transmitted. The third transmitting-key consists of an electro-magnet, F, the armature of which consists of a steel bar, *f*, constituting what is technically termed a "reed" or "tuning-fork." The core of the electro-magnet F is preferably in magnetic contact with one arm of the tuning-fork, and its remaining pole acts upon the other arm of the same. A local battery, *p*, has one of its poles connected with one terminal of the coils of the electro-magnet F, and the remaining terminal of this coil is connected, through the tuning-fork *f*, with a contact-spring, f'. The remaining pole of the battery *p* is connected with a contact-stop, f^2, applied to the spring f'. The parts are so adjusted that when the arm f^3 of the tuning-fork is separated from its other arm, f^4, the circuit of the local battery will be completed through the coils of the electro-magnet, which, being thus vitalized, attracts the arm f^3, thereby causing the spring f' to be separated from the point f^2. The separation of these parts interrupts the circuit, and the return vibration of the arm again completes the circuit, so that a continuous vibration of the tuning-fork will be maintained in a manner well understood.

Upon the arm f^3 of the tuning-fork is carried a reed or spring, f^5, which is applied to the contact-point f^6. The spring f^5 is in electrical connection with a conductor, 7, leading to one terminal of the coil c^3, the remaining terminal of which coils are connected through a conductor, 8, with one pole of the battery o^3. The remaining pole of this battery is connected, through the transmitting-key K^3, with the contact-point f^6. The movements of the arm f', occasioned by the action of the local battery p, cause the connections between the spring f^5 and the point f^6 to be made and broken at each vibration of the tuning-fork. If, therefore, the key K^3 be closed, the circuit of the battery o^3 will be made and interrupted, through the coils c^3, with a rapidity depending upon the organization of the tuning-fork and its contact-springs. The coils c^3, as already stated, are preferably carried upon extensions of the core G' G^2, and they are placed in the axial line of the core g' g^2. They are preferably so wound that magnetism which is induced by the action of the battery o^3 at the respective ends of the core G' G^2 is similar to that which is generated in the confronting poles of the core g' g^2 by the action of the battery o^2 when the key K' is at rest. This construction is not, however, essential, as the connections of these coils may be reversed.

It will be obvious that the currents caused to be generated in the coils of the armature A by the action of the rhythmic pulsations occasioned by the key K^3 will themselves be rhythmic or pulsatory, and these currents will be sent to line in the same manner as the currents occasioned by the operation of the keys K' and K^2. It is evident, moreover, that these pulsations or variations in strength of current may be superposed upon the pulsations or currents caused by the action of the keys K' and K^2; or, in other words, the operation of the battery o^3 is to momentarily increase or decrease the field of force of the armature, and whether or not that field of force be increased by the action of the battery o' or o^2 at the same time is immaterial so far as the production of undulations in the current sent to line is concerned. Whatever current, therefore, is being transmitted to line the undulations in the same will be present whenever the key K^3 is operated. These undulations are employed for actuating a third receiving-instrument in a manner which will be hereinafter described.

Considering, now, the receiving-instruments and their operation, R' R^2 R^3 represent three instruments, which are adapted to respond, respectively, to the currents occasioned by the depression of the keys K', K^2, and K^3, whether those keys be depressed one at a time or two or more simultaneously. The instrument R' is included in the circuit of a local battery, p', and this circuit is designed to be completed by the action of the currents produced through the agency of the key K'. To accomplish this result, I employ an instrument, T, consisting of two pivoted core-sections, t' and t^2, which are preferably semi-cylindrical in form, their flat surfaces being presented to each other. Surrounding these core-sections are two coils, t^5 and t^6, which are differentially wound, the one coil being included in the circuit of the main line, while the remaining coil is connected with the artificial line l' in a manner hereinbefore described. Currents from the main line traverse only the core of the coil t^5, reaching the earth through the contact-brushes and coils of the armature of the transmitter located at station II, whereas outgoing currents from the transmitter at station II traverse both coils, but in opposite directions, so that no effect is produced thereby upon the cores; or, in other words, the effect produced by the one is neutralized by that of the other. These core-sections are normally drawn toward each other by means of two springs, t^3 and t^4, respectively applied thereto. A permanent magnet, U, is so applied to the instrument that its respective poles extend into proximity to the core-sections t' and t^2. The tendency of this magnet is to separate the core-sections from each other. The tension of the springs t^3 and t^4, however, is sufficient to hold the sections together when they are not magnetized. Normally there is a current upon the line due to the battery o^2. This current is sufficient in strength and is of the proper polarity to so magnetize the core-sections that they tend to move toward the pole u' of the magnet U, and the attraction is sufficient to overcome the tension of the spring t^3. Likewise when the key K' alone is depressed and the battery o' is connected with the coils c' and c^2 the sections will be impelled in the opposite direction and the tension of the spring t^4 will be overcome.

Between the extremities of the core-sections t' and t^2 extends a pivoted arm, v. To the remaining extremity of this arm is applied a resting-stop, v', and a contact-stop, v^2. The arm v and the contact-stop v^2 constitute the electrodes, or the terminals of the circuit of the battery p', so that when the arm is in contact with its stop v' the circuit of the battery p^3 will be completed through the receiving-instrument R'. The arm v is normally held away from the contact-stop v' by the action of the core-section t^2. If, however, the core-section t' be made to press against the arm v, the latter will turn it upon its axis, so that the arm will strike against the stop v^2, thereby completing the local-circuit connections. Such a movement of the arm and of the core-section is obtained by means of the key K', for when this key is depressed the current transmitted to line is of the character and strength required to repel the section t' from the adjacent pole u' of the permanent magnet and attract it toward the pole u^2. The section t^2 is also actuated as already described. The instrument R' therefore responds to the movement of the key K'.

The receiving-instrument R^2, which is designed to respond to the currents occasioned by the action of the key K^2, is included in the circuit of the battery p^2, the respective poles of which are connected with the core-sections t' and t^2. When either of these two sections is out of contact with the arm v, the circuit of the battery p^2 is interrupted; but when both sections are allowed to come in contact with the arm v' then the circuit of the battery p^2 will be completed, and the instrument R^2 will respond. Such a movement of the core-sections is occasioned through the influence of a current from either battery o' or o^2 traversing the coil c^2 only, for the reason that the current which will then be generated and sent to line is of sufficient strength to cause either core-section to overcome the tension of its retractile spring. When the current is from the battery o^2, then the core-sections will both be in contact with the arm v, and at the same time they move the arm away from the stop v', for the reason that the current is of the polarity tending to impel the sections toward the pole u'. The instrument R^2 will therefore alone be attracted. When, however, both keys K' and K^2 are depressed, the current will be from the battery o' and the core-sections will move slightly in the opposite direction, thus actuating the arm v without separating from it, and thus not alone will the circuit of the battery p^2 be completed, but the arm v will be placed in contact with the stop v', thus completing the circuit of the battery p' and causing both instruments R' and R^2 to respond.

For the purpose of preventing a jarring or chattering contact in the circuit of the battery p^2, I prefer to employ the following device for insuring a complete interruption of the circuit when the current occasioned by the operation of the key K^2 has ceased. The armature w of the receiving-instrument R^2 is provided with a back contact-stop, w', through which the circuit of a subsidiary local battery, p^4, is completed when the armature is away from its electro-magnet. The circuit of this battery p^4 includes an electro-magnet, w^2, provided with an armature, w^3. The armature w^3 rests against its front contact-stop, w^4, so long as the electro-magnet w^2 is vitalized. This armature and contact-stop are included in the circuit of the battery p^2, and it is only when the armature-lever w^3 is in contact with its stop w^4 that the circuit of this battery can be completed by the action of the core-sections t' and t^2. The circuit of the battery p^4, however, remains completed while the instrument is at rest through the electro-magnet w^2, by reason of the armature w resting against the back stop, w'. When, however, the circuit of the battery p^2 is first caused to be completed by the action of the core-sections t' and t^2, the armature w is drawn forward and, although the normal circuit of the battery p^4 is thus interrupted, the electro-magnet w^2 remains vitalized, by reason of the current flowing from the two batteries p^2 and p^4 through the coils of the electro-magnet w^2, the stop w^4, the armature w, and the core-sections t' and t^2, the two batteries being connected in series. When, however, either core-section t' or t^2 is caused to separate from the arm v by reason of the operation of the key K^2, then will the last-named circuit, through the electro-magnet w^2, be also interrupted, and its armature-lever w^3 will fall away from the stop w^4, thus making a second interruption in the circuit, so that even though the core-section t' or t^2 should chance to jar against the arm v, yet the instrument R^2 will not be affected. The armature-lever w, however, immediately falls against its back contact-stop and again completes the circuit of the battery p^4 and causes the armature w^3 to resume its former position. In this manner I am enabled to obtain a certain interruption of the circuit-connections of the instrument R^2 at each operation of the key K^2, the duration of which interruption is sufficient to permit any line disturbances which might tend to produce a jarring contact at v to disappear.

The receiving-instrument R^3 is designed to be connected with the artificial line l in the following manner: A condenser, H, has one of its plates, h', connected with the main line, while the remaining plate, h^2, is connected through the coils of the receiving-magnet R^3 with the artificial line l'. Each current or impulse therefore which traverses the main line through the receiving-instrument causes a corresponding charge or change in potential of the condenser-plates. Such changes cause current movements through the coils of the electro-magnet of the receiving-instrument R^3. Applied to this electro-magnet is a reed-armature, Y, tuned to the same pitch as the transmitting-reed applied to the key K^3, and capable, therefore, of responding only to the electrical vibrations or undulations having the same frequency or fundamental pitch as those occasioned by the transmitter. A local battery, p^3, includes in its circuit a suitable receiving-instrument, R^3, which is actuated whenever the reed makes a vibrating contact with the contact-point y^2, carried upon the armature.

For the purpose of more readily balancing the inductive capacity of the main line I employ in the artificial line an inductive rheostat, J. This rheostat consists of a continuous strip of tin-foil or other suitable conducting material, which is arranged in successive coils j' j^2 j^3 j^4, the folds of each coil being parallel with each other, so that a current traversing the one coil returns in the opposite direction through the other coil in proximity to the first-named coil. It is obvious that an inductive action must take place between the parallel insulated folds of the conductors j in each coil, which will correspond in its nature to that which takes place between the main line and the earth or the surrounding conductors, and the effects produced will balance or neutralize each other in the opposing or differential coils of the receiving-instruments T. It is desirable, however, to so arrange the parts that a greater or less length of the artificial or compensating rheostat J may be included in the circuit of the artificial line *l*. For this purpose I prefer to connect the terminals of each coil *j* with switch-plates *i*, which may be coupled together by means of suitable switch-plugs, so as to practically cut them out of circuit, thereby varying the length of the artificial line and its electro-static capacity.

In a patent issued to me May 24, 1881, No. 242,092, there is shown and described an equating-rheostat, constructed of two parallel conductors composed of metals of different conductivities.

In referring to the armature A, I have spoken of it as constructed with a soft-iron ring as its core. I do not wish, however, to confine myself to this construction, for the inductive wire wound upon the armature-core may be alone employed, a core of wood or other non-magnetic material being substituted for the soft-iron core. In some instances it may be found desirable to employ a very thin layer of soft iron.

In Fig. 2 I have illustrated a modification in the method of constructing the transmitting apparatus for the purpose of obtaining currents of two different strengths. This consists in establishing or breaking a shunt-circuit of one layer of insulated wire, n^2, coiled around the soft-iron ring of the armature, together with the coil n', which corresponds to the coil *a* in Fig. 1. So long as this shunt-circuit is broken it has no effect on the currents induced in the other circuit coiled on the ring. When, however, this extra circuit is closed by the action of the key K^2, it will delay the displacement of the magnetic polarity of the armature, and thus materially diminish its inductive action upon the line-circuit. Variations in the efficiency of this shunt may be obtained by introducing more or less adjustable resistance n^3 into the circuit of the key K^2. The application of this modification to the invention will be obvious without further explanation.

I claim as my invention—

1. The combination, substantially as hereinbefore set forth, with an electric generator and three keys, which are respectively adapted to reverse the polarity of the current being generated, to decrease its strength, and to cause rhythmical undulations in the same, of a receiving circuit-controlling electro-magnet having two independently-movable core-sections, a circuit-closing lever applied to said sections, and actuated thereby in one direction by currents of one polarity, and in the opposite direction by currents of the opposite polarity, an electric conductor leading from one to the other of said core-sections, the connections of which conductor are completed by the contact of both of said core-sections with said lever, and a receiving-instrument responding to rhythmical undulations.

2. The combination, substantially as hereinbefore set forth, with an electric generator, and three circuit-controlling keys, the one of which serves to reverse the polarity of the current being generated by said generator, the second to decrease its strength, and the third to cause rhythmical undulations in the same, of two receiving-instruments, one responding to the movements of the first and second of said keys, and the other to the movements of the third key, whether singly or in combination.

3. The combination, substantially as hereinbefore set forth, with the inductive coil of wire in an electric generator, of a normal field of force for the same, three circuit-controlling keys, which, when actuated, respectively reverse the polarity of said field, decrease its strength, and render it rhythmically varying, and two receiving-instruments responding to the movements of said keys.

4. The combination, substantially as hereinbefore set forth, with the armature-coils of an electric generator, of three coils for establishing a field of force for the same, two batteries of opposite polarity, a key for connecting one or the other of said batteries with two of said field-of-force coils in series, a second key for cutting out one of said field-of-force coils, a third key, and means, substantially such as described, connected therewith for establishing rhythmic electric pulsations in the remaining field-of-force coil, and a main line connected with said armature-coils.

5. The combination, substantially as hereinbefore set forth, with an electric generator, of two coils for establishing the field of force for the same, which coils are connected in series, a key for interrupting the connections of one of said coils, two batteries of opposite polarity, and a second key for connecting one or the other of said batteries with the first-named key.

6. The combination, substantially as hereinbefore set forth, with the armature-coils of an electric generator, of a soft-iron field-magnet bar or core around which said armature-coils revolve, magnetizing-coils surrounding said bar or core, means, substantially such as described, for establishing in the last-named coils an electric current in one direction or in the opposite direction, and means, substantially such as described, for varying the length of the coils through which the current is thus transmitted.

7. The combination, substantially as hereinbefore set forth, with the armature-coils of an electric generator, of a soft-iron bar around which said coils revolve, two magnetizing-coils surrounding said bar, means, substantially such as described, for polarizing said bar in one direction or in the opposite direction at will, means, substantially such as described, for varying the degree of polarization thus established, a core applied to the exterior of said armature-coils, magnetizing-coils surrounding the same, and means, substantially such as described, for producing in the last-named coils electrical pulsations.

8. The combination, substantially as here-

inbefore set forth, with a main line and a device for transmitting electric currents of different characteristics over said main line, of two independently-movable core-sections, a coil surrounding said sections and included in the circuit of said main line, contact-points for placing said levers in electric connection with each other, means, substantially such as described, normally tending to place said levers in contact with said points, which levers are so adjusted that a current of a given strength will withdraw one or the other of the same from its contact-point, a battery the opposite poles of which are connected with said core-sections respectively, and a receiving-instrument included in the circuit of said battery.

9. The combination, substantially as hereinbefore set forth, with a main line and means, substantially such as described, for transmitting upon said main line currents having different characteristics, of two insulated independently-movable core-sections, a magnetizing-coil surrounding said sections and connected with said main line, a contact-lever for said sections, a receiving-instrument the circuit-connections of which are completed when said core-sections rest in contact with said contact-lever, means, substantially such as described, for causing one or the other of said sections to separate from said lever under the influence of a current having a given characteristic, a contact-point applied to said contact-lever, against which said lever is caused to rest under the influence of a current having a second characteristic, and a second receiving-instrument, which is actuated when said contact-lever is in contact with said stop.

10. The combination, substantially as hereinbefore set forth, with a main line and means, substantially such as described, for transmitting electric currents having different characteristics, of two insulated core-sections, a pivoted lever, tension-springs tending to hold said core-sections against said lever, which springs are so adjusted that under the influence of a current normally traversing the main line one core-section alone rests in contact with said lever, and two receiving-instruments respectively included in local circuits, the connections of which are controlled by said core-sections and said pivoted lever, respectively.

11. The combination, substantially as hereinbefore set forth, with two local receiving-instruments, of a pivoted lever for completing the circuit-connections of one of the same, two core-sections for completing the connections of the other and for controlling said lever, and tension-springs applied to said core-sections, tending to hold the same in contact with said lever, which springs are so adjusted that a current of a given polarity will overcome the tension of one and a current of the opposite polarity and the same strength will overcome the tension of the other, while a current of less polarity will allow said springs to place both of said sections in contact with said lever, but will move said lever upon its axis in one direction or the other, according to the polarity of the current.

12. The combination, substantially as hereinbefore set forth, of a permanent magnet, two pivoted soft-iron bars extending between the poles of said magnet, two springs respectively applied to said bars and tending to draw the same toward each other and away from the poles of said permanent magnet, magnetizing-coils surrounding said bars, which coils tend to move said bars in one direction or the other, accordingly as they are traversed by a current in one direction or the opposite, a contact-lever, and means, substantially such as described, for causing said bars to rest in contact with the said lever under the influence of a current of a given strength, and to actuate said lever in one direction or the other, according to the direction of said current, and for causing one or the other of said bars to separate from said lever under the influence of a current of increased strength, but to actuate said lever in one direction or the other in the same manner as under the influence of a current of the first-named strength.

13. The combination, substantially as hereinbefore set forth, with a differentially-wound electro-magnet the core of which consists of two insulated and independently-movable sections, of a permanent magnet applied to said sections, means, substantially such as described, for causing said sections to move in one direction under the influence of an electric current traversing one coil alone of said electro-magnet in a given direction, and in the opposite direction under the influence of a current traversing said coil in the opposite direction, a pivoted lever extending between said core-sections, and means, substantially such as described, for actuating said pivoted lever in one direction or in the other, accordingly as the current traversing said coil is in one direction or the other, and for causing one or the other of said core-sections to separate from said lever under the influence of currents having a predetermined strength.

14. The combination, substantially as hereinbefore set forth, with a main line and a transmitting-instrument adapted to produce electrical undulations upon said main line, of a receiving-instrument corresponding thereto, consisting of a reed-armature and an electro-magnet applied thereto, a condenser one plate of which is connected with one terminal of the coil of said electro-magnet, while the other plate is connected with said main line, and a conductor leading from the remaining terminal of said coil to the earth.

15. The combination, substantially as hereinbefore set forth, with a main and an artificial line and a transmitting device adapted to produce rhythmic pulsations, of a receiving-instrument designed to respond to such pulsations, an electro-magnet for actuating the same, a condenser one plate of which is connected with said main line, while the re-

maining plate is connected with one terminal of the coil of said electro-magnet, and a conductor connecting the remaining terminal of said coil with said artificial line.

16. The combination, substantially as hereinbefore set forth, with a telegraphic main line and means, substantially such as described, for transmitting and receiving electric currents having different characteristics, of an artificial line having included therein a series of inductive resistances, each consisting of parallel conductors of similar metal joined together at one end to form a continuous conductor, whereby a current traversing one conductor in a given direction returns through the other in the opposite direction.

17. The combination, substantially as hereinbefore set forth, with a telegraphic main line and means, substantially such as described, for transmitting and receiving electric currents having different characteristics, of an artificial line having included therein a series of inductive resistances, each consisting of parallel strips of similar metal joined together at one end to form a continuous conductor, through the two limbs of which the currents pass in opposite directions, and means, substantially such as described, for including more or less of said inductive resistance in said artificial line.

18. The combination, substantially as hereinbefore set forth, with a telegraphic main line and means, substantially such as described, for transmitting and for receiving electric currents of different characteristics, of a local battery, an electro-magnet included in the circuit of the same, a second electro-magnet, its armature and armature-lever, a front contact-stop applied to said lever through which the connections of said battery are normally complete, a second local battery the connections of which are normally complete through the armature-lever and back contact-stop of the first-named electro-magnet, and means, substantially such as described, for vitalizing the first-named electro-magnet, thereby causing the normal connections of the second local battery to be interrupted.

19. The combination, substantially as hereinbefore set forth, with a telegraphic main line, of the generator-coil a, the field-of-force coils c' and c^2, connected in series, the batteries o' and o^2, the transmitting-key K′, for connecting one or the other of said batteries with said coils, the key K^2, for cutting out one of said coils, the receiving-instruments R′ and R^2, and means, substantially such as described, for determining whether either or both of said receiving-instruments shall be actuated and causing them to respectively respond to the currents occasioned by the action of said keys.

20. The combination, substantially as hereinbefore set forth, with a telegraphic main line and means, substantially such as described, for producing currents of different characteristics, of the core-sections t' and t^2, the differential coils t^5 and t^6, surrounding said core-sections, the permanent magnet U, having its poles presented to said core-sections, the tension-springs t^3 and t^4, applied to said core-sections, the lever v, extending between said sections, and the receiving-instruments R′ and R^2, respectively, responding to the currents having the different characteristics.

In testimony whereof I have hereunto subscribed my name this 17th day of May, A. D. 1884.

STEPHEN DUDLEY FIELD.

Witnesses:
DANL. W. EDGECOMB,
CHARLES A. TERRY.