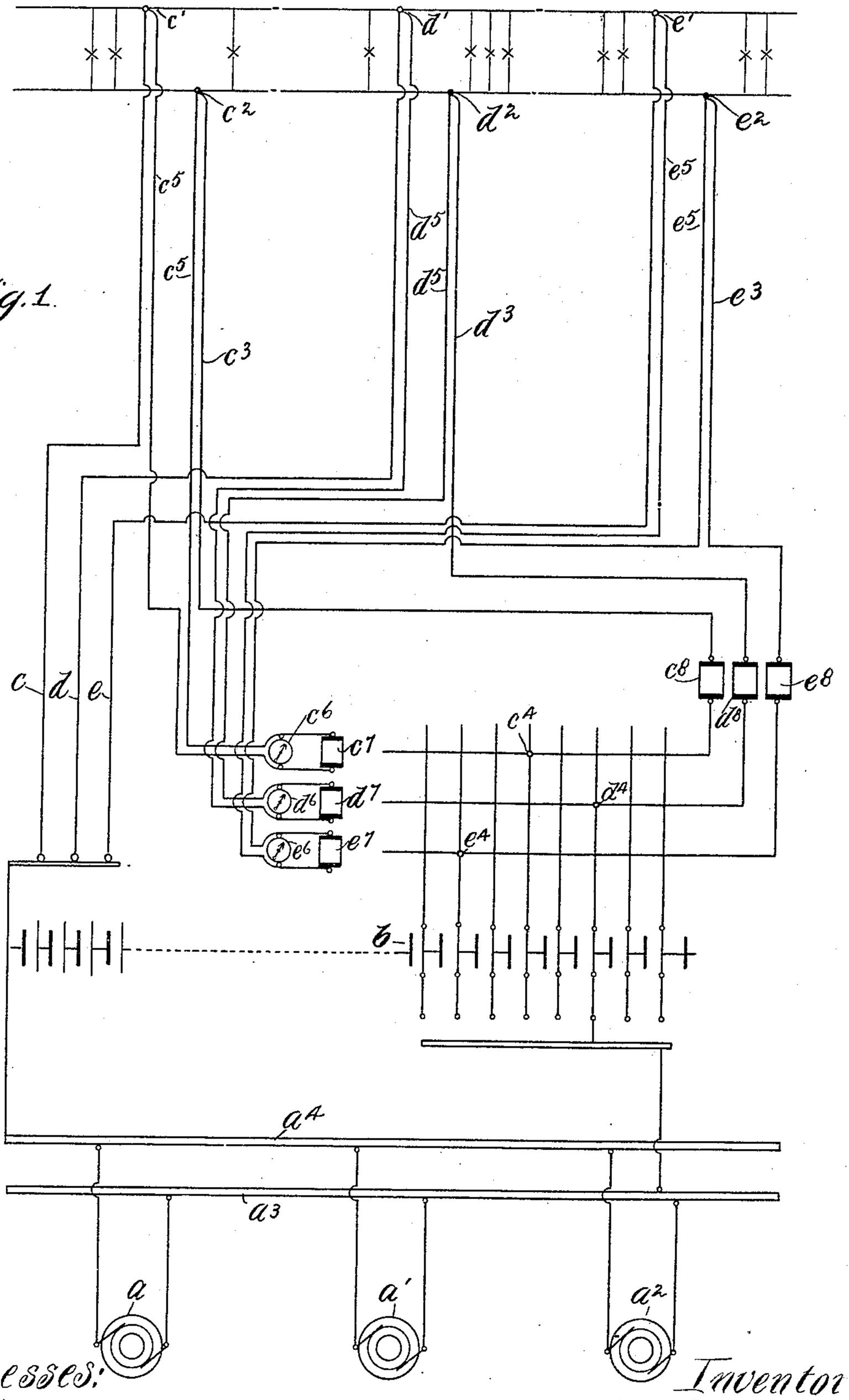
(No Model.) 2 Sheets—Sheet 1.

H. O. W. J. BREUL.

SYSTEM FOR REGULATING EFFECTIVE TENSION OF ELECTRICAL CIRCUITS.

No. 551,743. Patented Dec. 17, 1895.

Fig. 1.



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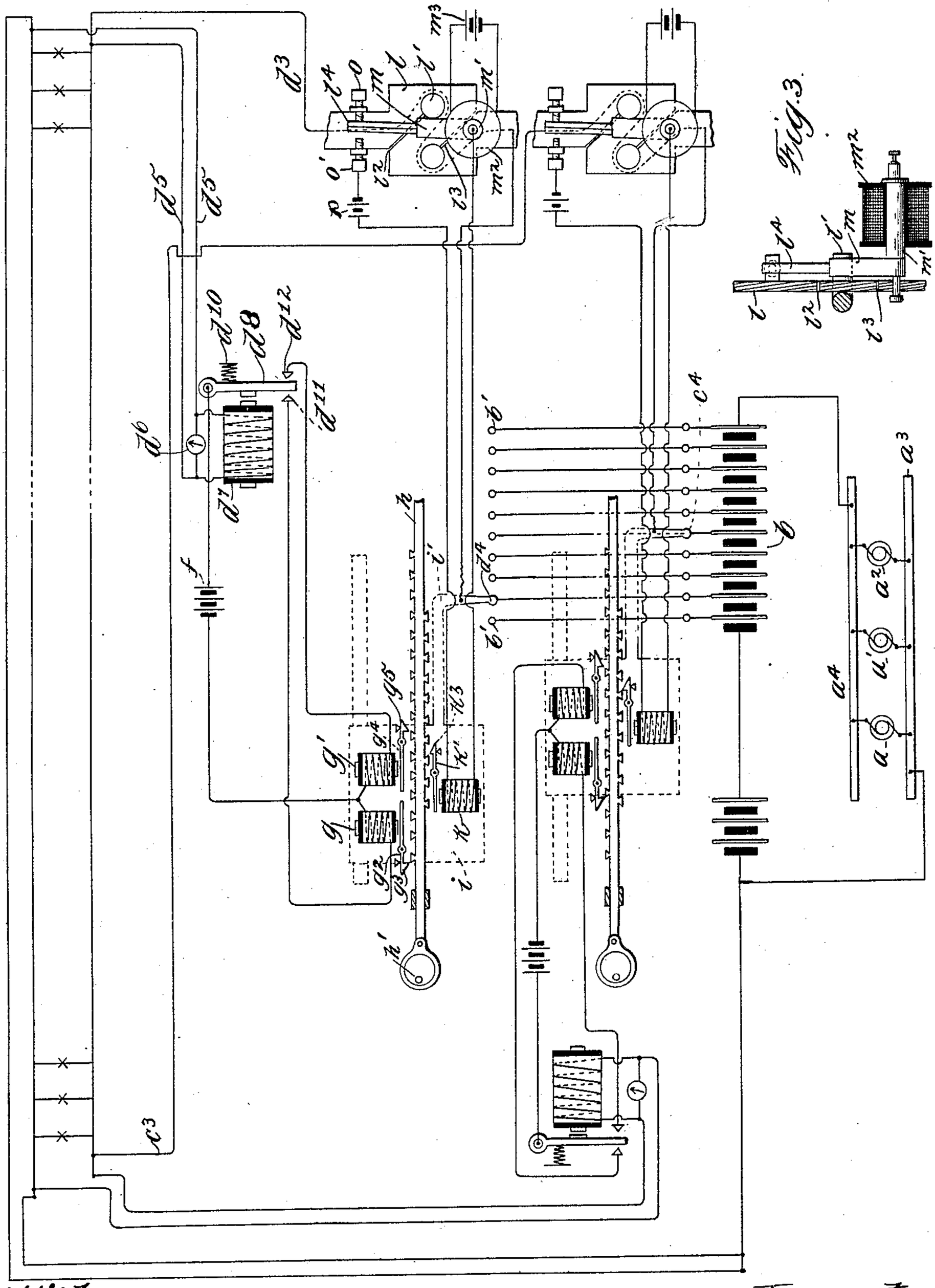

Fig. 1.

Fig. 3.

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UNITED STATES PATENT OFFICE.

HERMANN OTTO WILHELM JUSTUS BREUL, OF BERLIN, GERMANY.

SYSTEM FOR REGULATING EFFECTIVE TENSION OF ELECTRICAL CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 551,743, dated December 17, 1895.

Application filed November 17, 1893. Serial No. 491,287. (No model.) Patented in Germany July 12, 1890, No. 59,169; in Belgium December 8, 1890, No. 93,012; in France December 11, 1890, No. 210,144; in Austria-Hungary September 29, 1891, No. 45,991 and No. 78,757, and in Switzerland September 30, 1891, No. 4,151.

To all whom it may concern:

Be it known that I, HERMANN OTTO WILHELM JUSTUS BREUL, a subject of the King of Prussia, German Emperor, residing at the city of Berlin, Germany, have invented new and useful Improvements in Arrangements for the Regulation of the Effective Tension in Electrical Circuits, (for which I have obtained Letters Patent as follows: in Germany, No. 59,169, dated July 12, 1890; in France, No. 210,144, dated December 11, 1890; in Belgium, No. 93,012, dated December 8, 1890; in Switzerland, No. 4,151, dated September 30, 1891, and in Austria-Hungary, No. 45,991 and No. 78,757, dated September 29, 1891,) of which the following is a specification.

My invention relates to means for regulating the effective tension in electrical circuits, its object being to provide regulating mechanism for effectively maintaining the tension or voltage at the consumption-circuit practically constant, notwithstanding variations of resistance in the consumption-circuit.

In systems of distribution it is customary to connect the dynamos or sources of current with the consumption-circuits by means of a number of feeding conductors or circuits which extend from the source of current to a number of points upon the consumption-circuit. The feeding-conductors are calculated for a definite per cent. drop in voltage when working under normal conditions, and as the resistance of the consumption-circuit or the several sections thereof supplied by the respective feed-conductors varies some means must be provided for altering the supplied electromotive force in accordance with changes of resistance in the consumption-circuits to compensate for changes of percentage of drop through the feeding-conductors, due to the change of resistance in the consumption-circuit. It is necessary to maintain the voltage of the consumption-circuit constant, and as the resistance of the feeding-conductors does not change any increase of resistance of the consumption-circuit would cause an increase of voltage at the point of connection of the feeding-conductor with the consumption-circuit, while a decrease of resistance in the consumption-circuit would cause a decrease of voltage. It has therefore been the practice to provide at the central station, in multiple with the dynamo or source of current, a series of storage-batteries, switches being provided in connection with each of the feeding-circuits for cutting into circuit a greater or less number of batteries to increase or decrease the impressed electromotive force, and thus compensate for the increased or decreased loss of voltage through the feeding-conductors as the resistance of the consumption-circuits varies. These switches may be operated either by hand or by automatic mechanism. Potential or trial wires are run from the points of connection of the feeding-conductors with the consumption-circuits to potential-indicators at the central station, whereby the attendant may observe the potentials at the several points of connection of the feeding-conductors. Under theoretical conditions the points of connection with the consumption-circuits of all of the feeding-conductors would be maintained equal; but in practice the impressed electromotive force is varied, not continuously but by increment, the cells of the storage-batteries being usually about two volts each, so that the impressed electromotive force is always changed by increments of two volts. It may happen, therefore, that the potential at the point of connection with the consumption-circuit of one feeding-conductor may be greater than the potential at the point of connection of an adjacent conductor—not to exceed, of course, two volts—and in consequence a back current may be caused to flow through the feeding-conductor having the lower potential, thus throwing the cells of battery between the two feeding-conductors upon a short-circuit or circuit of low resistance, which may be traced through the cells over the two feeding-conductors and through the portion of the consumption-circuit between the points of connection of the feeding-conductors therewith. This has a tendency to destroy the batteries and impair the operation of the system, and it is the object of the present invention to provide means for preventing the formation of such a short-circuit. If the switch-contact of the feed-

ing-conductor having the lower potential be moved to cut into its circuit another cell, its potential will be raised sufficiently to prevent the passage of a back current, and in accordance with my invention I provide in each of the feeding-conductors a device which responds to a reversal of the current flowing therein for cutting into the circuit of said feeding-conductor an additional cell, thus raising the potential sufficiently to prevent the passage of the back current.

I will describe my invention by reference to the accompanying drawings, in which—

Figure 1 is a diagram of circuits, illustating the application of my invention. Fig. 2 is a diagram illustrating in detail the circuit arrangements. Fig. 3 is a view in elevation of the relay included in the feeding-conductors.

Like letters refer to like parts in the several figures.

As illustrated in Fig. 1, a number of dynamos a a' a^2 are connected in parallel between the bus-bars a^3 a^4, between which bars is also connected a series of storage-batteries b. Feeding-conductors c d e connect one pole of the current supply with points c' d' e' of the consumption-circuit, while points c^2 d^2 e^2 of the consumption-circuit are connected by feed-conductors c^3 d^3 e^3 with switch-contacts c^4 d^4 e^4, which are adapted to be moved into position to connect into circuit a greater or less number of cells of storage-battery b. Trial-wires c^5 c^5 extend from points c' c^2 to a potential-indicator c^6 at the central station, while trial-wires d^5 d^5 extend from the points d' d^2 to the potential-indicator d^6, and trial-wires e^5 e^5 extend from points e' e^2 to the potential-indicator e^6. The feeding-conductors are calculated for a definite drop in potential, and it is evident that if the resistance through the portion of the consumption-circuit supplied by the feeding-conductors c c^3 be decreased the potential or voltage at points c' c^2 will be decreased, and since for proper operation it is necessary that the potential at the points c' c^2 be kept constant it will be necessary to increase the impressed electromotive force to increase the voltage at the points c' c^2. This drop of potential will be indicated by the potential-indicator c^6 and the attendant will move the contact c^4 to the right to cut in a sufficient number of cells of the battery to increase the impressed electromotive force in the required degree.

Instead of operating switch-contact c^4 manually it may be operated automatically by means of mechanism represented diagrammatically by the device c^7, and which will be explained more fully hereinafter, the device c^7 operating to automatically change the position of the switch-contact c^4 to vary the electromotive force as required. Automatic devices d^7 and e^7 are provided in connection with the other circuits for likewise controlling the switch-contacts.

In the several feed-conductors c^3 d^3 e^3 are included the responsive devices c^8 d^8 e^8, which, if the system be manually operated, may be indicators adapted to indicate one direction of the current through the several conductors. If, for the reason above explained, the potential at the point d^2, for instance, be greater than the potential at the point c^2, so that a back current is caused to flow through the conductor c^3, the cells of battery between the switch-contacts c^4 and d^4 will be thrown on a circuit of low resistance which may be traced over conductor d^3 to point d^2, thence through the consumption-circuit to point c^2 and back through the conductor c^3. The reversal of the direction of current through the conductor c^3 will be indicated by the device c^8, and if manually operated the attendant would move the switch-contact c^4 one cell to the right, thus increasing the potential of the point c^4 above the point c^2 and causing the current to flow in the proper direction. Instead of taking the form of an indicator the device c^8 may be made in the form of automatic mechanism for shifting the contact-point c^4 one cell to the right.

In Fig. 2 I have illustrated more in detail the mechanism for automatically controlling the position of the switch-contact points, relay-magnet d^7, connected between the trial-wires d^5 d^5, being adapted to act upon its armature mounted upon a lever d^8 and opposed by a spring d^{10}. As the potential through the trial-wires increases, the magnet predominates over the spring and when the potential is increased to a predetermined point brings the lever d^8 into contact with the anvil d^{11}, thus closing the circuit of battery f through lever d^8, contact d^{11} and electromagnet g, while, when the potential decreases, the spring d^{10} acts to move the lever d^8 into contact with the anvil d^{12}, thus closing the circuit of the battery through the electromagnet g'. The armature of the electromagnet g is mounted upon a pivoted lever g^2, carrying upon its end a hook g^3 adapted when the magnet is energized to engage the teeth upon a bar h. The bar h is continuously reciprocated by means of an eccentric h', and each time the electromagnet g is energized and the hook g^3 brought into engagement with the teeth of the bar h the frame or carriage i (illustrated by dotted lines) upon which the magnet g and lever g^2 are mounted is moved to the left a distance equal to the stroke of the reciprocating bar h. Likewise the lever g^4 upon which the armature of magnet g' is mounted carries a hook g^5 adapted to engage the teeth upon the bar h, whereby the carriage i is moved to the right. Upon the carriage i is carried an arm i' which supports the contact-point d^4, adapted to make contact with the series of terminals b' b' connected with the cells of the battery b. The stroke of the bar h is equal to the distance between the terminals b', whereby contact d^4 is moved from terminal to terminal, either to the right or to the left, according as the electromagnet g' or electromagnet g is energized. By this arrange-

ment a decrease of the potential in the consumption-circuit below a predetermined point results in the movement of the contact d^4 upon the cell to the right to increase the impressed electromotive force, while an increase of the potential results in the movement of the contact d^4 to the left to decrease the impressed electromotive force. The apparatus, as above described, for moving the contact to the right or to the left according as the potential of the consumption-circuit varies, belongs to the prior art and in its individual capacity forms no part of the present invention.

The present invention relates more particularly to the means for introducing an additional cell of battery into the circuit of any feeding-conductor when a reversal of current takes place therethrough. For this purpose upon the carriage i is provided an electromagnet k, the armature of which is mounted upon a pivoted lever k', carrying the hook k^3 adapted to engage the teeth upon the reciprocating bar h. Upon a reversal of the current through the feeding-conductor, the electromagnet k is energized and the hook k^3 caused to engage reciprocating bar h to move the carriage i to the right and thereby cause the contact d^4 to engage the next terminal to the right to thus introduce into the circuit of the feeding-conductor through which the reversal of current takes place an additional cell to cause the current to flow in its normal direction. To accomplish the energization of electromagnet k by the reversal of the current through the feeding-conductor, I provide in the circuit of the conductor a relay, a preferred form of relay being illustrated in the drawings in Figs. 2 and 3. Upon a metallic plate l is mounted the bar l' of magnetic material bent into the form of a horseshoe and extending transversely through the plate l. Slots l^2 l^3 are provided in the plate whereby current passing through the plate from end to end is caused to partake of a circulatory path about the bar l', as indicated in dotted lines, to thus magnetize and impart polarity to the ends of the bar. Between the ends of the bar l' is provided an armature m mounted upon the rotatable core m' of an electromagnet m^2 which is connected in circuit with a battery m^3. A definite polarity is thus imparted to the armature m and is such that when the current through the feeding-conductor d^3, in which circuit the plate l is connected, is flowing in the proper direction the contact-arm l^4, carried upon the armature m, rests against the back contact o. When the current through the feeding-conductor d^3 is reversed the polarity of the ends of the bar l is reversed and the armature m is moved to bring the contact-arm l^4 into contact with the terminal o', thus closing the circuit of the battery p through the contact o' and contact-arm l^4 to the electromagnet k and back to the battery. The electromagnet k is thus energized and acts to move the contact d^4 one terminal to the right, thus including an additional cell in the circuit.

Similar apparatus is provided in connection with each of the feeding-conductors, and I have illustrated in Fig. 2 the apparatus included in the circuit of conductor c^3, the apparatus acting in the same manner to include an additional cell of battery in circuit upon the reversal of the current through the feeding-conductor.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a consumption circuit, of a number of feeding conductors connected therewith, means for increasing or decreasing the electromotive force impressed upon the several feeding conductors, and a device responsive to the reversal of current in a feeding conductor; substantially as described.

2. The combination with a consumption circuit, of a number of feeding conductors connected therewith, means for increasing or decreasing the electromotive force impressed upon the several feeding conductors, and a controlling device responsive to the reversal of current in a feeding conductor for increasing the electromotive force impressed thereon; substantially as described.

3. The combination with a consumption circuit, of a number of feeding conductors connected therewith, an accumulator battery, switches for cutting a greater or less number of cells of said battery into circuit with any particular feeding conductor, and a controlling device responsive to the reversal of current in a feeding conductor for cutting into the circuit of said feeding conductor an additional cell; substantially as described.

4. The combination with a consumption circuit, of a number of feeding conductors connected therewith, an accumulator battery, switches for cutting a greater or less number of cells of said battery into circuit with any particular feeding conductor, and controlling devices for operating said switches, one responsive to the potential in the consumption circuit and the other responsive to the reversal of current in a feeding conductor; substantially as described.

In testimony whereof I affix my signature in the presence of two witnesses.

HERMANN OTTO WILHELM JUSTUS BREUL.

Witnesses:

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JOHN B. JACKSON.