No. 688,614. Patented Dec. 10, 1901.

A. R. EVEREST.

REGULATOR.

(Application filed May 4, 1899.)

(No Model.) 3 Sheets—Sheet 1.

FIG. 1.

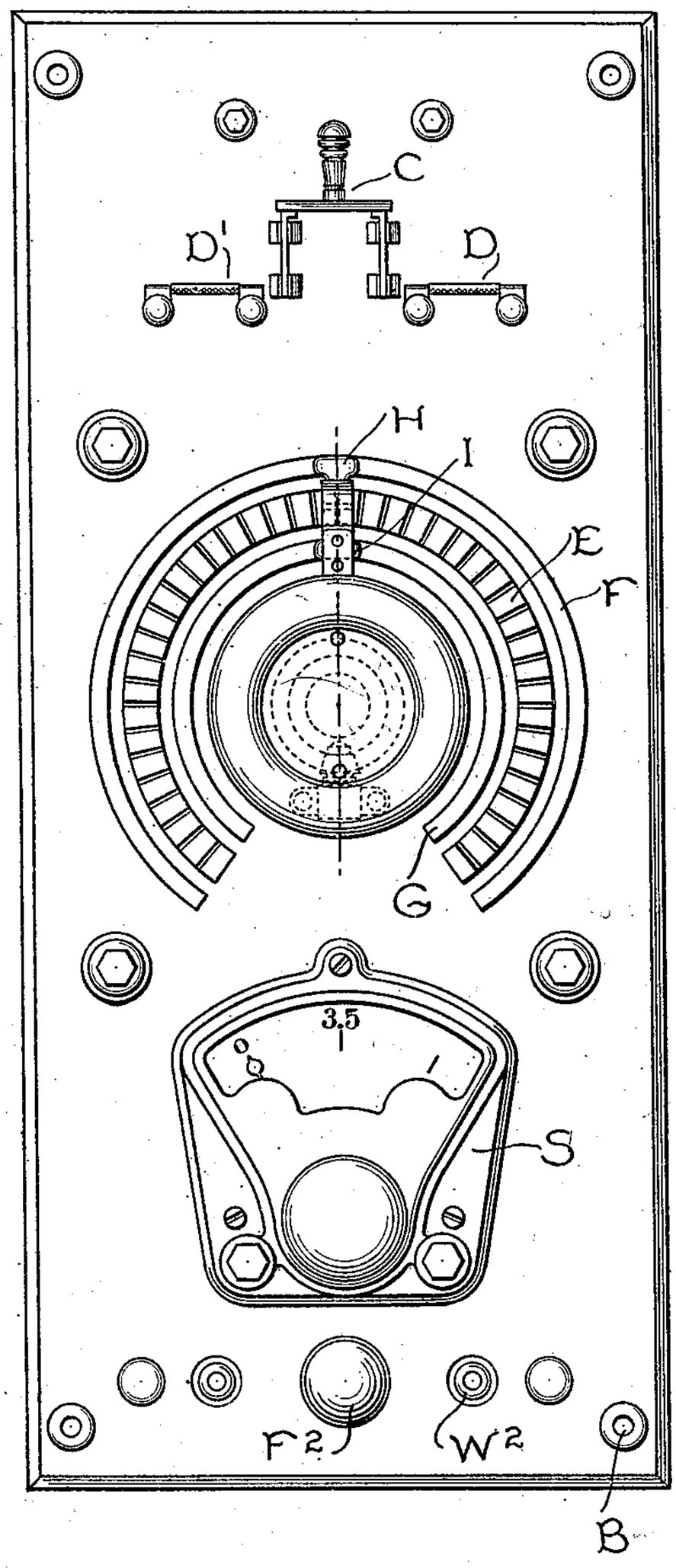
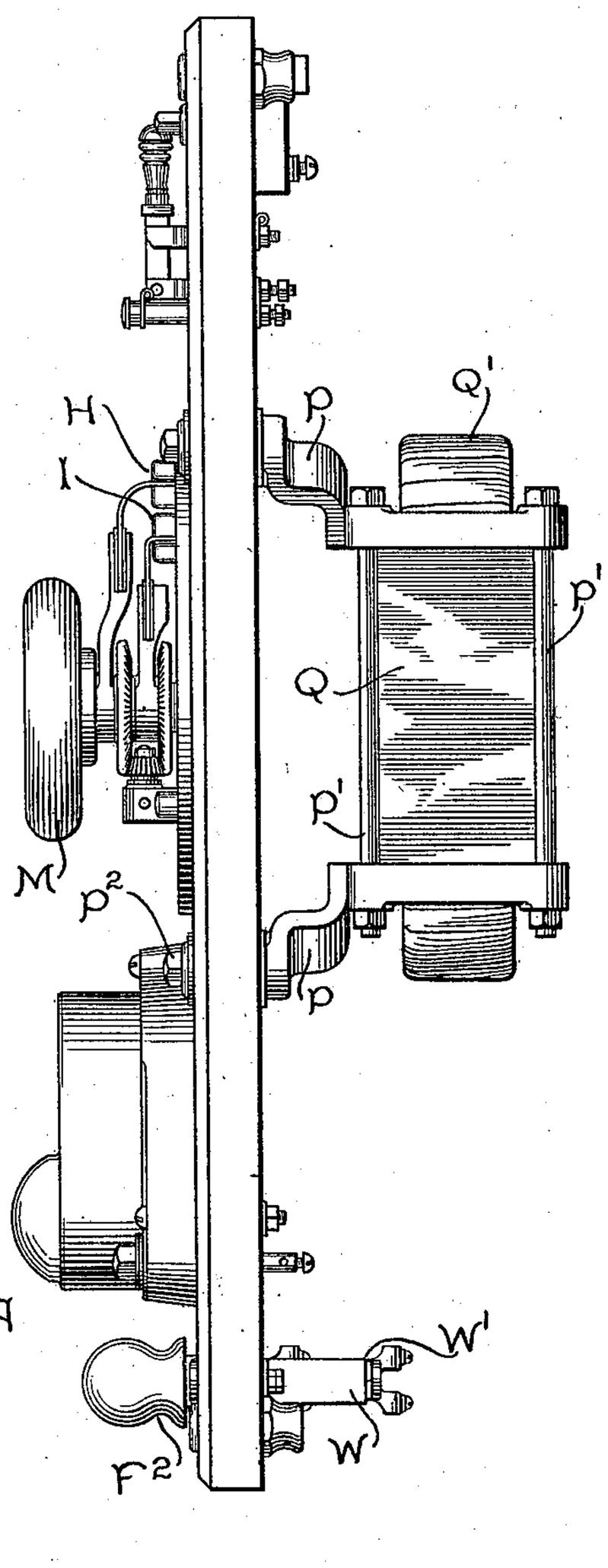


FIG. 2.



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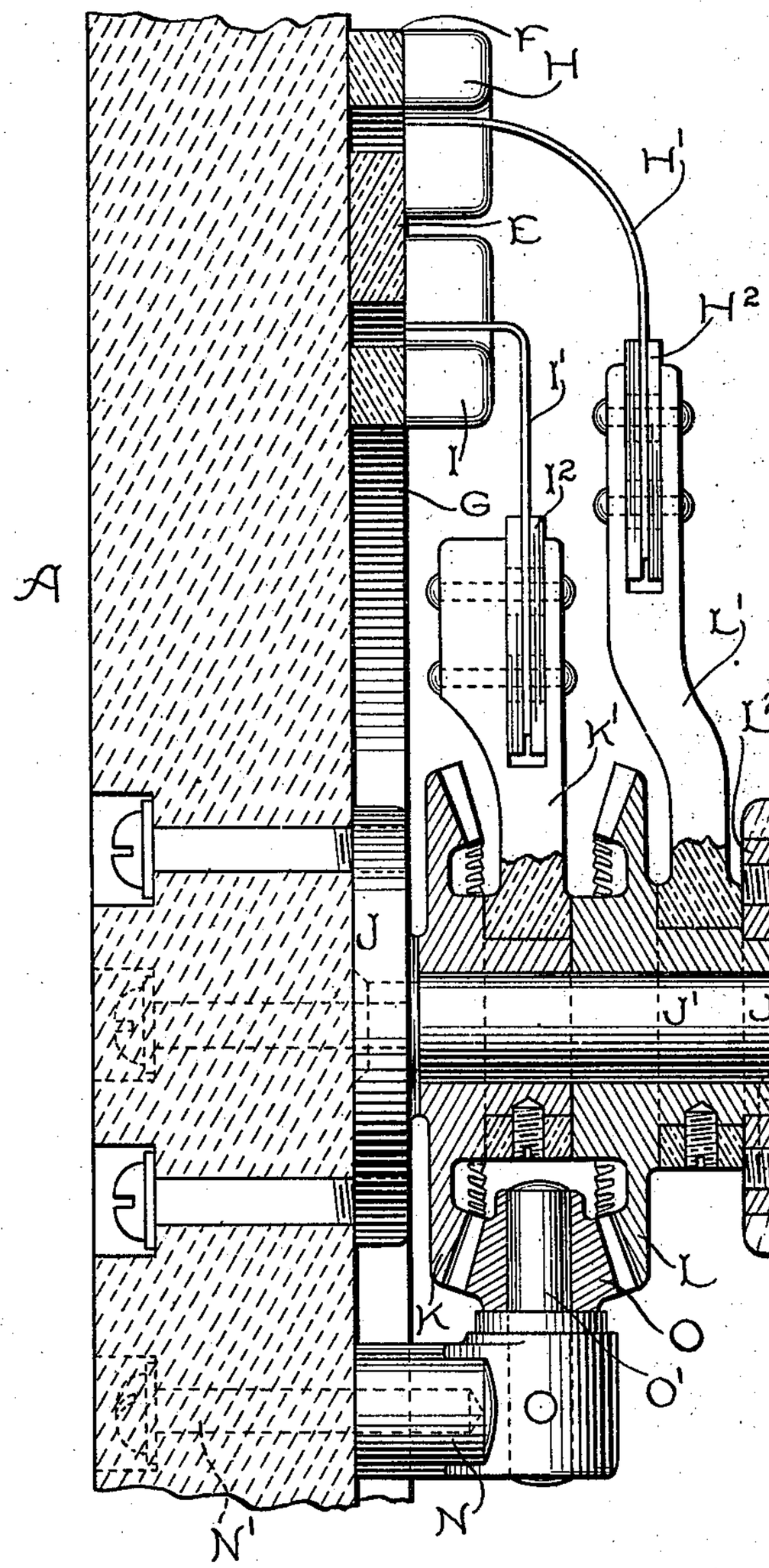

FIG. 3.

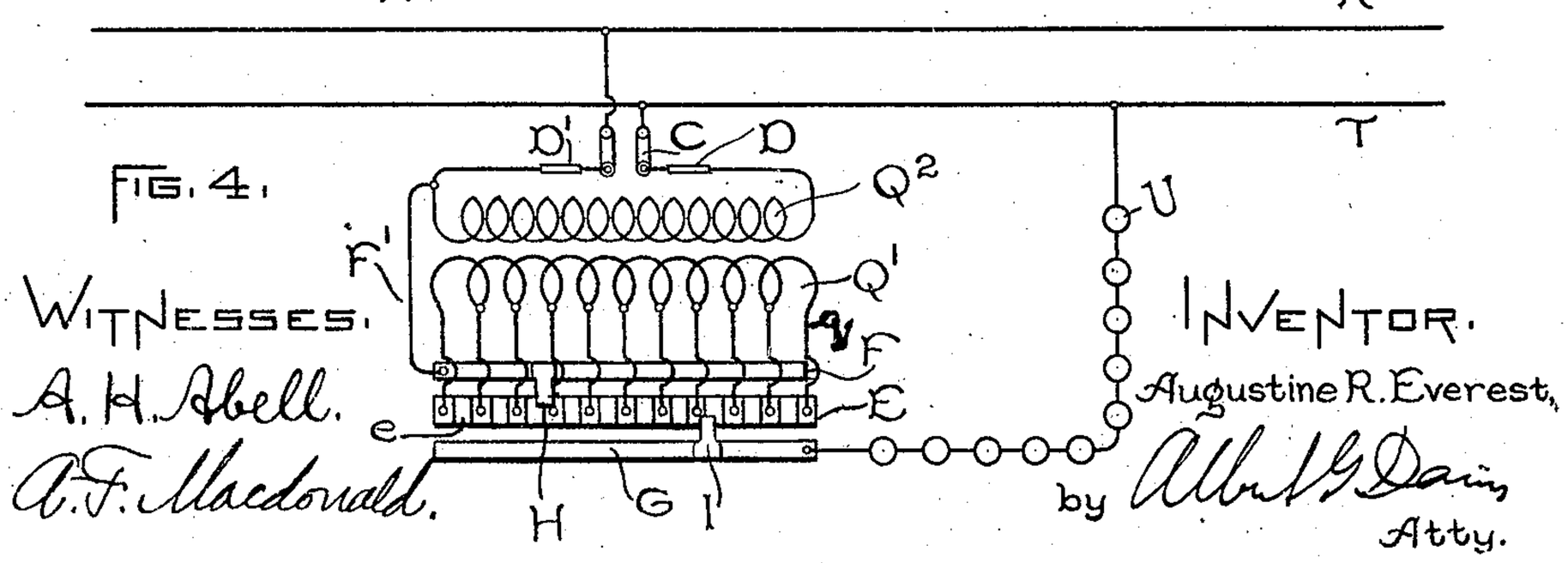

FIG. 4.

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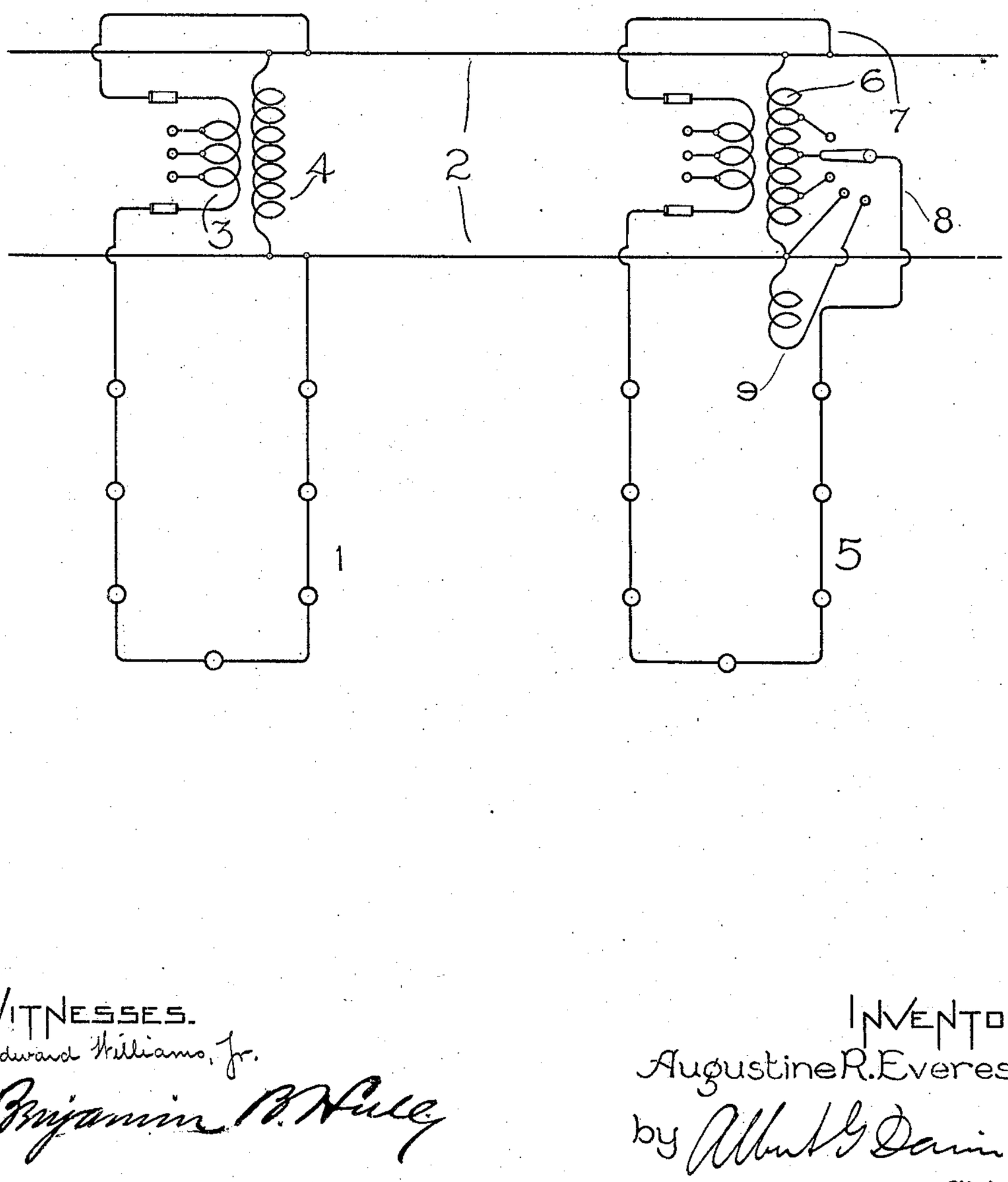
FIG. 5.



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UNITED STATES PATENT OFFICE.

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REGULATOR.

SPECIFICATION forming part of Letters Patent No. 688,614, dated December 10, 1901.

Application filed May 4, 1899. Serial No. 715,516. (No model.)

To all whom it may concern:

Be it known that I, AUGUSTINE R. EVEREST, a subject of the Queen of Great Britain, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Regulators, (Case No. 836,) of which the following is a specification.

My invention relates to the regulation of alternating-current systems of distribution, and has reference more specially to that type of regulator in which the electromotive force in a working circuit is altered by including in series therewith the electromotive force derived from the secondary of a transformer. This secondary electromotive force may be included in the working circuit either in conjunction with or in opposition to the initial electromotive force operating thereon, while intermediate gradations of electromotive force may be secured by varying the electromotive force of the secondary winding by changing the ratio of transformation of the regulating-transformer—as, for example, by varying the number of active secondary turns.

Heretofore when it has been desired to change the relation of the regulating electromotive force with respect to the electromotive force in the working circuit from conjunction to opposition or the reverse it has been customary to employ a suitably-connected reversing-switch. This is a troublesome complication, and my invention aims to do away with the same by the employment of a novel means for cutting in and out the turns of the secondary winding of the regulating-transformer. Instead of varying the turns from one end of the secondary winding only, I make use of a switching device having two moving contacts which operate to simultaneously vary the turns of the secondary winding from both of its ends. Each contact is connected to one of the terminals of the circuit to be regulated and has a continuous movement over fixed contacts connected at intervals to the whole length of secondary winding, so that when the moving contacts approach each other the amount of active secondary winding is reduced until a point is reached where both contacts make connection with the same point in the secondary winding. The winding is then entirely cut out of circuit. A continued movement of the contacts cuts in the secondary winding by degrees, but with its electromotive force reversed with respect to the working circuit.

The regulating-transformer is ordinarily constructed so that its secondary electromotive force is equal to ten per cent. of the initial electromotive force operating in the circuit to be regulated. The regulator thus allows an increase in electromotive force of ten per cent. above this initial value and ten per cent. below. In some cases, however, a still greater reduction in electromotive force is necessary. My invention aims to overcome this disadvantage, not by altering the nature or capacity of the regulator, but by altering the initial electromotive force of the circuit to be regulated. In accordance with my invention the working circuit instead of being connected across the supply-mains is connected across a source of electromotive force either of smaller or larger value. Thus the terminals of the working circuit may be connected one to one of the supply-mains to which the primary of the working transformer is connected and the other to an intermediate point in the primary of the transformer, or, if desired, only a portion of the primary may be included between the supply-mains and the working circuit connected to its extremities. The primary thus acts as a compensator or autoconverter, and it will therefore be evident that the initial electromotive force supplied to the working circuit may be made anything desired from zero up to a value greater than that between the supply-mains.

It is of course obvious that the working circuit might be supplied from a compensator or transformer independent of the regulating-transformer; but such an arrangement is of course objectionable on account of the additional cost and expense of operation. In accordance with my invention this additional cost and inconvenience is obviated by utilizing the primary of the regulating-transformer in the dual capacity of a primary and a compensator or autoconverter.

It will of course be understood that the electromotive force derivable from the secondary of the regulating-transformer is sub-

stantially the same whether the working circuit to be regulated is connected across both of the mains of the supply-circuit or to one of the mains and to a point in the primary non-coincident with the connection of the other main thereto.

My invention will be more readily understood by reference to the following description of an embodiment of the same, while its scope will be clearly and particularly pointed out in the appended claims.

In the accompanying drawings, which illustrate my invention, Figure 1 is a front elevation of a panel equipped with a regulating-switch. Fig. 2 is a side elevation of the same. Fig. 3 is a sectional detail on a large scale of the operating mechanism, and Figs. 4 and 5 are diagrams of connections.

I have shown my improved regulating-switch mounted on a panel A, made of marble, slate, or other suitable material, each of the four corners of which is provided with a metal bushing B, designed to receive a bolt or other device for supporting the panel in place. As herein shown, the panel is complete in itself, so that one or more of the regulators may be added to or taken away from a station without affecting the operation of any other regulating-switch. Mounted on the upper part of the panel is a double-pole single-throw switch C, which is arranged to open and close the primary circuit of the transformer mounted on the back of the board. Situated near the lower terminals of the switch are fuses D and D', the fuses being arranged on the front of the panel, so that they are readily accessible. Situated in about the middle of the panel and arranged to form more or less of a circle are a number of segmental contacts E, and these contacts are connected to sections of the secondary of a transformer, which is mounted on the back of the board, as will be explained hereinafter. Concentrically arranged with respect to the segmental contacts and insulated therefrom is a conductor F, forming a more or less complete circle. Mounted on the panel and concentrically arranged with respect to the above-mentioned contacts is a conductor G, extending a number of degrees corresponding with the amount of movement of the moving contacts. Mounted for movement over the stationary contacts is a pair of contacts H and I. The former is arranged to bridge contacts F and E and the latter to bridge contacts E and G. The construction and arrangement of these contacts are best shown in Fig. 3. Mounted on a head J, which is secured to the panel A by screws, is a stud J', and mounted for rotary movement on the stud are two bevel-gears K and L. The gear K is provided with a hub, and rigidly secured to this hub is an arm K', which carries the contact I. The contact I is composed of a flat metal block having a contact-surface on its under side arranged to rub on the contact ring or plate G and the segmental contacts E. The block is carried by a flat spring-arm I', which is mounted in the forked end of the arm K' and is insulated from the arm by two flat pieces of fiber I^2 or other similar material. The gear L is provided with a hub, and rigidly secured thereto is a forked arm L', which is arranged to carry the contact-block H. Between the block and the arm and insulated therefrom by pieces of fiber H^2 is a flat spring H'. The contact-block is provided with a smooth under surface and is arranged to bridge the contact-ring F and the segmental contacts E. Rigidly secured to an extension of the hub of the gear L is a collar L^2, to which the operating-handle M is secured by screws. Fastened to the outer end of the stud J' is a collar J^2, which holds the gears in operative relation. Mounted on a suitable support N, which is secured to the panel by two screws N', (shown in dotted lines,) is a pinion O, which is free to rotate on the stud O' and meshes with the bevel-gears K and L, so that when motion is imparted to the gear L in one direction it will impart a corresponding movement to the gear K, but in the opposite direction. With the gears arranged as described the contacts H and I move in concentric paths, one inside of the other. By this arrangement both contacts can be made to move from one extremity to the other of the concentrically-arranged stationary contacts. Situated on the lower portion of the board is an ammeter S of any desired type, the one shown being designed more particularly to indicate 3.5 amperes, since the regulator is more especially intended for use where that amount of current is the standard, and any deviation from that amount requires that the regulator shall be adjusted. Mounted in brackets P on the back of the panel is a transformer of any suitable construction, the one shown comprising a body of laminæ Q, a secondary coil Q', and a primary coil Q^2, mounted within the secondary coil. The brackets, in addition to supporting the transformer, serve to hold the laminæ and are clamped together by the bolts P'. The brackets are retained in place by bolts P^2, which extend through to the front of the panel. By arranging the transformer so that it is separated from the panel by an air-space good ventilation is afforded and at the same time danger from short circuits is reduced to a minimum.

Referring to Fig. 4, R and T represent the mains of an alternating-current system of distribution, and connected across these mains is the primary winding Q^2 of a transformer. The circuit through the transformer is controlled by the double-pole switch C, and fuses D and D' are employed to interrupt the circuit when overloaded. For the purpose of illustration the contacts E, F, and G have been shown developed in a straight line, since it renders the operation of the regulator easier to understand.

Extending from the secondary Q' to the con-

tacts E are a number of leads *q*, shown as connected at intervals to the secondary winding. Between the contacts E and insulated therefrom are pieces of metal *e*, which form no portion of the circuit, but are designed to support the contacts when they move from one contact to the next. It will be noted that the pieces of metal *e* are slightly wider than the moving contacts H and I. This is to prevent the moving contacts from short-circuiting a turn or section of the secondary in passing from one fixed contact to the next. The fixed contact-strip F is connected by means of a conductor F′ to one side of the primary winding, and the fixed contact-strip G is connected to the other terminal of the circuit to be regulated. In the present instance a number of lamps U are included in the circuit to be regulated; but any other form of translating device may be substituted, if desired.

Assuming that the contacts H and I are standing on the same contact, which by reason of the construction of the regulator means that they are in the position shown in Fig. 1, the secondary is entirely out of circuit and has no effect upon the voltage supplied to the work-circuit. If the contacts are moved to a new position by rotating the handle M in a clockwise direction, the voltage due to the secondary winding is added to that of the system, while if the contacts are moved in an anticlockwise direction the voltage of the secondary opposes that of the system and the voltage between the contact G and the main T is decreased.

As stated above, when the contacts H and I are opposite each other and on the same contact the secondary has no effect on the voltage of the system; but the instant they are moved either side of this point the voltage of that much of the secondary as is included between the contacts is added to or subtracted from that supplied to the translating devices. By reason of this construction I am enabled to do away with a separate reversing-switch and the consequent contacts and moving parts, yet at the same time to secure the same result as with a reversing-switch without interrupting the circuit of either of the windings.

This regulator is satisfactory for use within certain limits—as, for example, where the voltage of the secondary is ten per cent. of that of the working circuit—thus giving a total variation of voltage of twenty per cent.—ten per cent. above and ten per cent. below the normal voltage of the working circuit. It sometimes happens, however, that a different voltage is required than can be obtained by the use of a regulator thus proportioned, while at the same time it is inadvisable, because of the increased cost and inconvenience, to employ a regulator the second winding of which is capable of giving the increased voltage necessary for purposes of regulation. To provide for this emergency, the working circuit is not connected directly across the supply-mains, but is connected across a length of the primary winding of the transformer greater or less than that included between the supply-mains. The primary winding thus acts as a compensator to vary to any amount desired the voltage supplied to the working circuit. This voltage as thus varied may be regulated, as before, by adding thereto or subtracting therefrom the voltage produced in the secondary winding of the regulator.

For purposes of comparison Fig. 5 illustrates the connections, respectively, in the cases where the working circuit is connected directly across the mains and where it is connected across a length of primary winding different from that included between the mains. The circuit 1 is connected directly across the mains 2 and is regulated by means of the voltage set up in the secondary 3 of the regulating-transformer, the primary of which is indicated at 4. The connections of the circuit 5 differ from those of the circuit 1 only in that it may be connected across a length of the primary 6 different from that included between the mains 2. It will be obvious that the initial voltage impressed upon the working circuit 5 depends upon the amount of primary winding included between the terminals 7 8 of the working circuit 5. The terminal 8 of the working circuit may be so arranged as to be connected with any one of a number of points in the primary winding or to an extension of the same, as indicated at 9, and to make these connections a plug-connector may be employed.

Referring to Figs. 1 and 2, I have shown the mechanical construction of the apparatus used to make these connections. On the back of the panel and connected in circuit with the contact F is a metallic strap W, and mounted on the strap are three sockets W′, which are directly in line with the circular contacts W^2, mounted on the back of the panel. The contacts W^2 are connected to the various sections of the primary winding, while the sockets W′ are connected to one end of the primary winding, so that by inserting the plug F^2 through any one of the contacts W^2 until it enters one of the sockets W′ the amount of primary winding between the terminals of the working circuit may be varied.

Although I have shown my invention as applied to an alternating-current system of distribution, it will be evident that many of its features may be used in other relations as well.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a controller for electric circuits, the combination of a plurality of fixed contacts in coöperative relation to a plurality of moving contacts having a common center and arranged so as to pass each other, and means for simultaneously imparting movement to the moving contacts in opposite directions.

2. In a controller for electric circuits, the combination of a series of fixed contacts each connected to a circuit, moving contacts mounted for engagement therewith, the moving contacts being so arranged that they can pass each other while engaging with the same contact, and means for simultaneously actuating the moving contacts.

3. In a controller for electric circuits, the combination of a plurality of fixed contacts each connected to a section of a winding mounted on an iron core, contacts or brushes arranged to move over the fixed contacts in opposite directions to vary the circuit connections, the arrangement being such that when the moving brushes rest on the same contact all of the winding is cut out of circuit, and means for actuating the brushes.

4. In a controller, the combination of supports, brushes mounted thereon for concentric movement, a bevel-gear mounted on each of the supports, a pinion arranged to mesh with the gears and a handle which is secured to one of the brush-supports.

5. In a controller, the combination of a spindle, a brush-holder mounted thereon, a bevel-gear attached to the holder, a second brush-holder also mounted on the spindle, a bevel-gear attached to this holder, a pinion meshing with the gears, a support for the pinion and an operating-handle secured to one of the gears.

6. In a controller, the combination of a set of insulated contacts, a pair of brushes mounted for movement over the contacts in opposite directions, and a contact over which the brushes simultaneously pass in moving from one extreme position to the other.

7. In an alternating-current regulator, the combination of a transformer having two windings in inductive relation to each other, taps extending from one of the windings to a set of contacts, an adjustable connection extending between the other winding and a fixed contact and brushes mounted for movement over the set of contacts, the arrangement being such that when the brushes are moved one way from a given position they cut one of the windings into circuit in a manner to raise the voltage of the system, and when moved in the opposite direction to decrease the voltage.

8. In a regulator for alternating currents, the combination of a subdivided primary winding connected to the mains of a system and acting to excite a second winding, a working circuit including said second winding and connected across points in the first winding, contacts for varying the amount of said second winding in circuit, and means for varying the amount of primary winding in circuit.

9. The combination of a subdivided main source of electromotive force, a subdivided auxiliary source of electromotive force, and a work-circuit supplied from the main source of electromotive force and having in series therewith a selected number of subdivisions of the auxiliary source of electromotive force.

10. The combination of a subdivided main source of electromotive force, a subdivided auxiliary source of electromotive force, a work-circuit supplied from a selected number of subdivisions of the main source of electromotive force and having in series therewith a selected number of subdivisions of the auxiliary source of electromotive force, and means for varying the number of subdivisions of the auxiliary source of electromotive force included in said circuit.

11. The combination of a single row of fixed contacts, means for maintaining the contacts at different electrical potentials, two contacts movable over the row of fixed contacts and coöperating therewith, and means for simultaneously moving the said two contacts equal distances on either side of a middle position.

12. The combination of a single row of fixed contacts, means for maintaining the contacts at different electrical potentials, two contacts movable over the row of fixed contacts, and means for moving the movable contacts in opposite directions into connection with every fixed contact.

13. The combination of a row of fixed contacts, means for maintaining the contacts at different electrical potentials, two contacts each movable over the row of fixed contacts and adapted to make connection with any of said fixed contacts, and means for moving one of the movable contacts from a fixed contact of higher potential to a fixed contact of lower potential and coöperating means for simultaneously moving the other movable contact from a fixed contact of lower potential to a fixed contact of higher potential, thereby varying the difference of potential between the two movable contacts.

In witness whereof I have hereunto set my hand this 1st day of May, 1899.

AUGUSTINE R. EVEREST.

Witnesses:
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DUGALD MCKILLOP.