No. 670,952. Patented Apr. 2, 1901.

A. R. EVEREST.

POTENTIAL REGULATOR.

(Application filed Sept. 24, 1897.)

(No Model.) 2 Sheets—Sheet 1.

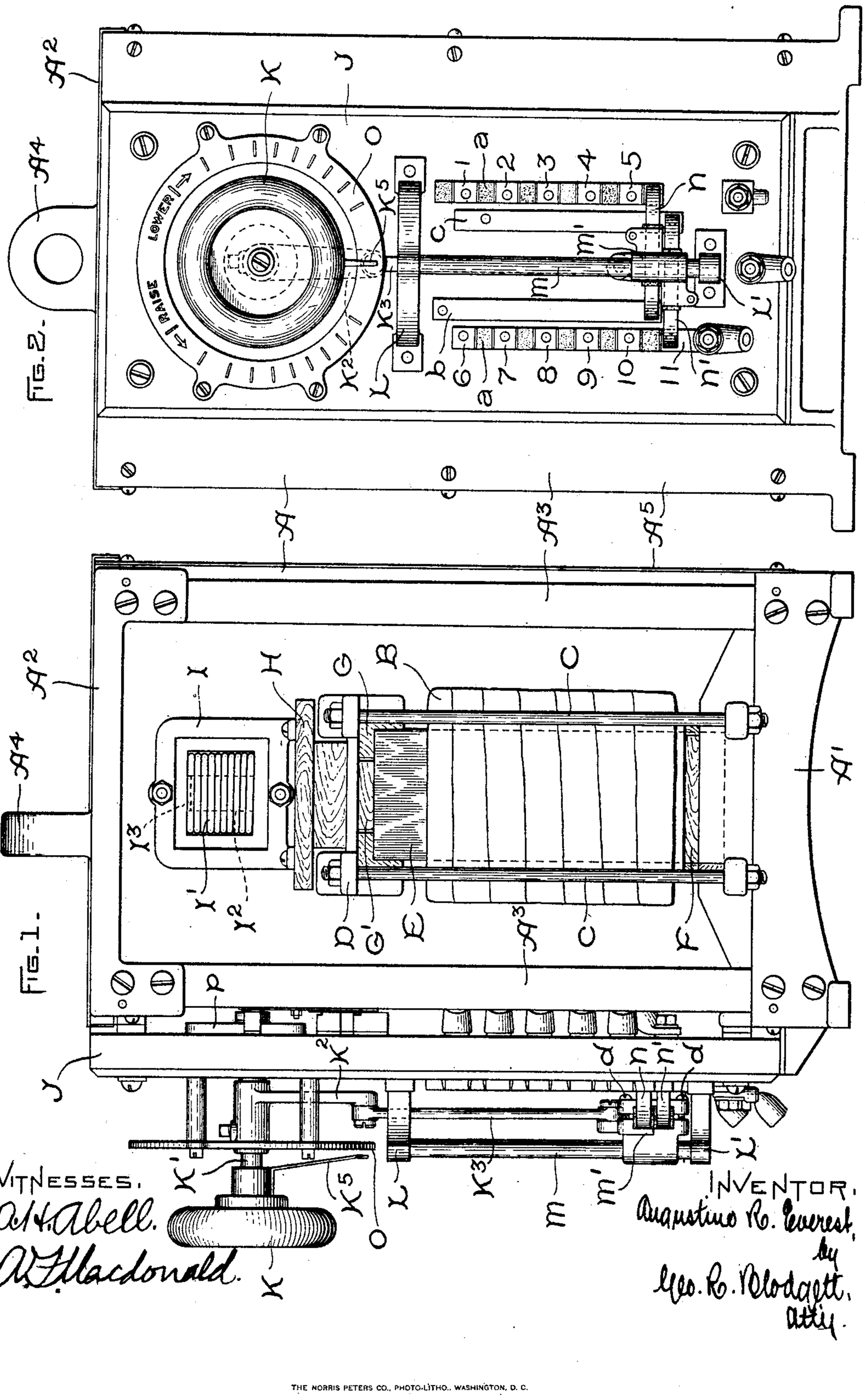


FIG. 2.

FIG. 1.

WITNESSES.
A. H. Abell.
A. F. Macdonald.

INVENTOR.
Augustino R. Everest,
by
Geo. R. Blodgett,
Atty.

No. 670,952. Patented Apr. 2, 1901.

A. R. EVEREST.

POTENTIAL REGULATOR.

(Application filed Sept. 24, 1897.)

(No Model.) 2 Sheets—Sheet 2.

FIG. 3.

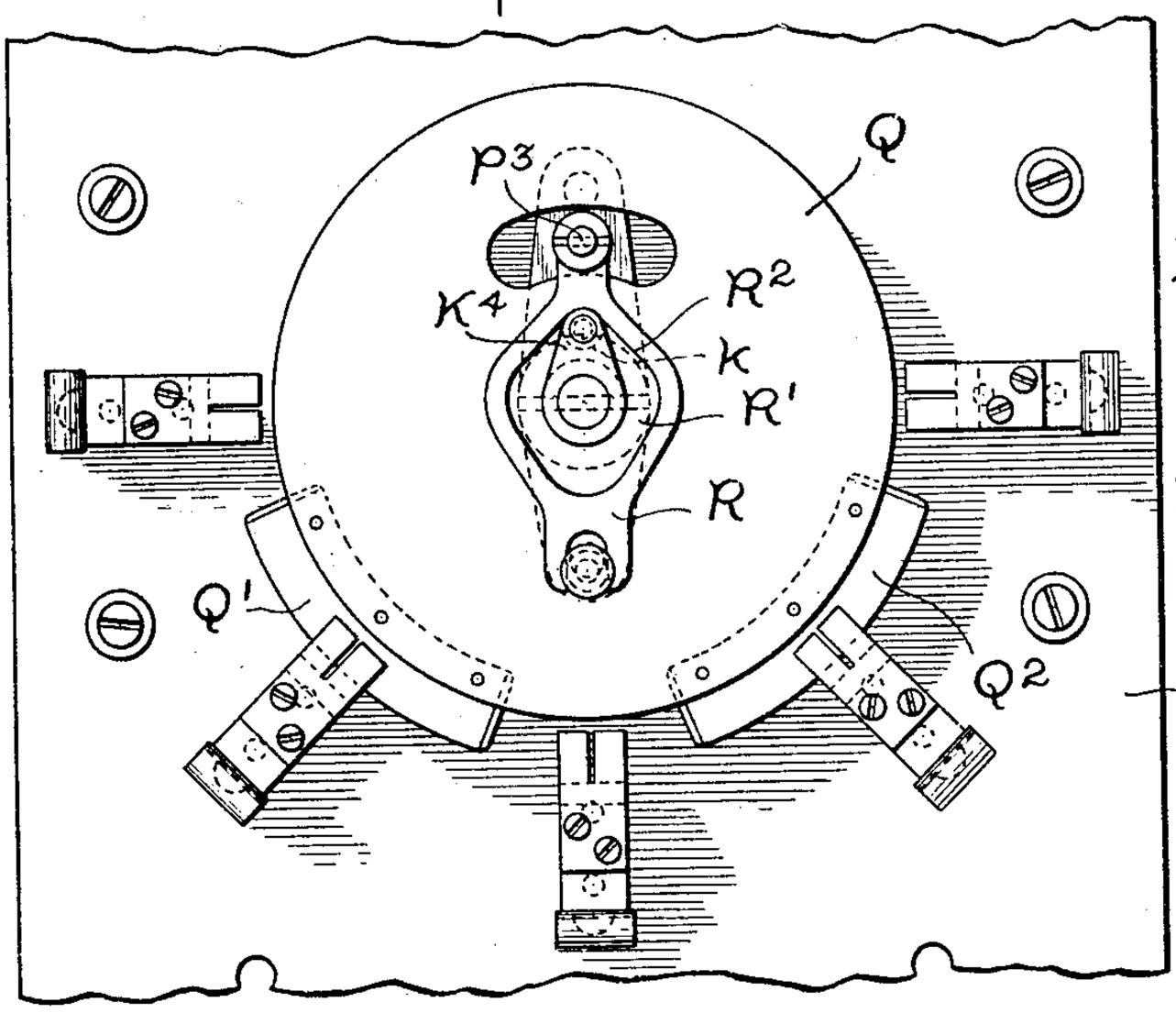


FIG. 4.

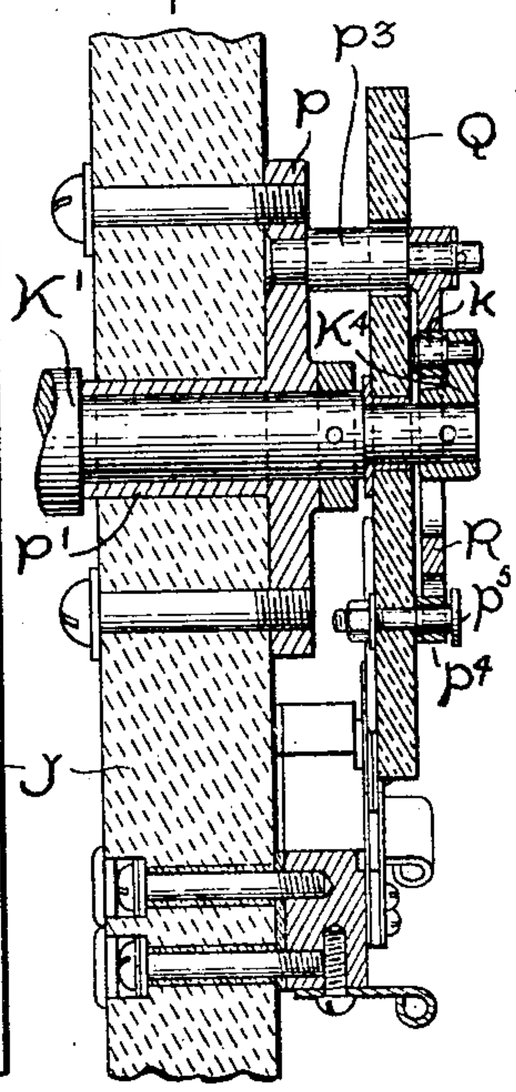


FIG. 5.

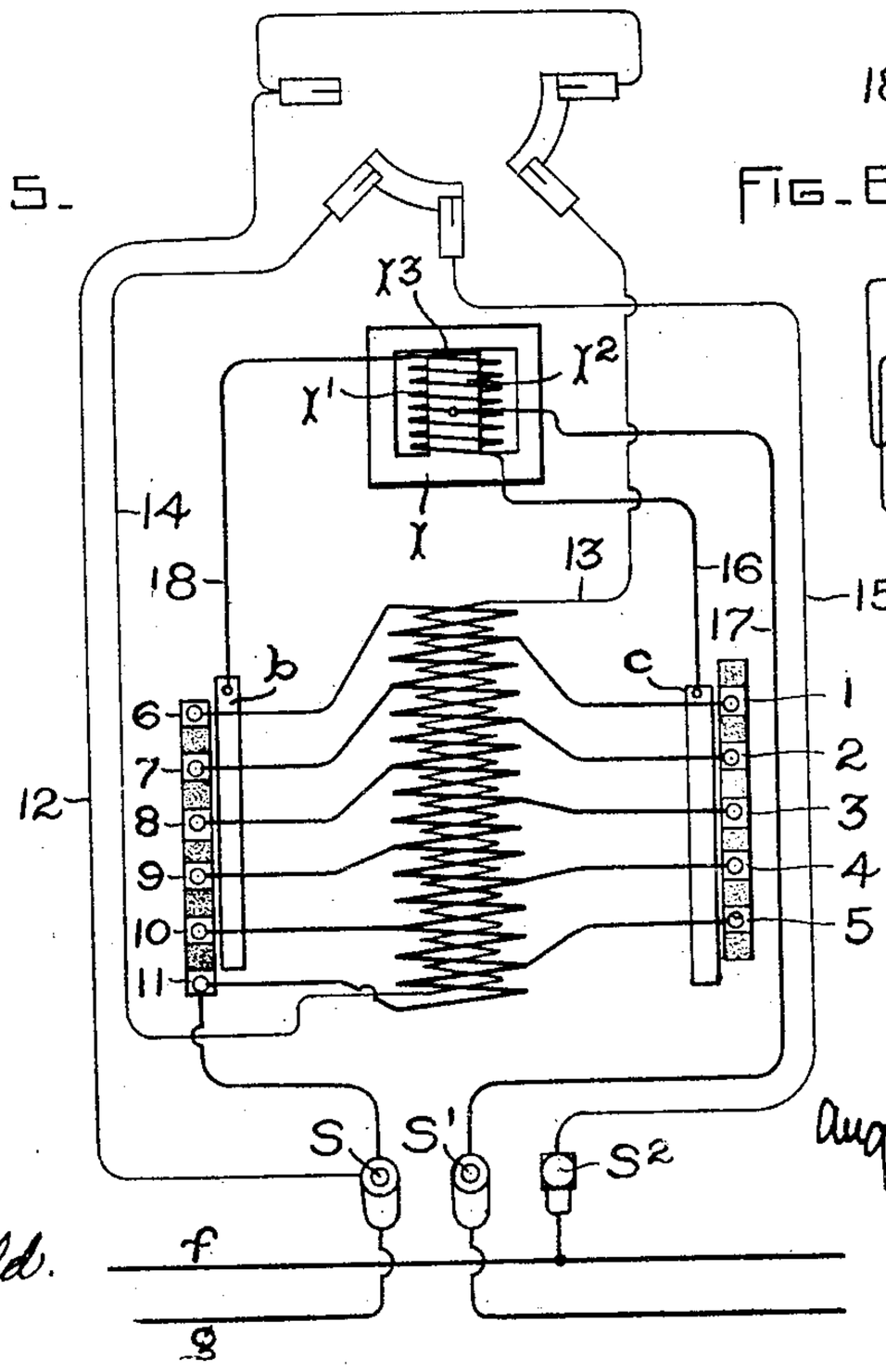
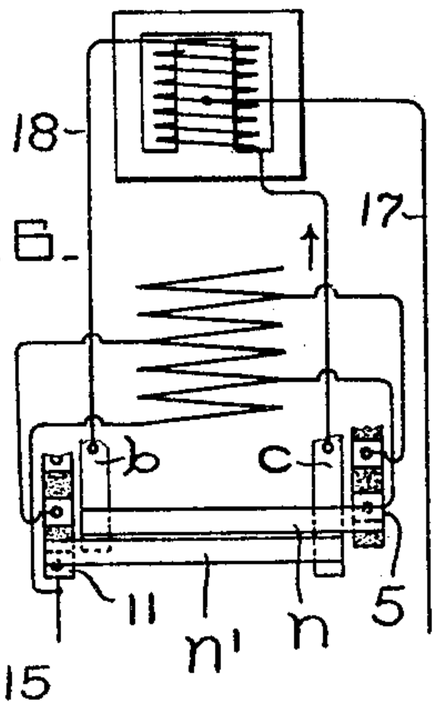


FIG. 6.



WITNESSES:
A. H. Abell.
A. F. Macdonald.

INVENTOR:
Augustus R. Everest, by
Geo. R. Blodgett,
Attn.

UNITED STATES PATENT OFFICE.

AUGUSTINE R. EVEREST, OF LYNN, MASSACHUSETTS, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, OF NEW YORK.

POTENTIAL-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 670,952, dated April 2, 1901.

Application filed September 24, 1897. Serial No. 652,862. (No model.)

To all whom it may concern:

Be it known that I, AUGUSTINE R. EVEREST, a subject of the Queen of England, residing at Lynn, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Potential-Regulators, (Case No. 614,) of which the following is a specification.

The present invention has for its object to simplify the construction of regulators employed for varying the potential of alternating-current systems of electric distribution; and to this end it consists in the parts and combination of parts more fully described and claimed hereinafter.

My invention in general comprises a transformer having a primary winding connected through a reversing-switch across the supply-mains, with a secondary winding arranged in sections and adapted to be connected wholly or partially in series with one of the supply-mains. Assuming that the regulator is employed on a thousand-volt circuit, then with the primary connected in such manner as to produce the maximum voltage on the secondary opposing the main-line voltage the feeders will be supplied with a voltage—as nine hundred, for example. On the other hand, if the secondary voltage is in a direction to assist the main-line voltage, caused by reversing the primary winding, the voltage supplied to the feeders will be boosted above normal—as eleven hundred, for example. It is understood, of course, that intermediate voltages are obtained by varying the number of secondary turns in circuit. It has been proposed heretofore to vary the voltage of alternating-current systems in the manner above described; but the switches employed to reverse the primary and cut the secondary sections into and out of circuit being separate it necessitated the use of both hands and also required considerable attention on the part of the operator to see that both switches were actuated at the proper time. This difficulty was particularly noticeable when the voltage was varying slightly each side of the normal, as then both switches had to be actuated.

In carrying out my invention I propose to eliminate the uncertainty and inconvenience of operation above referred to by arranging the switches in such manner that a single handle controls them both and by connecting the switches so that the reversing-switch operates automatically at the proper time.

In the accompanying drawings, Figure 1 is a side elevation of my improved apparatus. Fig. 2 is a front elevation of the same. Figs. 3 and 4 are details of the reversing-switch. Fig. 5 is a diagram of connections, and Fig. 6 is a detail showing use of choking-coil.

Mounted within a metal casing A is a transformer B, having a primary winding next to the core, with a secondary winding which is divided into ten sections wound over it. The number of sections represents one-half the number of steps or positions of the regulator, and it is to be understood that the number can be varied as desired. The inclosing case consists of a casting A′, forming the base, and a casting A^2, forming the top. These are secured together by four vertically-extending angle-irons A^3, located at the corners. To facilitate handling, an eyebolt A^4 is formed integral with the top casting A^2. Preferably the frame is covered by sheet metal A^5 to protect the transformer from injury. To secure the transformer in place within the casing, a cap D is employed, which is secured to the base by four vertically-extending bolts C. The transformer-core E is insulated from the base A′ by a strip of wood F, and between the cap and the core L-shaped pieces of wood G and a strip G′ are employed for the same purpose.

Supported by a block of wood H, located on top of the transformer, is a choking-coil I, connected in circuit in such manner that it prevents destructive sparking at the brushes when moved from one contact to another and also forms a part of the circuit of one of the mains. The core of the choking-coil comprises a plurality of iron punchings of the form shown in Fig. 5. The coil I′ is wound over tongue I^2, and between the tongue and one side of the core is an air-gap I^3.

Mounted upon a bracket in front of the casing is a piece of slate or other non-combustible insulating material J, upon which are mounted two vertical rows of short contacts numbered from 1 to 5 and from 6 to 11, inclusive. These contacts are connected to the

secondary sections, the arrangement being such that alternate sections are connected to each row of contacts. Between these short contacts are bridging-pieces *a*, forming no part of the circuit, but preventing the brushes from catching between contacts. Extending parallel with the contacts are metal strips *b* and *c*, connected to the outer terminals of the choking-coil.

Mounted in support L at one end and support L′ at the other is a rod M, and sliding thereon is a brush-holder M′. The brush-holder carries two brushes N and N′. Brush N establishes connection between contact-strip *b* and contacts 1 to 5, inclusive, and brush N′ between contact-strip *c* and contacts 6 to 11, inclusive. The brushes are insulated from each other and the holder and are clamped in position by screws *d*.

Situated above the contacts is a hand-wheel K, mounted on shaft K′, and carried thereby is an indicator K^5, adapted to travel over dial O and indicate the various positions of the regulator. Rigidly secured to shaft K′ is an arm K^2, and connecting the outer end of the arm with brush-holder M′ is a pivoted rod K^3. When the hand-wheel is rotated in either direction from the position shown, it causes the brush-holder M′ to move in a vertical direction and vary the circuit connections. The shaft K′ is journaled in a bearing P′, formed by an extension of casting P, located on the back slate piece J. Shaft K′ is prevented from moving endwise by a shoulder at the front end and a collar near the rear end. Sleeved upon shaft K′ is a disk Q, of insulating material, and mounted thereon are switch-blades Q′ Q^2, adapted to engage with the stationary contacts mounted on the back of slate piece J. Secured to casting P is a stud P^3, and pivotally secured to its outer end is a forked arm R, having a central opening R′, the edges R^2 of which form cam-surfaces. On the rear end of shaft K′ is an arm K^4, carrying at its outer end a small roller *k*, adapted to engage with cam-surfaces R^2 and cause a limited angular movement of the disk Q. The cam-surfaces R^2 are formed on an arm R, pivoted at one end to a stud P^3, projecting from the piece J, the opposite end of the arm being forked and arranged so as to engage an antifriction-roller P^4 on a pin P^5, fixed to the disk Q.

When the hand-wheel is rotated in either direction from the position shown, motion is imparted to arm K^4. Roller *k*, working on cam-surface R^2, causes arm R to swing around on stud P^3 as a pivot and impart rotary movement to disk Q. The contacts carried by the disk then engage with the stationary contacts.

With brushes N and N′ arranged as shown current enters at binding-post S from main *g*, and one circuit is by fine wire 12, by wire 13 through the primary of the transformer, wire 14, reversing-switch to wire 15, and to binding-post S^2, which is connected to main *f*, the opposite side of the system. Starting again at binding-post S, the circuit is by way of contact 11 to brush N′, to contact-strip *c*, by wire 16 to the center of the choking-coil, and thence by wire 17 to binding-post S′ and the opposite side of the system. With brush N engaging with one of the fixed contacts—as 5, for example—the current enters as before, passes through a section of the secondary to contact 5, to brush N, to contact-strip *b*, by wire 18 to the choking-coil, and out the center tap by wire 17 to binding-post S′.

It will be seen that with the brushes in either of the positions above described current flows through a portion only of the choking-coil, thus reducing to a minimum the energy consumed thereby.

In passing from one position to another the brushes N and N′ will short-circuit a section of the secondary, and to prevent injury to the apparatus the choking-coil is wound so that the cross-current due to the difference of potential between the brushes is small—as ten or twenty per cent. of the full-load current, for example.

When the apparatus is supplying its maximum amount of current to the system, the currents flowing in the two sides of the choking-coil are approximately equal, and so far as the choking-coil itself is concerned practically neutralize one another, the difference being only sufficient to produce an effect corresponding to that produced by the cross-current alone, which is quite small. Moreover, as the cross-current lags almost ninety degrees behind the main current a balance sufficiently close for all practical purposes is obtained.

Referring to Fig. 6, brush N is shown partially resting on contact 5 and brush N′ partially resting on contact 11. The current enters contact 11, flows across brush N′ to contact-strip *c*, through the choking-coil in the direction of the arrow to the central tap 17, and to binding-post S′. A second path for the current is from contact 11 through the lower section of the secondary coil to contact 5, by brush N to strip *b*, by wire 18 to choking-coil I′, and to central tap 17, where it unites with the first circuit.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a potential-regulator, the combination of a transformer having a primary winding connected across the circuit-mains, a reversing-switch included in circuit with the primary winding, a secondary winding divided into sections, contacts for including more or less of the secondary winding in circuit with one of the mains, and a single operating-handle so arranged that as it is moved from one extreme position to the other, it will cut the sections of the secondary out of circuit, reverse the primary at a time when the secondary is out of circuit, and cut the sections of the secondary back into circuit.

2. In a potential-regulator, the combination of a transformer having a primary con-

nected across the circuit-mains, a secondary winding divided into sections, contacts for including more or less of the secondary winding in circuit with one of the mains, brushes adapted to engage with the contacts, a choking-coil connected between the brushes to prevent disruptive sparking and arranged to maintain the circuit of one of the mains continuous at all times, and a tap leading from the winding of the choking-coil at a point between the ends so that when only one brush is in circuit, the current will only traverse a portion of the coil.

3. In a potential-regulator, the combination of a primary winding, a divided secondary winding, contacts for cutting the secondary into and out of circuit, brushes engaging with the contacts and adapted while moving from one position to another to short-circuit a portion of the secondary winding, a choking-coil connected between the brushes, comprising a number of turns of wire wound over an iron core with a tap to one of the mains taken from a point between the ends of the coil, the number of turns in the choking-coil being sufficiently great to reduce the cross-current between the brushes to a proportionately small amount of the total current flowing through the apparatus.

4. In a regulator, the combination of a winding, means for generating an electromotive force therein, fixed contacts mounted upon a suitable support and connected to points in said winding, brushes mounted for engagement with these contacts, a reversing-switch for changing the direction of said electromotive force, and a single handle for operating the brushes and reversing-switch.

5. In a potential-regulator, the combination of a transformer, two rows of fixed contacts, brushes coöperating therewith, a secondary for the transformer divided into sections and connected to the fixed contacts, a reversing-switch mounted for oscillating movement on a spindle and included in circuit with the primary of the transformer, an operating-handle for actuating the reversing-switch, an arm mounted on the spindle of the reversing-switch, and a link between the arm and the brushes for imparting a reciprocating movement to the brushes.

6. In a potential-regulator, the combination of a transformer having a primary and a divided secondary winding, two sets of contacts connected to the sections of the secondary winding, contact-strips extending parallel to the contacts, brushes adapted to connect the strips with the contacts, a holder for the brushes mounted for reciprocating movement on a support extending parallel with the contacts, and a handle mounted for oscillating movement connected to the brush-holder by a link so that a reciprocating movement is imparted to the brushes.

7. In a potential-regulator, the combination of a transformer having a primary and a divided secondary winding, a reversing-switch in the primary winding, rows of contacts connected to the secondary sections, brushes mounted for engagement therewith, and a single handle for reversing the primary and actuating the brushes, the relation of the parts being such that as the handle is moved from one extreme position to the other, the secondary is first cut out, the primary reversed at a time when the secondary is out of circuit, and the secondary, included in circuit again.

8. In a reversing-switch, the combination of a disk mounted for oscillating movement, contacts carried by the disk adapted to engage with fixed contacts, an arm pivoted to the base or other stationary part of the switch at one end and engaging with a pin carried by the disk at the other, a handle for actuating the pivoted arm, and means permitting a movement of the handle independent of the arm.

9. The combination of a disk mounted for oscillating movement, a shaft upon which is mounted the operating-handle, a stud, an arm pivoted to the stud, at one end and engaging with a pin carried by the disk at the other and provided with a cam-surface, and an arm carried by the operating-shaft engaging with the cam-surface.

10. The combination of mains, two inductively-related windings in fixed position with respect to each other, one being connected across the mains and the other in series with one of the mains, and means controlled by a single operating-handle for progressively varying and then reversing the direction of the induced electromotive force in the series-connected winding.

In witness whereof I have hereunto set my hand this 20th day of September, 1897.

AUGUSTINE R. EVEREST.

Witnesses:
JOHN W. GIBBONEY,
WILLIAM J. WOOLDRIDGE.