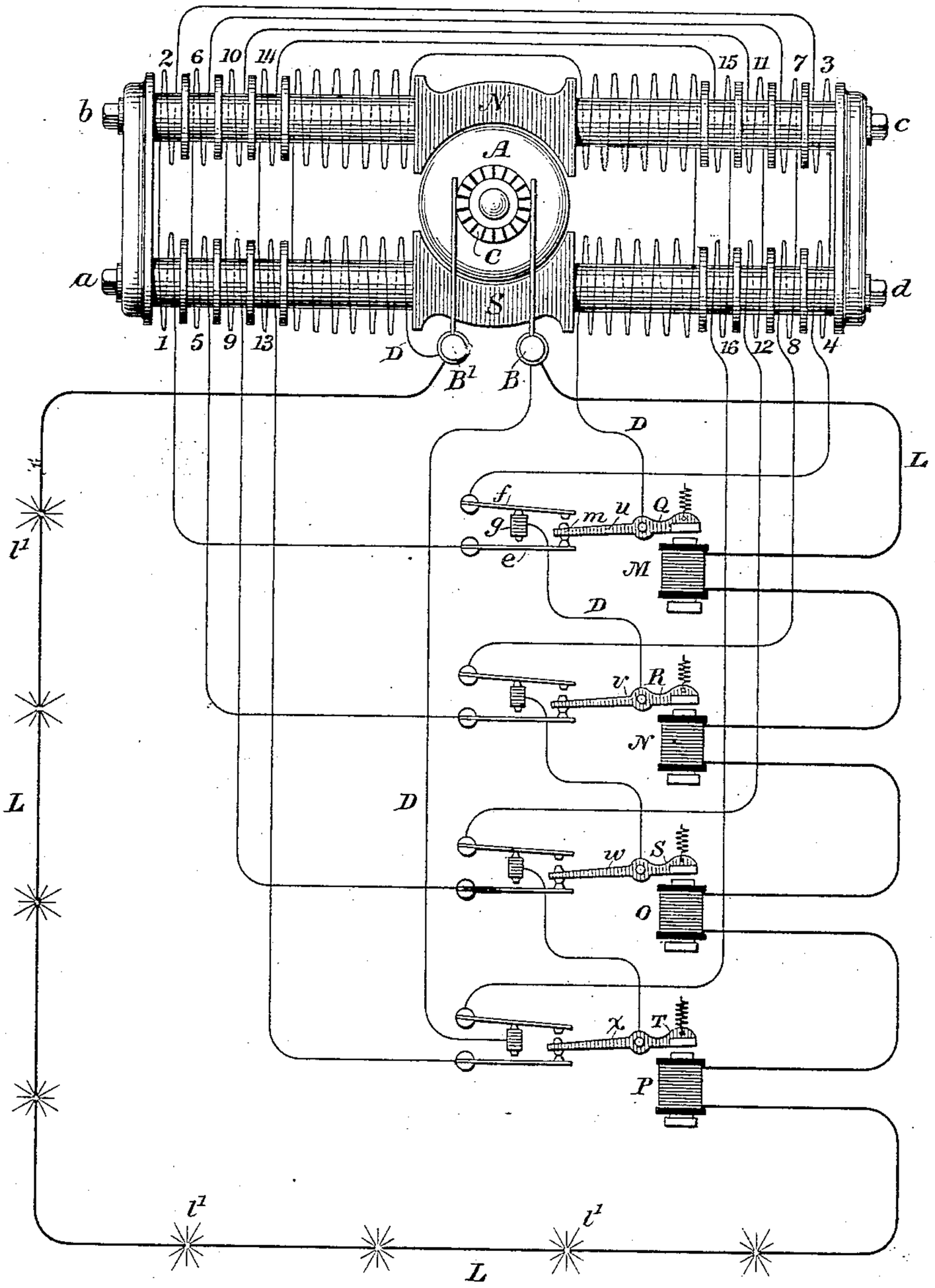
(No Model.) 2 Sheets—Sheet 1.

C. L. BUCKINGHAM.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 294,307. Patented Feb. 26, 1884.

Fig. 1.



WITNESSES

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Geo W. Breck.

INVENTOR

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

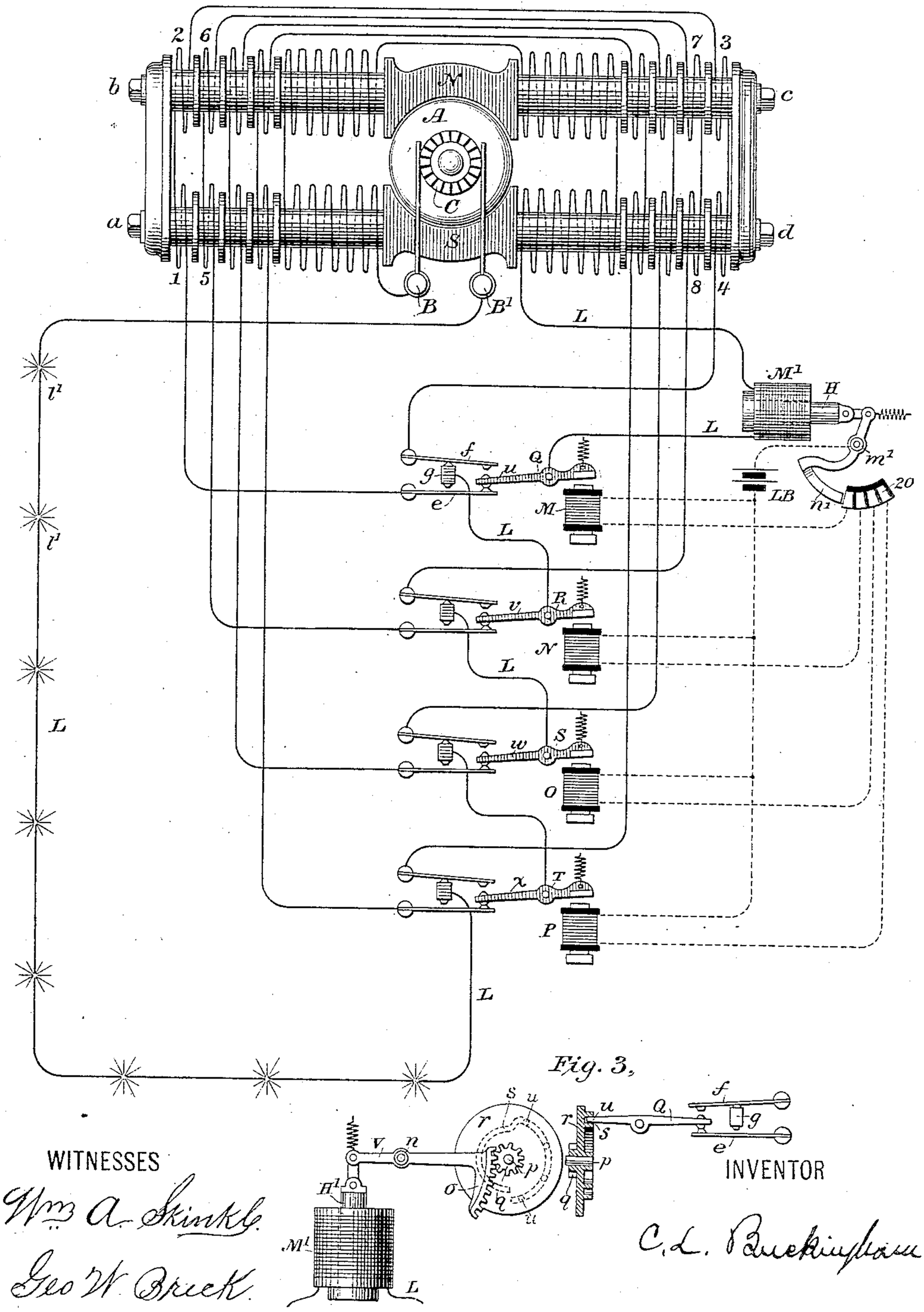

Fig. 3.

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CHARLES L. BUCKINGHAM, OF NEW YORK, N. Y.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 294,307, dated February 26, 1884.

Application filed December 17, 1883. (No model.)

To all whom it may concern:

Be it known that I, CHARLES L. BUCKINGHAM, of the city, county, and State of New York, a citizen of the United States, have invented a new and useful Improvement in Regulators for Varying the Field-Magnetism of a Dynamo-Electric Machine, of which the following is a specification.

It is generally necessary that the speed of rotation of the armature of the dynamo-electric machine and of the engine driving the armature be uniform. If the field-magnetism were also uniform, the electro-motive force of the dynamo-machine would be invariable, and a current of electricity directed to a working-circuit would be variable and inversely proportional to its resistance.

The object of my invention is to render the field-magnetism automatically variable and the electro-motive force of the dynamo-machine always proportional to the resistance of the external or working circuit by a novel method and apparatus, whereby a more nearly uniform strength of current in the working-circuit may be obtained than has heretofore been accomplished. To this end I divide at least one-half of the field-coils into many sections, and provide each of said subdivisions with a pole-changer, whereby each section may have its terminals reversed by the operation of its pole-changer, thereby enabling a current flowing through the field-coils to pass through the section in a direction opposite to that which it would have had before the operation of the pole-changer. By this means the magnetic effects due to any section of the field-coils is reversed upon the operation of the pole-changer, and one pole-changer after another, in succession, throughout the series, may be operated, when the field-magnetism will be rendered *nil*, providing one-half of all the field-coils have been reversed. The pole-changers are controlled by an electro-magnet or electro-magnets whose coils form a part of the working-circuit, or whose action is controlled thereby. If the additional resistance of one or more electric lamps be inserted in said circuit, the current strength will be correspondingly diminished, or, if a like resistance be removed from circuit, the current strength will be increased. In either case one or more of the pole-changers will be operated. If resistance be inserted, a coil-section of the field-magnet must be so reversed as to augment the field-magnetism rather than neutralize a part. If resistance be removed, a coil-section must be so reversed that a coil which before served to augment the field-magnetism may not only not contribute to strengthen the field, but will neutralize a part of the magnetism due to the remainder of the field-coils.

I will now describe my invention by reference to the accompanying drawings.

Figure 1 represents my improved regulator with the field-coils in the shunt-circuit D in respect to the external or working circuit, and the electro-magnetic devices for controlling the regulator are placed in and form a part of the external circuit, L. Fig. 2 represents my regulator in connection with field-coils, which, together with devices for controlling the regulator, form parts of the working-circuit.

For convenience of illustration, I have shown four sets of reversible field-coils (though it may be necessary to employ more) longitudinally arranged along the field-cores. If field-magnets having four limbs, *a*, *b*, *c*, and *d*, be used, it is obvious that upon a reversal of current through any one of the field-coils, providing said coils were wound entirely upon one limb, as limb *a* of the cores of the field-magnet, the poles of the field-magnets would be displaced—for example, the pole S would be displaced to the right. To avoid such displacement, I make each section of the field-coils comprise four individual or component coils, so arranged that normally the coils 2 and 3, for instance, produce a north pole at the middle of *b c*, and the coils 1 and 4 a south pole at the middle of *a d*, and in like manner every reversible coil-section is symmetrically arranged upon the field-cores.

In practice, instead of winding coils 1 2 3 4 at the extremities of the field-poles, and 5 6 7 8 longitudinally within and adjoining coils 1 2 3 4, and so on, thereby making a series of longitudinal coil-sections, a single layer of wire may be wound over the entire limbs *a b c d*, to form one reversible coil-section, and a second, third, and fourth reversible coil-section may be wound in superposed layers over the first.

A is an armature of a dynamo-electric machine, adapted to rotate in the hollowed-out space between the poles of the field-magnet, having a commutator, C, and brushes B B'. From brush B the main line L passes through electro-magnets M N O P, and thence through a series of electric lights or other electrical translators to the opposite commutator-brush, B'. From brush B' the circuit D, when armature-levers Q R S T, which are respectively pivoted at points *n v w x*, are in their retracted positions, has its path first through the large non-reversible coil, and then to the pivot or point *u*, hammer *m*, spring *e*, field-coils 1 2 3 4, lever *f*, anvil *g*, thence to pivot or point *v*, and in like manner through all of the reversible coils to the opposite commutator-brush, B.

The pole-changers of the regulator are in position for all of the lamps *l'* to be inserted in circuit, and the main-line resistance will then be so far increased as to weaken the current sufficiently to permit the retraction of all of the pole-changing armatures. Under this condition the reversible coils all conspire to produce a maximum strength of field-magnetism. If one or more lights *l'* were removed from circuit, the main-line current would be increased and one or more of the armature-levers Q R S T (and that armature-lever would first be attracted which is adjusted to respond to the weakest current) would be attracted to their electro-magnets. If Q were attracted, hammer *m* would be raised and lever *f* lifted from anvil *g*, and *f* would then rest upon *m*, and *e* against *g*. The current in branch D then, instead of flowing from *u* in the direction 1 2 3 4, would pass through said coils from *u* in the direction 4 3 2 1. In the same way the current through coils 5 6 7 8, or other section, may be independently reversed. The current therefore may be reversed in the several sections successively and retained so reversed through all of said sections.

The adjusting-springs of the various pole-changing arms should be arranged to respond to slightly-different strengths of current, in order that they may be brought into action successively, but not simultaneously; otherwise reversals and re-reversals of two or more field-sections might intermittently occur, whereby the field-magnetism would be momentarily varied to a large extent rather than by such small amounts as would be nearly proportional to changes in resistance in the working-circuit.

It is obvious that upon a movement of a pole-changing arm the field-section connected therewith is first cut out of circuit and afterward reversed. By this means, in the process of reversal of a field-section, the field-magnetism is first reduced by the cutting out of the same, and still further by its reversal. It will also be seen, if each of the pole-changing arms, as Q, were only sufficiently moved to permit spring *e* to come in contact with anvil *g* without raising spring *f* from said anvil, that each field-section would only be cut out of circuit, or short-circuited, instead of being reversed.

As shown in Fig. 2, the field-coils are placed in series with the coils of the armature in the working-circuit, and also the coils of the magnet M'. M' has an axial armature, H, which controls a lever, V, pivoted at *m'*, and has at its opposite end a long contact-arm, whereby as armature H is attracted connection may be made between *n'* and one or all of a series of contact-strips, 20, to close the branches of the local battery L B, including local magnets for controlling the pole-changers of the coil-sections of the field-magnets. It is obvious that, instead of placing the magnets for controlling the pole-changers in the working-circuit, they may be placed in a circuit derived from the working-circuit.

Fig. 3 shows a mechanical device, controlled by magnet M', for operating the pole-changers, one at a time. Lever V is provided with a segment of gear-teeth, *o*, which mesh with the teeth of pinion *p*. Upon the same shaft, *q*, with *p* is a disk, *r*, having a cam-groove, *s*, in its face. One portion of the cam-groove is in the arc of a circle, and is of large circumference, while the remaining part of said groove is of small circumference, and is likewise in the arc of a circle. The ends of the pole-changing arms normally rest in that part of the groove of large circumference. If, however, the disk *r* be rotated by the action of armature H', the pole-changing arms will pass, one at a time, into the other part of the groove, and thereupon cause the sections of field-coils to be successively reversed. A reverse movement of H' will cause a reversal of the field-sections.

What I claim, and desire to secure by Letters Patent, is—

1. In a dynamo-electric machine, the combination of a series of coil-sections of the field-magnets, and a series of pole-changers for reversing the circuit through any one or all of the coil-sections, and means, controlled by variations of current in the working-circuit, to operate said pole-changers.

2. The combination of a reversible coil-section of the field-magnets, a pole-changer for reversing said coil-section, and an electro-magnet controlled by variations of resistance in the working-circuit, to operate said pole-changer.

3. The combination of a reversible coil-section of the field-magnets, a pole-changer for reversing said coil-section, and an electro-magnet placed in the working-circuit, for controlling said pole-changer.

4. The combination of a series of field-magnet sections whose component parts are symmetrically arranged, substantially as described, a pole-changer for reversing said section, and an electro-magnet for controlling said pole-changer by variations of current in the working-circuit.

5. The combination of a series of reversible field-magnet sections, a corresponding series of independent pole-changers, a mechanical device for operating said pole-changers in suc-

cession, and an electro-magnet for controlling said mechanical device for controlling the pole-changers.

6. The combination of a series of field-magnet sections and a corresponding series of devices, each of which is adapted to short-circuit its corresponding field-section, a mechanical apparatus for operating said devices, and an electro-magnet placed in the working-circuit, for controlling said mechanical apparatus.

7. The combination of electro-magnet M', placed in the working-circuit, a series of circuit-controlling arms, Q R S T, a series of field-coil sections, and means for bringing said arms successively into operation, substantially as specified.

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Witnesses:

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