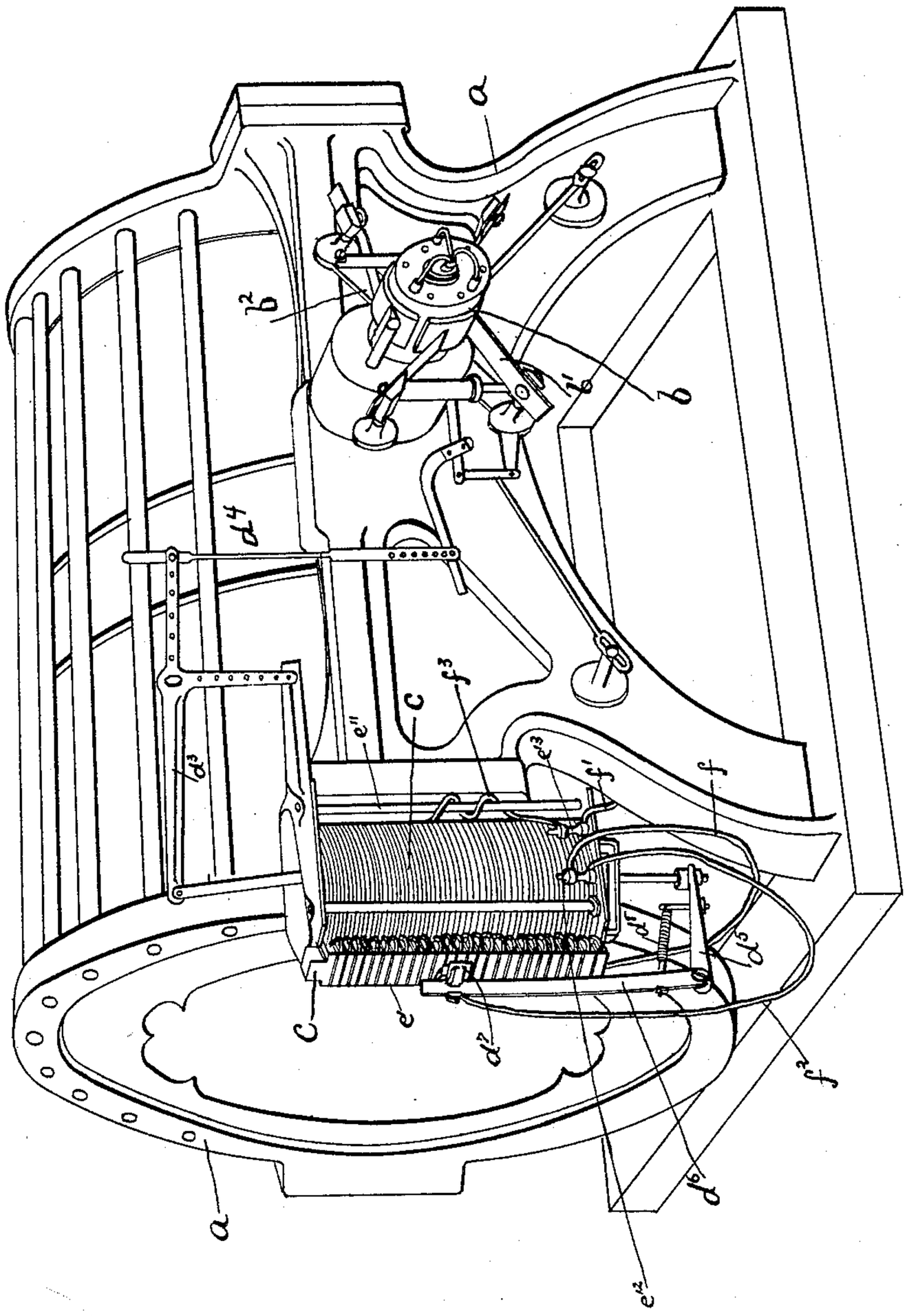
(No Model.) 2 Sheets—Sheet 1.

A. S. KROTZ.

ELECTRIC CURRENT REGULATOR.

No. 559,585. Patented May 5, 1896.

Fig. 1.



WITNESSES:

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(No Model.) 2 Sheets—Sheet 2.

A. S. KROTZ.

ELECTRIC CURRENT REGULATOR.

No. 559,585. Patented May 5, 1896.

Fig. 3

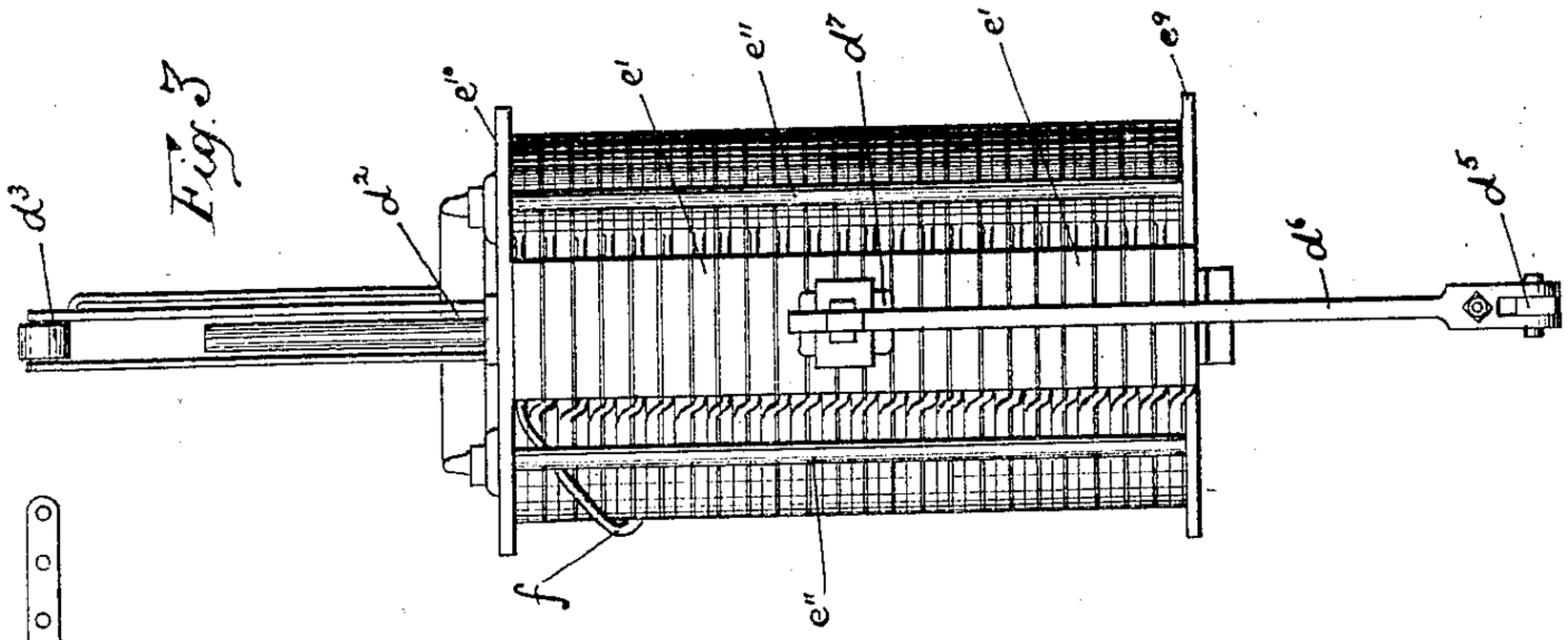

Fig. 4

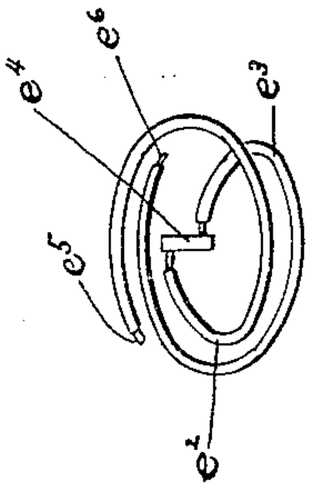

Fig. 5

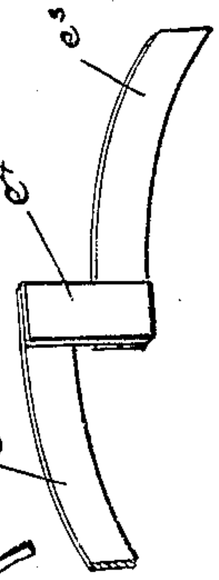

Fig. 2

WITNESSES:

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UNITED STATES PATENT OFFICE.

ALVARO S. KROTZ, OF SPRINGFIELD, OHIO, ASSIGNOR OF ONE-HALF TO OLIVER S. KELLY AND OLIVER W. KELLY, OF SAME PLACE.

ELECTRIC-CURRENT REGULATOR.

SPECIFICATION forming part of Letters Patent No. 559,585, dated May 5, 1896.

Application filed January 22, 1894. Serial No. 497,591. (No model.)

To all whom it may concern:

Be it known that I, ALVARO S. KROTZ, a citizen of the United States, residing at Springfield, in the county of Clark and State of Ohio, have invented certain new and useful Improvements in Electric-Current Regulators, of which the following is a specification.

My invention relates to improvements in electric-current regulators; and the object of my invention is to provide a device of novel construction adapted to be connected in the main circuit with any source of electric supply, the construction being such that the regulation of the current will be effected so that the output from the source of supply shall be commensurate with the work to be performed.

My improved regulator is especially adapted for use with dynamic generators, though it may be employed in connection with any form of battery, either primary or secondary.

My invention consists in the various constructions and combinations of parts hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a perspective view illustrating my device as attached to any ordinary dynamo and used for shifting the brushes on said dynamo so as to vary the output thereof. Fig. 2 is a detail view, partly in section, of my improved regulator removed. Fig. 3 is a side elevation of the same. Figs. 4 and 5 are detail views illustrating the method of producing my improved solenoid used in the regulator.

Like parts are represented by similar letters of reference in the several views.

In carrying out my invention I employ an improved form of solenoid arranged in the main circuit, this solenoid being constructed in sections, each of these sections consisting of a winding entirely independent electrically from the windings of the other sections, the winding of each of said sections being connected electrically at its opposite ends with a contact device, whereby the said sections may be brought into or cut out of circuit.

In the accompanying drawings, *a a* represent an ordinary dynamo, *b* the commutator, and *b'* the brushes, supported on a movable frame b^2 in the usual way.

c c represent my improved regulator, which consists, essentially, of a solenoid *d* and a core d', having a stem d^2, connected with a vibrating lever d^3, which in turn is connected by a link d^4 to the movable frame b^2, carrying the brushes *b'*.

The solenoid *d* consists, essentially, of sections *e*, each consisting of a coil or coils of wire of novel arrangement, said coils being insulated one from the other and each connected to metallic contact-plates *e'*, arranged at one side of the solenoid. In forming the sections *e* I preferably employ flat wire, insulated in the usual manner, each of said sections being formed in two coils e^2 e^3, wound spirally, with all the wire forming one coil lying in one plane and all the wire forming the other coil lying in a parallel plane. This is accomplished by connecting the inner ends of the respective coils e^2 e^3 together by a metallic connection e^4, preferably by soldering or otherwise joining the parts, as indicated in Figs. 4 and 5. The coils forming the sections are then wound in opposite directions from the inside outwardly, thus leaving the free ends e^5 e^6 at the outside or periphery of the coil, while the coils constituting each section are substantially one coil, as an electric current traversing said coil passes in the same direction around the axis of said coil. The sections being thus formed I construct the solenoid by taking a metallic tube e^7, having attached thereto at one end a suitable flange or plate e^9. One of the sections *e* is then placed around the tube, said sections being preferably wound upon a mandrel or otherwise formed so as to leave a central opening slightly larger in diameter than the outer diameter of the tube e^7. A disk of paper or other suitable insulating material is placed between the plate e^9 and the first section. Succeeding sections are then added in the same manner, with insulating material between the same, until a sufficient number are secured to form the solenoid, any desired number being employed. A plate e^{10} is then placed over the tube and the two plates connected by clamping-rods e^{11}, thus holding the same firmly together. In placing the sections one above the other in this manner it should be stated that the outer ends of each coil are arranged at the same side of the solenoid and are connected to the contact-plates in the fol-

lowing manner: The first section, beginning at the top, is connected at one end to the first contact-plate. The opposite end of said section is connected to the next succeeding contact-plate, which is also connected to one end of the succeeding section, the connection being continued in this manner so that each contact-plate forms an electrical connection between the respective sections which adjoin said plate, the lower contact-plate e' having an electrical connection with the lower coil only of the last section, thus leaving the circuit open at this point. The stem d^2 of the core d' is extended in opposite directions and projects at opposite ends from said solenoid. To this stem is secured at the bottom a projecting arm d^5, having hinged thereto a yielding lever d^6, carrying at its outer extremity a contact-block d^7, of carbon or other high-resistance material, which is held yieldingly against the contact-plates e' by a spring d^8. This contact-block d^7 is made of a sufficient size to contact with two or more of said contacting plates e', and is connected electrically by a flexible connection f^2 to a binding-post e^{12}, located for convenience on the bottom plate e^9 of the solenoid. A second binding-post e^{13} is connected by a wire f^3, or otherwise, to the first contact-plate e' in the series. The line-wires $f\,f'$ are connected to the binding-posts e^{12} and e^{13}, so that a circuit is established through the coils of the solenoid which are above the contact-block d^7. The connections to the lever d^3 are so made as to counterbalance the weight of the core d' and its connections, including the contact-block d^7, so that in the normal condition, without any current through the solenoid, the core d' will fall slowly by gravity to the bottom of the solenoid, carrying with it the brushes or such other regulating devices as are attached to the lever d^3. As the current is applied to the line-wires $f\,f'$ the solenoid d' is drawn upwardly by the magnetic field of the respective coils. The contact-block d^7 being connected to the core moves therewith and is adapted to stand substantially opposite the same, so that as the core rises the sections which are below said core are cut out of circuit, thus keeping the entire available magnetic field of said solenoid above said core, so that it is susceptible to the same magnetic strength in any point of its travel, no matter what the size or length of the solenoid may be, and it may be composed of any number of sections. The effective magnetic force operating the same will be substantially equal at any point of travel of the core. Now, by connecting suitable controlling devices to the said core, the current in the main circuit can be controlled as desired. This I have shown accomplished in the drawings by connecting the brushes of a dynamo thereto, so that as the core is moved the output of the dynamo is regulated in the usual way. It is obvious that the same result may be accomplished by employing in connection with the solenoid a variable rheostat to throw more or less resistance into the circuit; or it may be connected to automatic cut-out devices, so as to throw a greater or less number of battery-cells into circuit as the strength of said circuit is diminished or increased by the demand thereon. The current passing through the main line is thus kept constant, the regulator being adapted to increase the voltage to correspond to the work to be performed up to the capacity of the source of electrical energy which supplies the circuit.

The contact-block d^7, having a high resistance, being adapted to contact with two or more of the contact-plates e', it will be seen that the current will be divided into those sections with which the block is directly connected, the strength of the magnetic field of these sections being weakened correspondingly, so that as the core is moved in either direction the shifting of the magnetic field by the cutting in or out of more or less of the sections is more gradual and thus the regulation more successful than it would be if the contact was made with one section only so as to throw said section completely in or completely out as the contact-block moves back and forth in unison with said core.

By having the adjustable solenoid in sections, as described, means are provided by which the regulator may be readily built up to any desired capacity. Having each section wound in separate coils, which extend from the inside outwardly, both ends of the coil are brought to the outer surface without the necessity of crossing the coils by one end of said wire.

A regulator as thus described, it has been found, is extremely successful in operation and responds readily to any change in the current, so as to compensate therefor by proper adjustment of the controlling devices which govern the current in the line in circuit with the said controller.

Having thus described my invention, I claim—

1. In a regulator, a sectional solenoid, the sections of which are joined together by exposed metallic connections, a movable device connected to the core of said solenoid so as to contact successively with the exposed parts of the respective solenoid-sections, said movable contacting device having a high resistance being adapted to simultaneously connect with two or more of said sections, substantially as specified.

2. In a regulator, a sectional solenoid having metallic plates connected between the respective sections, a contacting device moving with the core of said solenoid so as to contact with said plates, an electrical connection from one of said sections to an electric circuit, which circuit also includes said contacting device, said contacting device having a high resistance being of a size sufficient to include in the contact thereof two or more of said plates whereby the current is caused to divide

between the sections adjacent to said core, substantially as specified.

3. A sectional solenoid composed of sections, each of which consists of two coils of wire wound in opposite directions and connected together at the center so as to bring their free ends on the outside, exposed metallic plates forming an electrical connection between the respective sections, a contacting device moving with the core of said solenoid so as to contact with said plates, said contacting device having a high resistance being of a size sufficient to contact with two or more of said plates, substantially as specified.

4. An electrical circuit, including means for controlling the current passing through said circuit, a sectional solenoid connected to said circuit at one end and open at the other end, and a connection from the core of said solenoid to the circuit-controlling device, a high-resistance contacting device also moving with the core of said solenoid and adapted to contact successively with the exposed parts of the respective solenoid-sections, and a connection from said contacting device to said circuit, substantially as specified.

5. An electrical circuit, including means for controlling the current passing through said circuit, a sectional solenoid, the core of which is connected to the circuit-controlling device, a high-resistance contacting device adapted to move with the core of said solenoid, said solenoid-sections having exposed portions, two or more of which are at all times in contact with the moving contacting device, the contacting device in one end of said solenoid being included in said circuit, substantially as specified.

In testimony whereof I have hereunto set my hand this 14th day of December, A. D. 1893.

ALVARO S. KROTZ.

Witnesses:
OLIVER H. MILLER,
CHAS. I. WELCH.