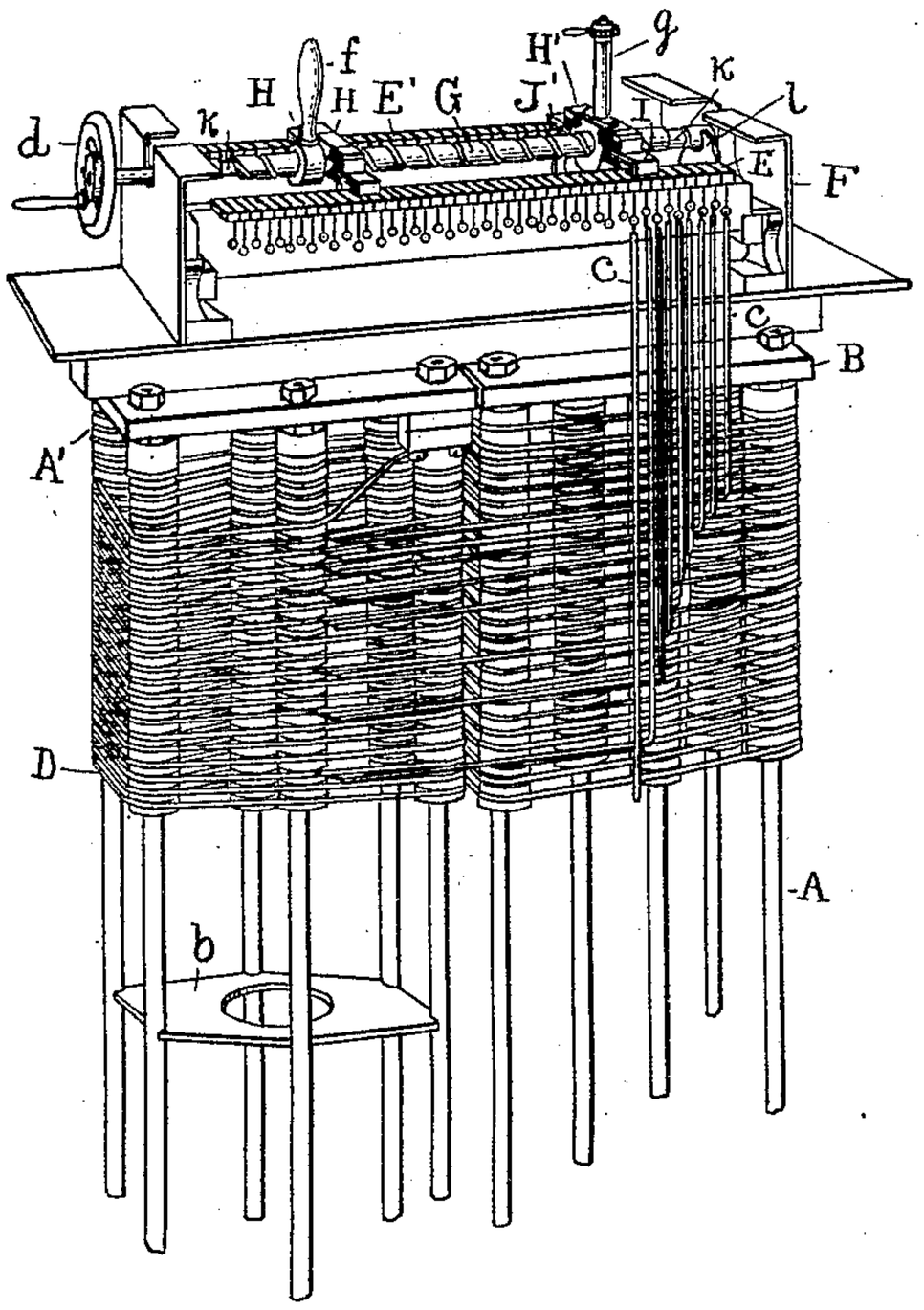
(No Model.) 5 Sheets—Sheet 1.

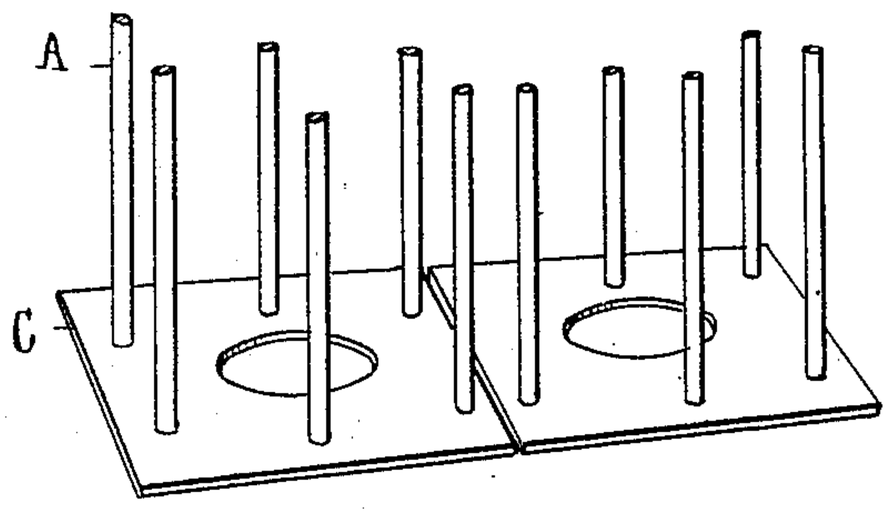
J. C. MAYRHOFER.

REGULATOR FOR ELECTRICAL CIRCUITS.

No. 552,495. Patented Dec. 31, 1895.

Fig. 1.





Witnesses
Morris A. Clark.
John R. Taylor.

Inventor
Joseph Carl Mayrhofer
By his Attorneys
Dyer & Driscoll

(No Model.) 5 Sheets—Sheet 2.

J. C. MAYRHOFER.

REGULATOR FOR ELECTRICAL CIRCUITS.

No. 552,495. Patented Dec. 31, 1895.

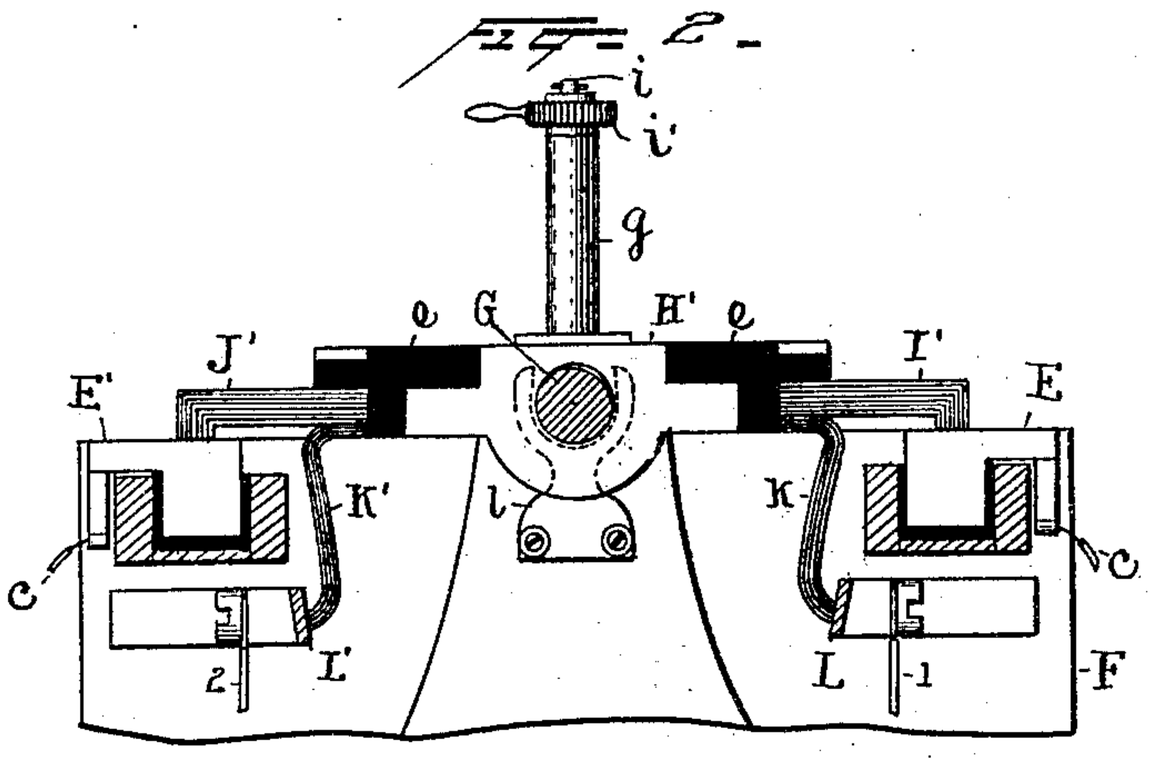


Fig. 3.

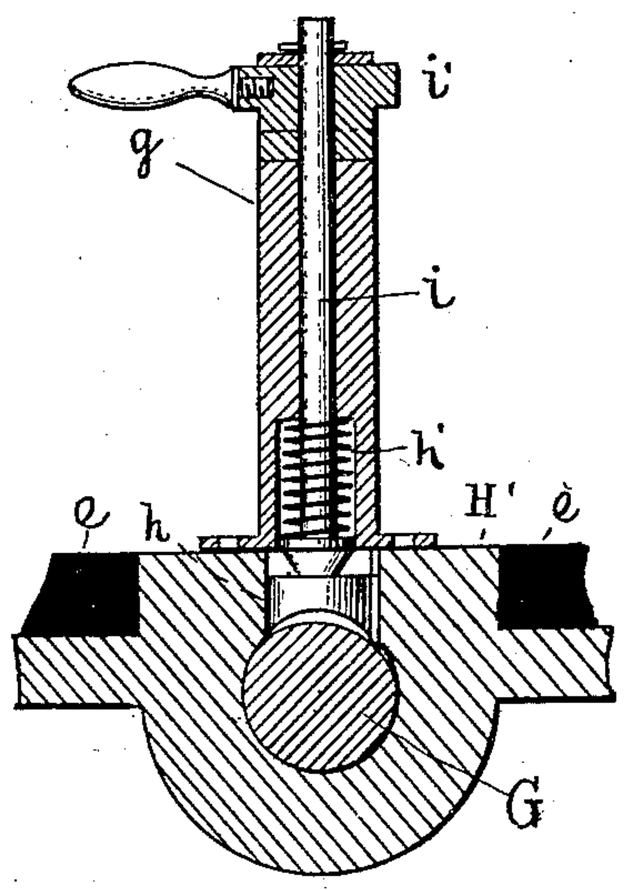


Fig. 4.

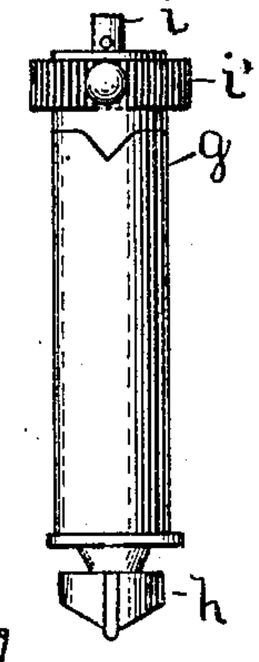


Fig. 5.

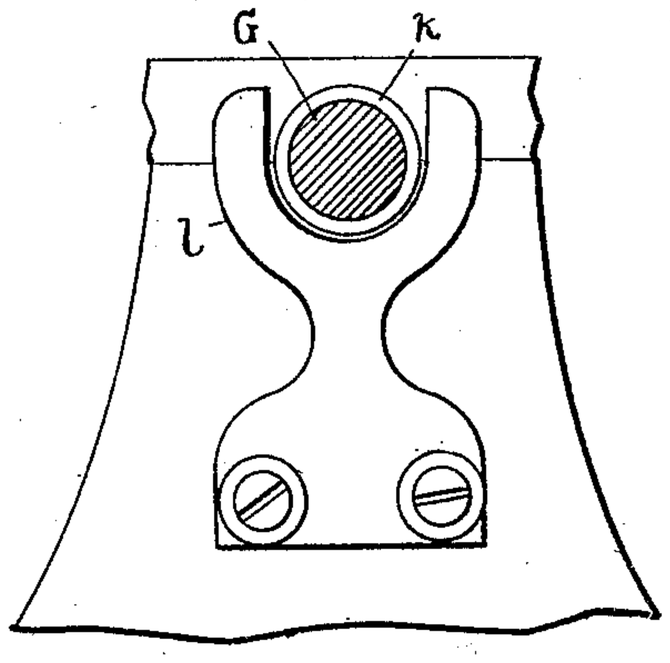
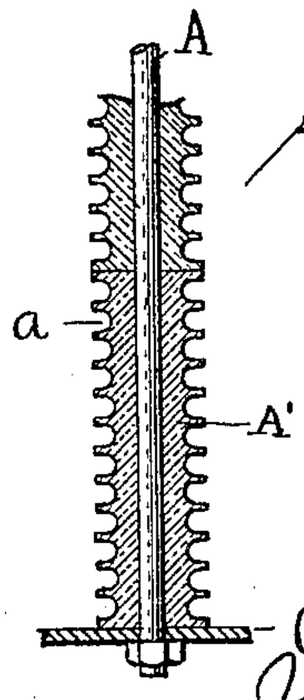


Fig. 6.



Witnesses
Morris A. Clark.
John R. Taylor.

Inventor
Joseph Carl Mayrhofer
By His Attorneys
Dyer & Driscoll

(No Model.) 5 Sheets—Sheet 3.

J. C. MAYRHOFER.

REGULATOR FOR ELECTRICAL CIRCUITS.

No. 552,495. Patented Dec. 31, 1895.

Fig. 7.

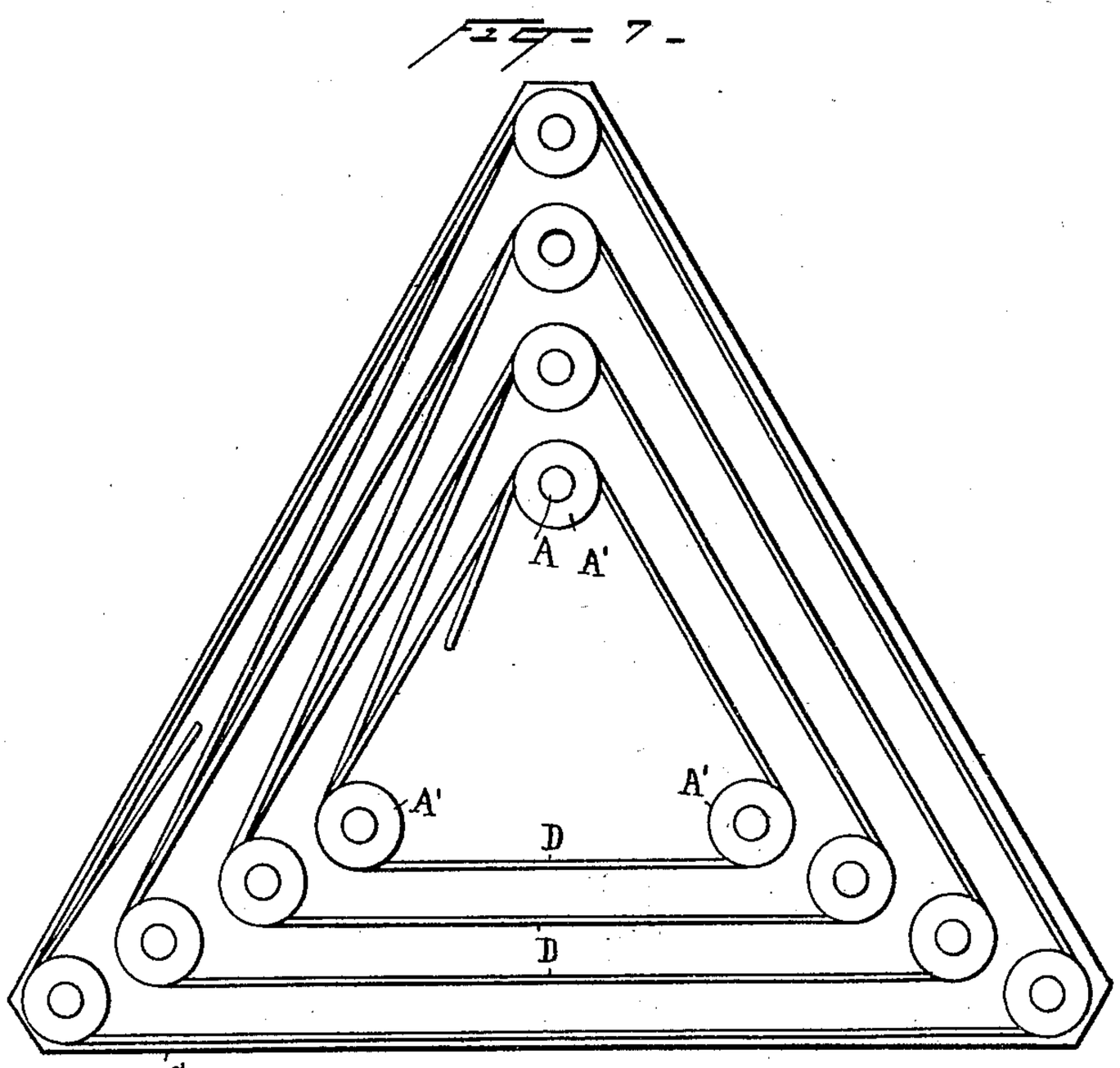
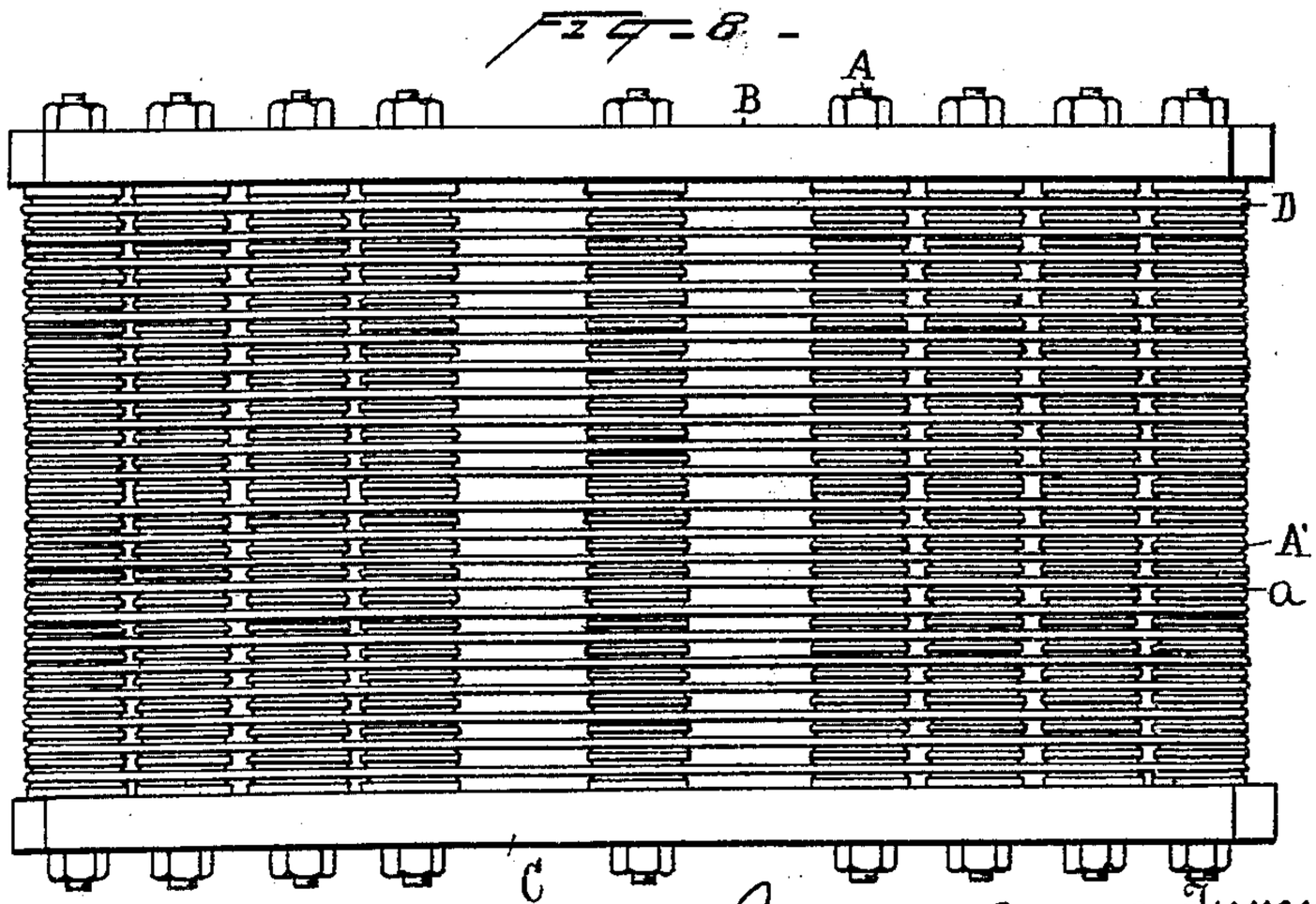


Fig. 8.



Witnesses
Morris A. Clark.
John R. Taylor.

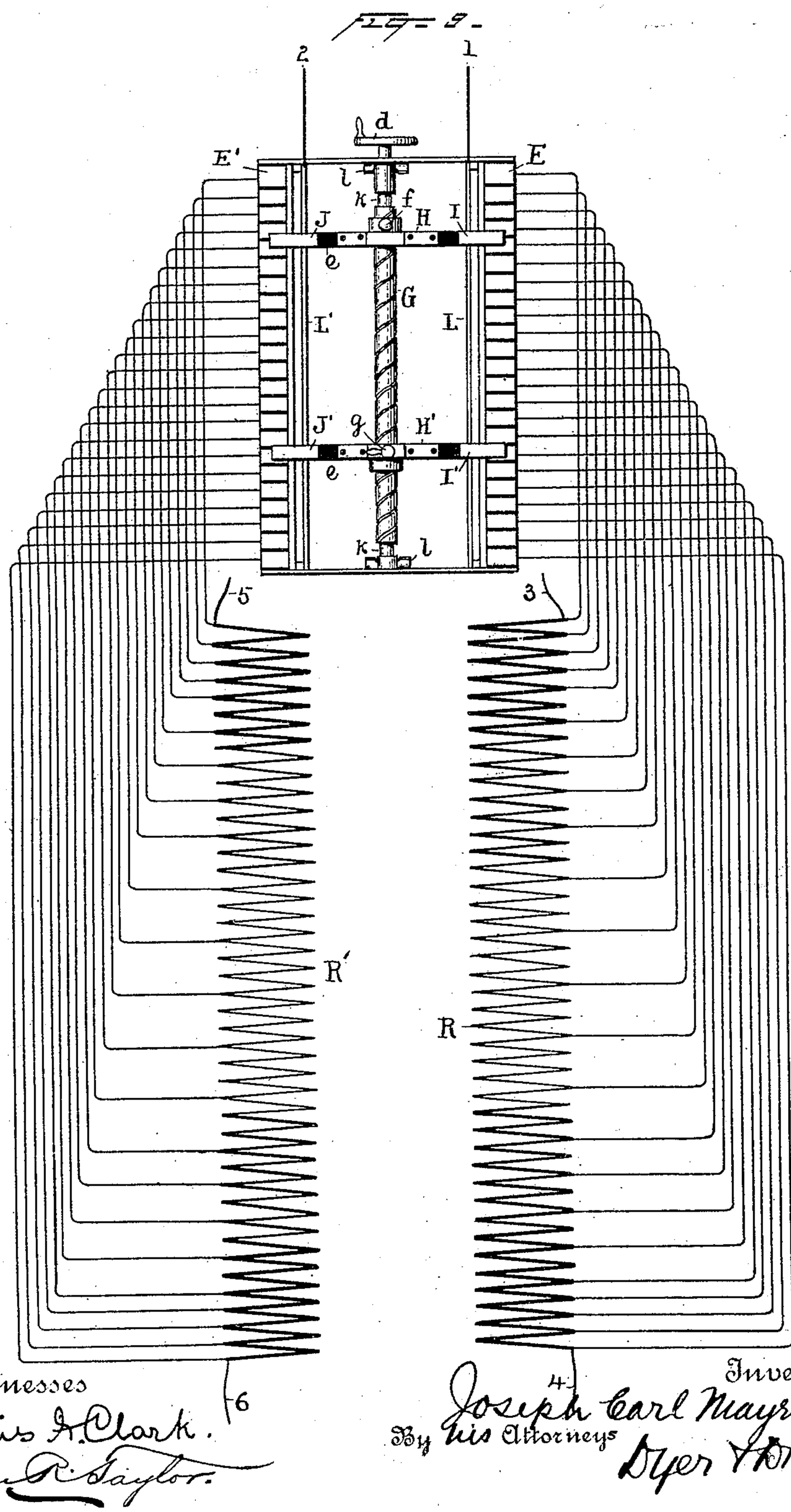
Inventor
Joseph Carl Mayrhofer
By his Attorneys
Dyer & Driscoll

(No Model.) 5 Sheets—Sheet 4.

J. C. MAYRHOFER.

REGULATOR FOR ELECTRICAL CIRCUITS.

No. 552,495. Patented Dec. 31, 1895.



Witnesses
Norris A. Clark.
John R. Taylor.

Inventor
Joseph Carl Mayrhofer
By his Attorneys
Dyer & Driscoll

(No Model.) 5 Sheets—Sheet 5.

J. C. MAYRHOFER.

REGULATOR FOR ELECTRICAL CIRCUITS.

No. 552,495. Patented Dec. 31, 1895.

Fig. 10.

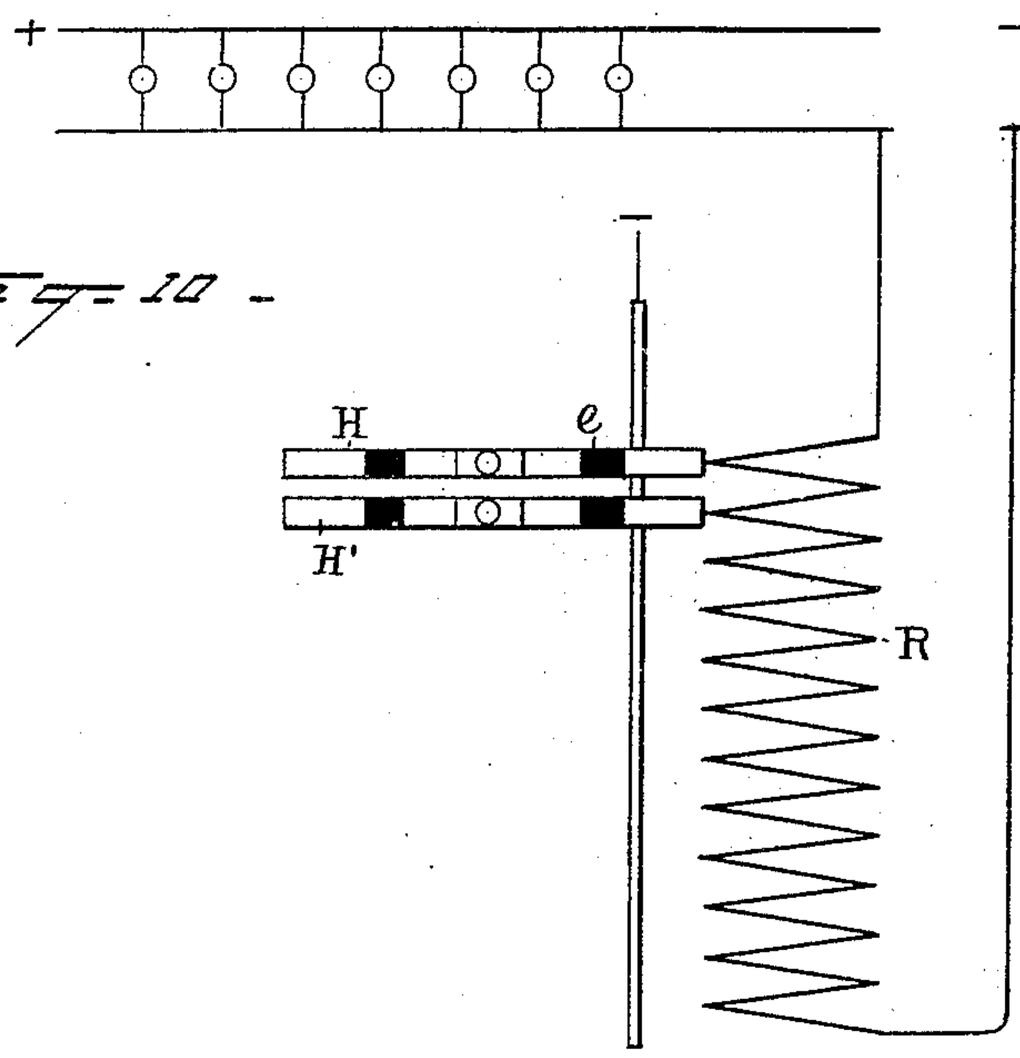
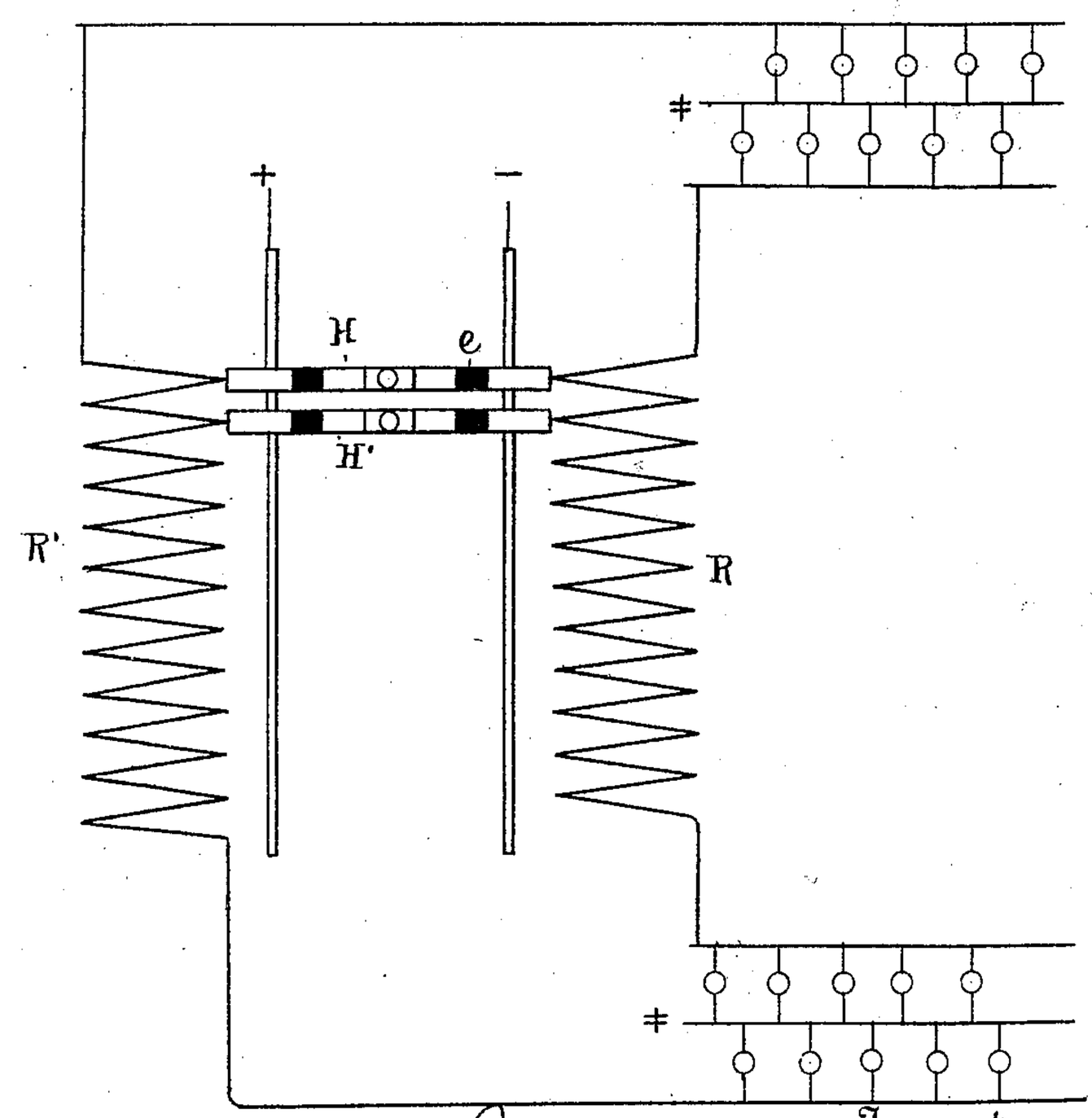


Fig. 11.



Witnesses
Morris A. Clark.
John R. Taylor.

Inventor
Joseph Carl Mayrhofer
By his Attorneys
Dyer & Driscoll

UNITED STATES PATENT OFFICE.

JOSEPH CARL MAYRHOFER, OF NEW YORK, N. Y., ASSIGNOR TO DENMAN THOMPSON, OF WEST SWANZEY, NEW HAMPSHIRE.

REGULATOR FOR ELECTRICAL CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 552,495, dated December 31, 1895.

Application filed July 5, 1895. Serial No. 555,083. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH CARL MAYRHOFER, a citizen of the United States, residing at New York city, in the county and State of New York, have invented a certain new and useful Improvement in Regulators for Electrical Circuits, of which the following is a specification.

My invention relates to regulators for electrical circuits especially designed for regulating incandescent electric lights for theatrical purposes.

My object is to produce a regulator of this character which, while simple in its operation, will provide for all the conditions necessary for such a regulator, and hence may be manipulated without a high degree of skill and without the liability of mistake; further, to make such a regulator simple and durable in its construction, so that it will not readily get out of order, but will withstand without injury the use to which it is subjected for a long period of time.

In the accompanying drawings, forming part hereof, Figure 1 is a perspective view of my regulator with the resistance-wires and the spools upon which they are wound partly removed to disclose the construction. Fig. 2 is a cross-section through the commutator of the regulator. Figs. 3 and 4 are views of the lock for engaging one of the commutators with the operating-worm. Fig. 5 is a section through the operating-worm, showing the return-spring at the end of the shaft. Fig. 6 is a vertical section showing the construction of the frame upon which the resistance-wire is wound. Fig. 7 is a horizontal section of a modified construction for the winding of the resistance-wire. Fig. 8 is a side view of this modified construction. Fig. 9 is a plan view of the commutator with a diagram of the connections, and Figs. 10 and 11 are simplified diagrams showing two ways of using the regulator.

The supporting-frame for my resistance is constructed of metal rods A properly secured to top and bottom metal plates B C. Upon these rods are slipped spools A′ provided with circumferential grooves *a* and made of porcelain. Two or more of these spools are placed over each rod, according to the length it is desired to make the frame and the length that it is convenient to manufacture the porcelain spools. Where the frame is of considerable length, as illustrated in Fig. 1, one or more intermediate supporting-plates *b* may be placed between the rods A of the frame for bracing them apart and enabling them to withstand without undue bending the strain of winding the wire upon the spools. These plates engage the rods A between adjoining spools A′, which are separated sufficiently to make room for the plates. The resistance-wire D is bare wire, preferably of high specific resistance, such as German-silver wire, but of course any suitable wire may be employed. This wire is wound around the spools of the several rods composing the frame and is connected at proper intervals by properly-insulated lengths *c* of wire with the commutator. The wires *c* forming the commutator connections are soldered to the resistance-wire D and are preferably covered with a suitable fireproof insulation, such as one composed wholly or principally of asbestos.

In the form of construction illustrated in Fig. 1 each frame is composed of six vertical rods A, around which the wire D is wound, and two of these frames are secured together, constituting one resistance-box. The modified arrangement illustrated by Figs. 7 and 8 is one in which the metal rods A, connecting top and bottom plates B C and covered with grooved porcelain spools A′, are arranged in several series, each composed of three or more rods, the different series of rods being located successively at greater distances from the center of the frame. Three porcelain-covered rods are illustrated for each series, giving the frame a triangular form, although any other number of rods greater than two may be employed and the frame given any suitable form. The bare resistance-wire D is wound first around the innermost series of rods until the space afforded by the grooves in the porcelain spools carried by those rods is fully occupied, when the second series of rods and spools is placed in position and the end of the resistance-wire is carried to this second set of rods and wound around the spools upon the rods, as in the first case, and so on until all the sets of rods are occupied. This arrangement of the resistance is a compact one, permitting the same length of wire to be used

in a frame of less height. By the employment of the metal sustaining-rods, connecting end plates and grooved porcelain spools placed on such rods, a substantial construction is produced, the bare wire employed is effectively insulated, one coil from another, and the coils are maintained a definite distance apart, which may be less than in other forms of construction without danger of short-circuiting, while a free circulation of air is permitted to keep the wire cool.

The commutator which I employ for my regulator is one composed of a straight range of contact-plates E, properly insulated from each other and connected by the wires *c* at different points in the length of the continuous resistance-wire D. I preferably employ a second range of similar commutator-bars E′ for each of my regulators where the regulator is designed for a three-wire circuit; but for a two-wire circuit a single range of commutator-bars can be employed. The commutators E and E′ are mounted in a suitable frame F, located, preferably, on top of the resistance-frames and arranged parallel to each other a suitable distance apart.

Centrally between the commutators is journaled in the frame a worm-shaft G, provided at one end with a hand-wheel *d* for turning it, which hand-wheel may be replaced by a cog-wheel where several regulators are connected together. Sliding on the shaft G and guided thereby are two cross-bars H H′, carrying at their ends brushes I I′ and J J′, which engage with the commutators E E′ and are insulated from the cross-bars by suitable blocks of insulating material *e*. Attached to the cross-bars and in electrical connection with the commutator-brushes are shown brushes K K′, making contact with straight metal strips L L′, which are mounted in the frame F below the commutators. All the brushes are composed, preferably, of a number of flat strips of copper laid one on top of the other and held firmly together at their inner ends where attached to the cross-bars and turned at their outer ends so as to bear "end-on" upon the commutators and the circuit-strips, as illustrated in Fig. 2.

The cross-bars H H′ are provided with handles *f g*, by which the cross-bars can be moved by hand lengthwise of the frame, such cross-bars sliding freely over the worm-shaft G. The cross-bar H′ is provided with a nut-section *h*, which is pressed by a spring *h′* into contact with the worm-shaft, so as to engage the cross-bar with the worm and force it to travel lengthwise of the frame F as the worm is turned. The nut *h* is connected by a rod *i* with a turning cam *i′* on top of the handle *g*, whereby the nut-section can be engaged with or disengaged from the worm by the turning of the cam, and the cross-bar H′ may thus be connected with the worm-shaft, so as to be moved thereby, or be disengaged from the worm-shaft, so that it can be moved by hand. The other cross-bar H may be similarly provided with a locking device for engaging it with the worm-shaft, although preferably only one cross-bar is so arranged. At the ends of the worm-shaft there are provided grooves *k*, into which the nut-section *h* is moved by the turning of the worm-shaft, disengaging the nut-section from the worm and preventing injury to the parts when the cross-bar H′ is moved by the worm to either end of the frame and the rotation of the worm is continued.

U-shaped springs *l* are provided at the ends of the worm-shaft for throwing the nut *h* back into engagement with the worm when the movement of the worm is reversed after the cross-bar H′ is moved to either end of the frame.

The connections between the commutators and the resistances are illustrated in Fig. 9, in which R and R′ represent two resistance-coils connected with the two commutators E and E′. Each of these resistance-coils may be wound upon a single frame, as illustrated in Fig. 1, or upon two or more frames. Whether mounted upon one or more frames, each resistance-coil is continuous from end to end, its two ends being connected with the opposite end plates of its commutator, and the intermediate plates of the commutator, from the ends to the center of the commutator, being connected to the resistance-coil at different points along its length from its ends toward its center, as illustrated in Fig. 9. Each resistance-coil is also constructed of several sizes of wire, as illustrated, the meeting ends of the wires of different sizes being soldered together to form a continuous metallic circuit. The largest size wire is employed at the two ends of the coil, and the smallest size at the center, with one or more intermediate sizes between the end coils and the center coils. In addition to thus increasing the resistance of the wire for each turn as it approaches the center of the coil, the connections *c* between the coil and the commutator are placed farther apart at the center of the coil than at the ends of the coil. Consequently, due both to the diminished size of the wire and the greater number of turns between the connections, as the center of the coil is approached the commutator is adapted to produce much wider variations in resistance along the center of its range than at its ends for each step of movement of the cross-bars H H′, which is a feature of importance in my regulator. The contact-strips L L′ have circuit connections 1 2 made therewith, while the resistance-coils R R′ are also provided with end circuit connections 3 4 and 5 6.

My regulator may be employed with various arrangements of circuit connections. To illustrate its operation I have shown two such arrangements in Figs. 10 and 11, which are simplified diagrams from which the operation of the regulator will be understood.

In Fig. 10 two lamp-circuits are shown as regulated by the resistance-coil R. By mov-

ing the cross-bars II and H′ together the current in one circuit will be increased as that in the other circuit is decreased. By moving the two cross-bars from the center of the resistance in opposite directions the current in both circuits will be increased. By moving the two cross-bars from opposite ends of the resistance simultaneously toward the center the current in the two circuits will be decreased. By moving either cross-bar alone toward and away from the other the current in the lamp-circuit connected with the end of the coil occupied by the cross-bar moved will be increased or decreased, according to whether the cross-bar is moved toward or away from its end of the commutator, while the current in the other lamp-circuit will remain unchanged. The regulator may be used in this manner with a two-wire circuit, in which case one resistance-coil and one commutator would be omitted; or, if provided with both resistance-coils and commutators, each coil and commutator could be connected with different circuits.

As illustrated in Fig. 11 the two resistance-coils are connected at their opposite ends to the outside wires of two three-wire circuits, and in a similar manner by moving the cross-bars II and H′ together in the same direction the current in one circuit is increased while that in the other circuit is decreased. By moving the cross-bars away from each other from the center of the commutators toward the ends the current in both circuits will be increased simultaneously. By moving the cross-bars from opposite ends of the commutator toward the center the current in both circuits will be decreased simultaneously, and by moving either cross-bar alone the current in the circuit controlled by it will be increased or decreased, according to the direction of movement, while the current in the other circuit will remain unchanged.

What I claim is—

1. In an electric light regulator, the combination with a resistance coil, of a series of commutator plates connected at intervals with said coil, circuit connections from the opposite ends of the coil independent of the commutator, and two contacts having circuit connections movable over the commutator, whereby different circuits may be regulated independently or together in the same or opposite directions, substantially as set forth.

2. In an electric light regulator, the combination with a resistance coil, of a series of commutator plates connected at intervals therewith, the steps of the commutator having a gradually increasing resistance from the ends toward the center, circuit connections independent of the commutator from the ends of the coil, and a contact provided with a circuit connection movable over the commutator, substantially as set forth.

3. In an electric light regulator, the combination with a resistance coil made of wire having a decreased diameter toward the center of the coil, of a series of commutator plates connected at intervals with the coil, the steps of the commutator including an increased number of turns of the coil toward the center of the commutator, circuit connections from the ends of the coil independent of the commutator, and a contact provided with a circuit connection movable over the commutator, substantially as set forth.

4. In an electric light regulator, the combination with a resistance coil, of a series of commutator plates connected at intervals with the coil, the steps of the commutator increasing in resistance toward the center, and two contacts having circuit connections movable over said commutator, substantially as set forth.

5. In an electric light regulator, the combination with a resistance coil, of a series of commutator plates connected at intervals with said coil, the two contacts movable over said commutator, a worm-shaft, and a lock for engaging and disengaging one of such contacts with said worm-shaft, substantially as set forth.

6. In an electric light regulator, the combination with the two ranges of commutator plates E, E′, and the resistance coils R, R′, of the cross-bars H, H′, carrying contact brushes I, I′, J, J′ and K, K′, and the contact strips L, L′, substantially as set forth.

7. In a regulator for electric lights, the combination with the commutators E, E′, of the cross-bars H, H′, carrying contact brushes, the worm-shaft G, upon which the cross-bars slide, and a lock for locking the cross-bar H′ to the worm-shaft, substantially as set forth.

8. In a regulator for electric lights, the combination of the rods A, porcelain spools A′, bracing plates *b*, and resistance wire D, substantially as set forth.

This specification signed and witnessed this 20th day of June, 1895.

JOS. CARL MAYRHOFER.

Witnesses:

EUGENE CONRAN,

JOHN R. TAYLOR.