(No Model.) 2 Sheets—Sheet 1.

C. WIRT.

ELECTRICAL INDICATOR.

No. 345,755. Patented July 20, 1886.

Fig. 1.

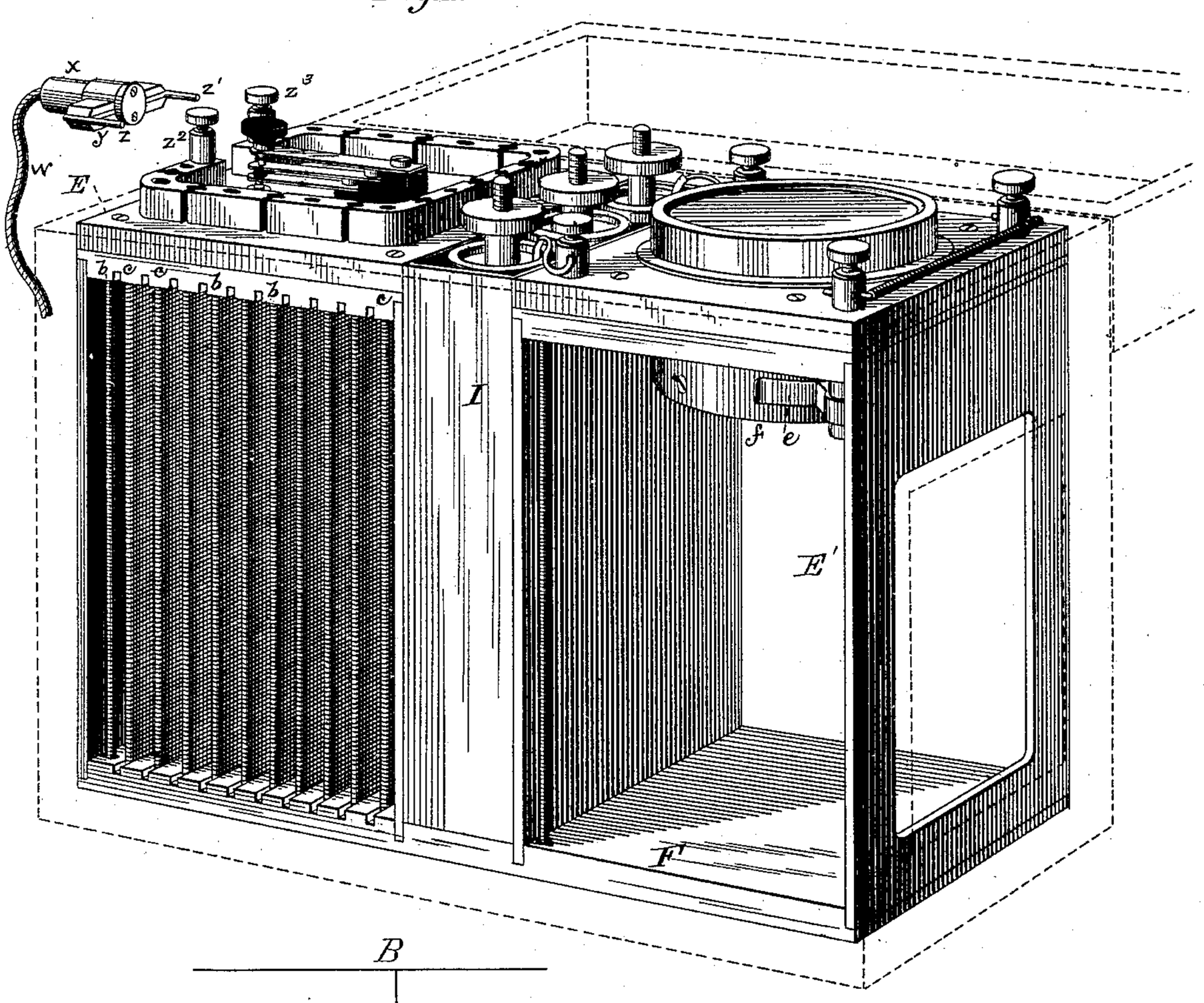
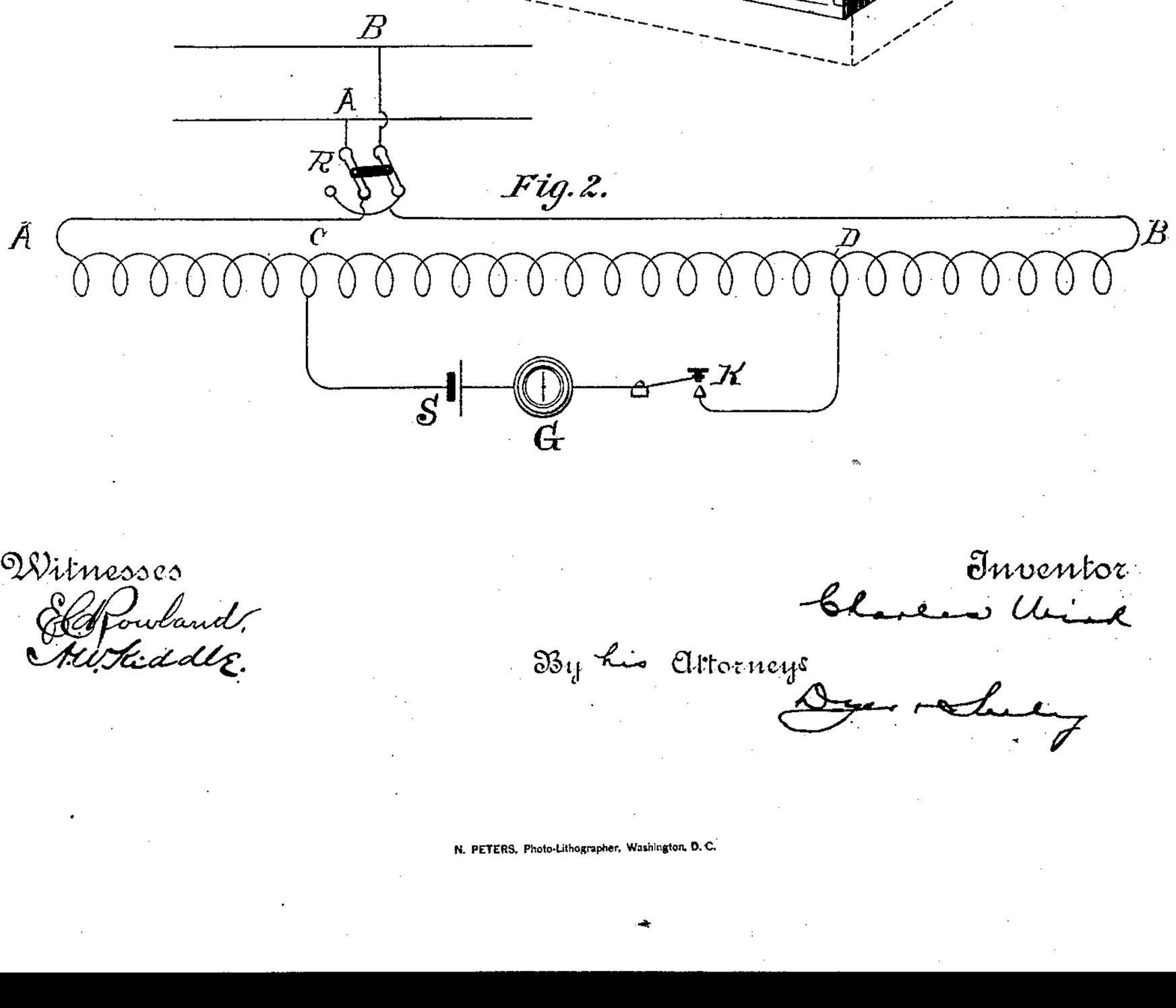


Fig. 2.



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(No Model.) 2 Sheets—Sheet 2.

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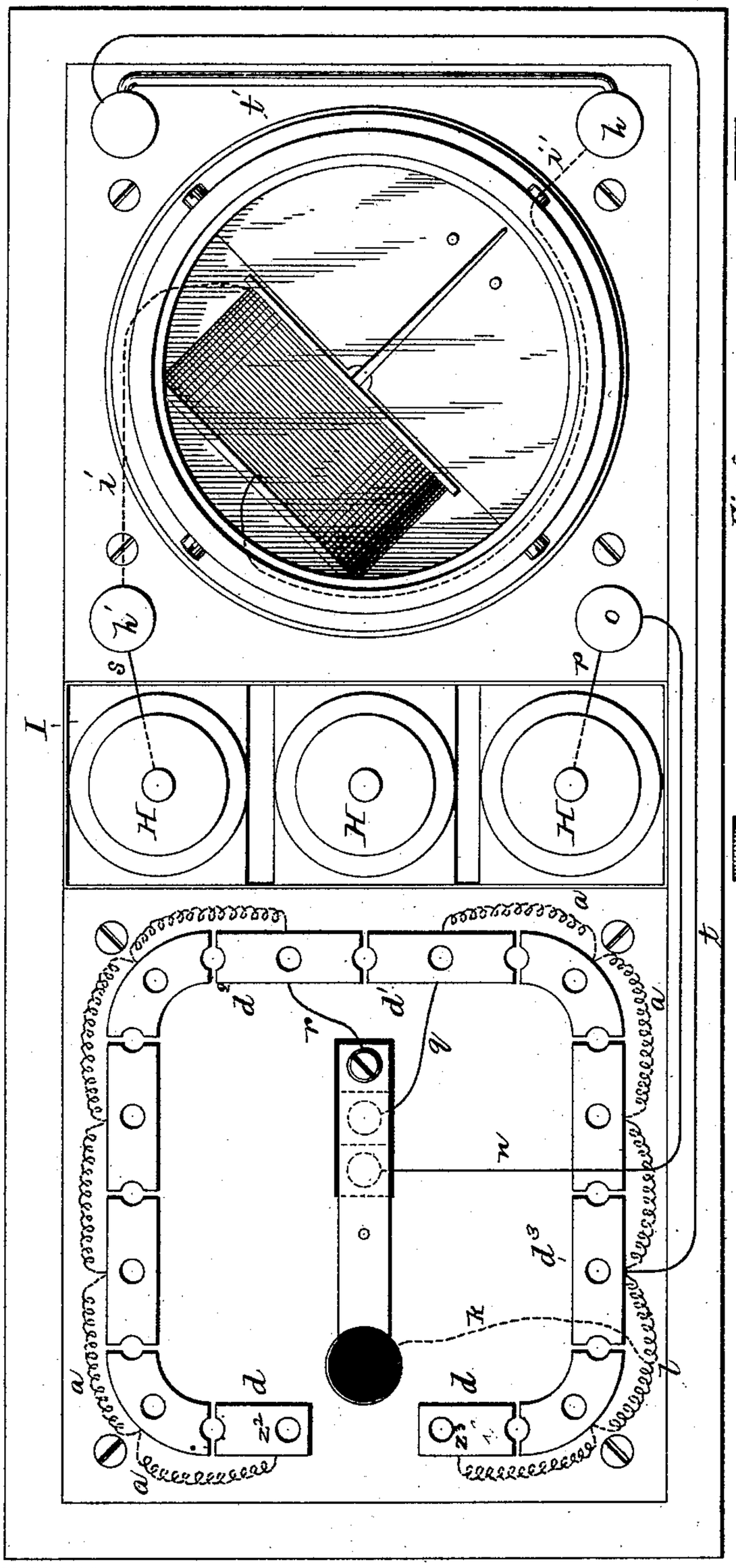

Fig. 3.

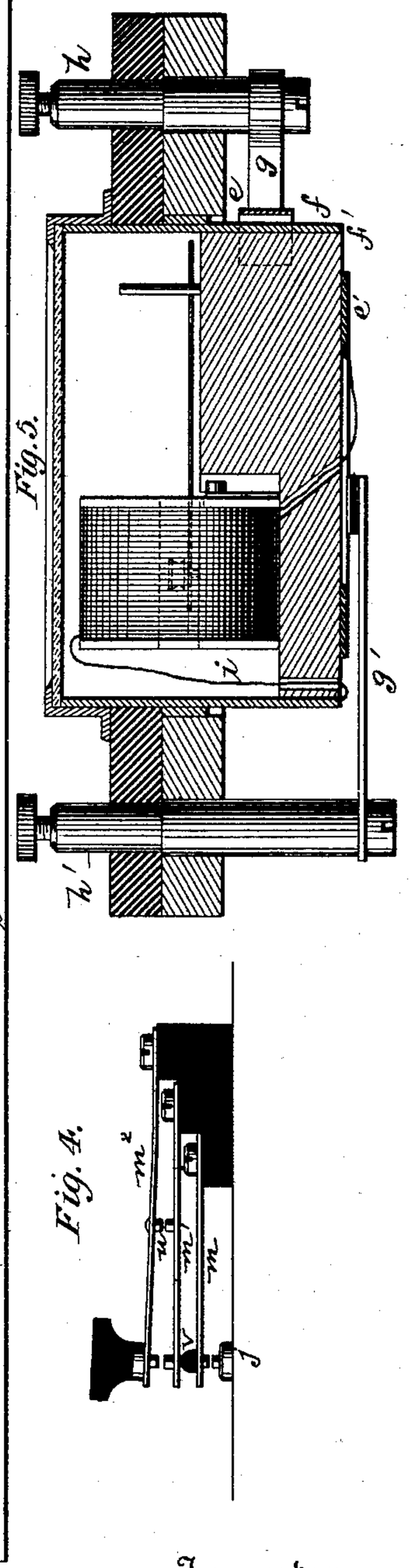

Fig. 5.

Fig. 4.

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UNITED STATES PATENT OFFICE.

CHARLES WIRT, OF CHIGAGO, ILLINOIS.

ELECTRICAL INDICATOR.

SPECIFICATION forming part of Letters Patent No. 345,755, dated July 20, 1886.

Application filed October 2, 1885. Serial No. 178,853. (No model.)

To all whom it may concern:

Be it known that I, CHARLES WIRT, of Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Electrical Indicators, of which the following is a specification.

My invention relates to an instrument or apparatus for measuring the electro-motive force existing at any part of an electric circuit.

The instrument consists, essentially, of a graduated variable resistance, and a shunt around a part of said resistance, including a standard battery, a galvanometer, and a circuit making and breaking key. The resistance is connected between the two points whose difference of potential it is desired to measure. When the key is closed, the standard electro-motive force of the battery is opposed by the electro-motive force of that portion of the circuit whose electro-motive force is to be measured, and if these two are equal the galvanometer-needle will remain at zero, there being no current in the shunt. If, however, one electro-motive force is greater than the other, the needle will be deflected. The variable resistance is then adjusted until the needle returns again to zero, when the electro-motive force is known by the resistance in circuit, the resistance-sections being graduated so as to indicate this, as will be explained.

My invention further consists in the novel devices and combinations of devices employed by me in carrying out the principle of operation just explained, as hereinafter set forth and claimed.

In the accompanying drawings, Figure 1 is a perspective view of a complete instrument embodying my invention; Fig. 2, a diagram illustrating the principle of the invention; Fig. 3, a top view of the instrument with diagram of the connections; Fig. 4, a view of the key which I prefer to employ, and Fig. 5 a section of the galvanometer.

Referring first to Fig. 2, A B represent a variable series of resistances connected across the circuit the electro-motive force in which it is desired to indicate. In a shunt around a portion, C D, of the resistances are a standard battery, S, a galvanometer, G, and a key, K. In the resistance-circuit is a circuit-reversing switch, R. When the key is closed, the battery-current opposes the main current in C D, and the electro-motive forces are in the following proportions: The electro-motive force from A to B is to the opposing standard electro-motive force as the resistance from A to B is to the resistance from C to D. The ratio of A B and C D is altered by varying the number of resistance-coils in circuit. If the galvanometer is deflected when the key is closed, then the resistance A B in circuit is decreased or increased until it again stands at zero. Then the total of the nominal values of resistance A B in circuit represent the electro-motive force from A to B.

Referring to Figs. 1, 3, 4, and 5, E E′ are two wooden boxes or frames mounted on a common base, F. Frame E supports within it the resistance-coils, which consist of insulated wire *a a*, coiled upon flat strips *b b*, which are held in slots *c c*. These coils are connected by connections through the top of the frame with plates *d d′*, as shown in Fig. 3, so that the insertion of a plug between two plates cuts out of circuit that portion of the resistance which is connected to those plates. The battery consists of three compartments, H H H, constructed and arranged as set forth in an application made by me of the same date herewith, and is placed in a suitable case, I, in the space between the two frames E E′. Frame E′ supports the galvanometer. The connections to the galvanometer are so made as to permit the instrument to be turned so as to bring its needle to zero, whereby the necessity for using external attraction for this purpose is done away with. Such connections are made by a curved spring, *e*, bearing on the circular metal case *f* of the galvanometer and carried by an arm, *g*, extending from binding-post *h*, and a curved spring, *e′*, bearing on a metal ring, *f′*, on the insulating-bottom of the instrument and carried by an arm, *g′*, extending from binding-post *h′*. From case *f* and ring *f′* wires *i* and *i′* extend, respectively, to the galvanometer-coils. The key in the shunt is a double key. From its lower stationary contact, *j*, a wire, *k*, extends to a point, *l*, on the adjustable resistance. From its lower circuit-closing strip, *m*, wire *n* extends to bind-

ing-post *o*, from which wire *p* goes to one of the battery-terminals. From strip *m'* wire *q* goes to plate *d'* of the rheostat, and from m^2 wire *r* goes to plate d^2. The other terminal of the battery is connected by wire *s* with binding-post *h'*. Plate d^3 of the rheostat is connected by wires *t t'* with binding-post *h'*. The double key closes one circuit before the other, the extra contacts *u* being provided, so that m^2 must make contact with *m'* before the latter pushes *m* down upon *j*, and so as to lessen contact resistance. *m* and *m'* have an insulating-button, *v*, between them. The connections with the circuit whose electro-motive force is to be determined is made through conductors combined in a flexible cord, *w*, in any suitable manner. At the end of this cord is a connecting device, which consists of a body of insulating material, *x*, having a cross-piece, *y*, which carries two metal pins or plugs, *z z'*. The flexible cord enters *x*, and its conductors are therein connected with *z z'*. To make connection the pins are thrust into the holes of the binding posts z^2 z^3 of the rheostat. When both contacts of the key are closed, the circuits are as follows: From z^2 through such resistances *a* as are in circuit to d^2 by *r*, to m^2 and *m'* by *q* to *d'*, and again by *a a* to z^3. This corresponds with circuit A B of Fig. 2. The shunt is from *l* to *j m n o p* to battery *s i'* to galvanometer, *i t' t* to d^3. The key (*m j*,) battery, and galvanometer are thus shunted around a portion of the resistance, as represented by C D of Fig. 2.

The operation is as follows: Connection with the circuit having been made as described, the galvanometer is first turned so as to bring its pointer to zero. Then the key is tapped and closes first the resistance-circuit and then the battery-shunt through a portion of said resistance, so that the two currents are there opposed. If the electro-motive force of one is more than that of the other, the needle will be slightly deflected. Portions of resistance *a a* are then cut out of circuit until the needle again returns to zero, whereupon the electro-motive force of the circuit under consideration is known, is denoted by the amount of resistance which is in circuit. If, when the key is first closed, the galvanometer is violently deflected, it indicates that the two currents are in the same direction. The plugs *z z'* are then withdrawn, and the connecting device turned around so as to put each plug in the other binding-post, and thus reverse the circuit. This may often occur in practice, as when the indicator is connected with the circuit at a point where the direction of the current is not known. It is therefore desirable to have a circuit-reverser of some kind, and that above described is a very simple and convenient form. I may, however, employ any other suitable device for the same purpose—such, for instance, as the circuit-reverser R of Fig. 2. By means of the double key the resistance-circuit may be kept closed without closing the battery-circuit; or, if desired, the resistance-circuit may be closed by inserting a plug between *d'* and d^2. The binding-posts *h* and *h'* are provided so that the galvanometer may be used for other work, if desired.

The use of the connecting device for the flexible cord is not confined to this apparatus alone. It is evident that such a device may be used in any case where a flexible cord is to be connected to binding-posts, and is advantageous over the usual practice of having two loose ends for the conductors, since these are not unlikely to come in contact and produce a short circuit when the cord is dropped from the binding-posts.

The resistance-coils are wound in single layers, and, being on flat spools, there is little heating and little danger of a short circuit occurring. The preferred way of forming the coils is to wind the wire on paper tubes and then compress them into the flat shape.

The whole apparatus is placed in an inclosing-box, (shown by dotted lines M M in Fig. 1,) and is thus conveniently transported from place to place. The frames E E may be conveniently removed from the box, and the battery-case also may be readily taken out for refilling.

What I claim is—

1. In an electrical indicator, the combination of a variable resistance adapted to be connected across the two points of the circuit at which its electro-motive force is to be determined, a shunt around a definite portion of said resistance, means for producing a counter electro-motive force in said shunt, and means for indicating the current in said shunt, substantially as set forth.

2. In an electrical indicator, the combination of the variable resistance, the shunt including the standard battery, galvanometer, and key, and a reverser for the resistance-circuit, substantially as set forth.

3. The combination of the supporting-frame provided with slots of the flat resistance-spools held by said slots, substantially as set forth.

4. The combination, with a galvanometer, of sliding contacts permitting the turning of the galvanometer, substantially as set forth.

5. The combination, with a galvanometer having a metal case and a metal ring on its insulating-bottom, of a contact-spring bearing on said case, a contact-spring on said ring, and connections from said case and said ring to the galvanometer-coils, substantially as set forth.

This specification signed and witnessed this 21st day of September, 1885.

CHARLES WIRT.

Witnesses:
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ALBERT N. EASTMAN.