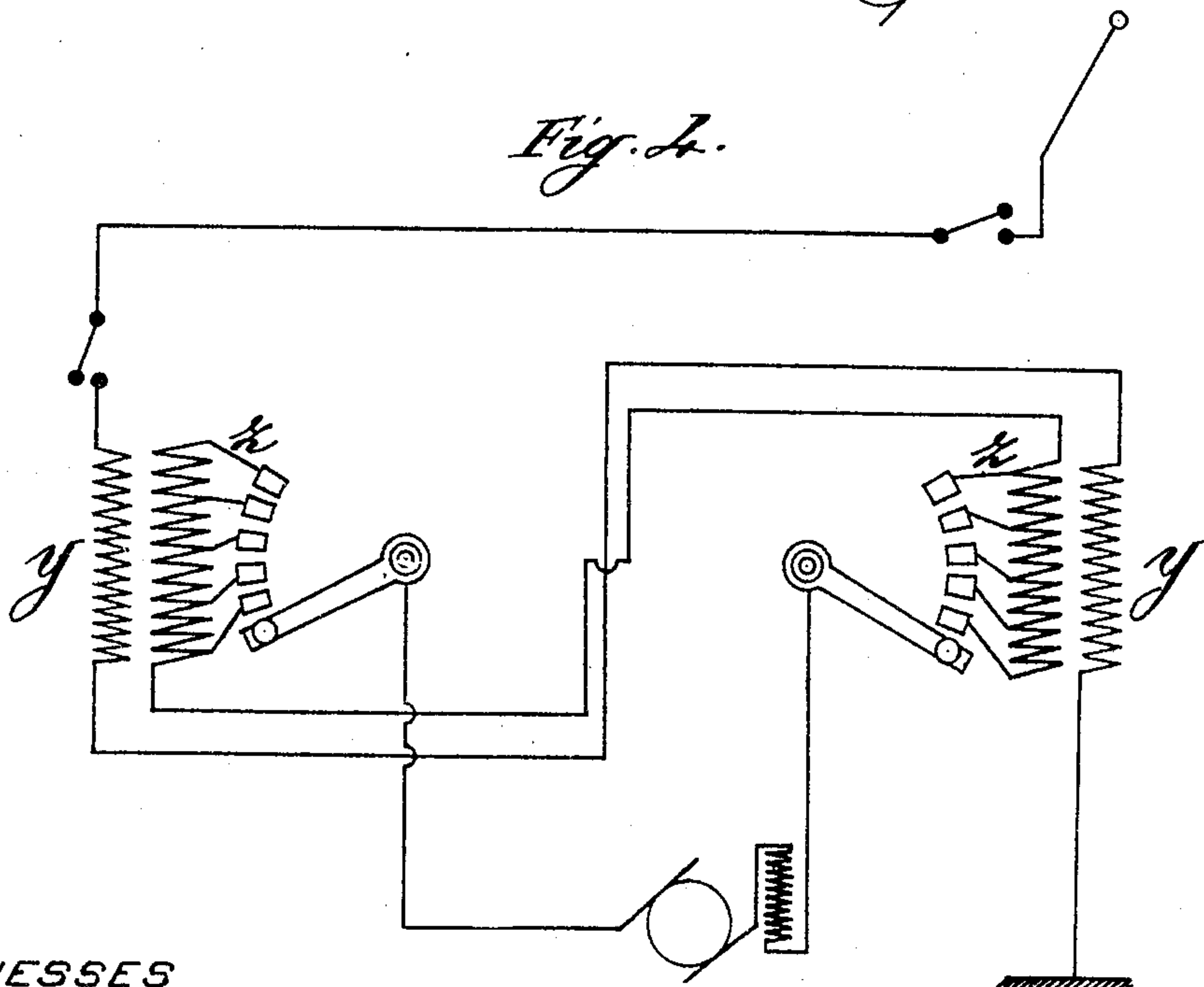
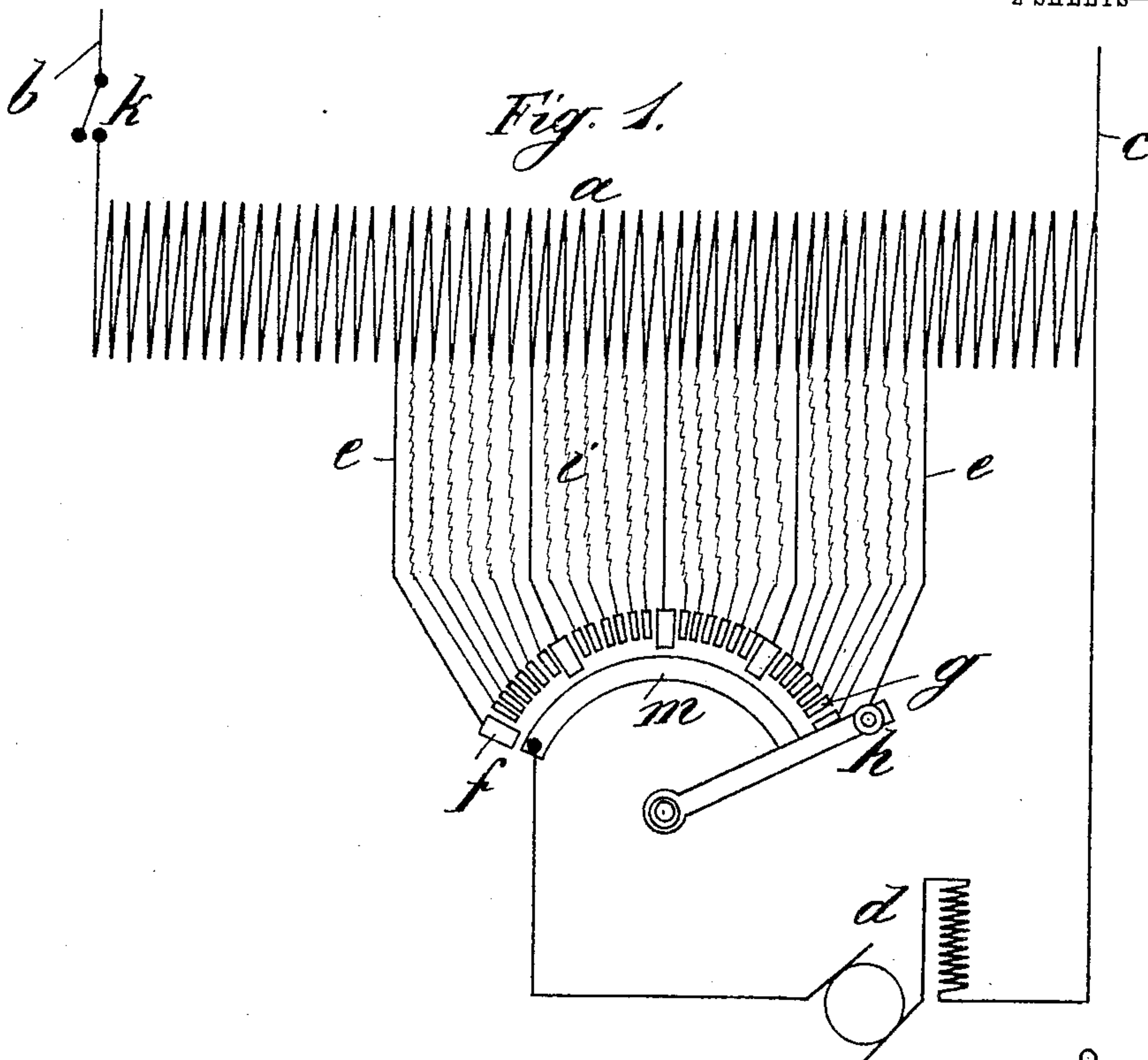


ALTERNATING CURRENT REGULATOR.

APPLICATION FILED FEB. 11, 1904.

2 SHEETS—SHEET 1.



WITNESSES
E. A. Allen.
Walter Bates, Jr.

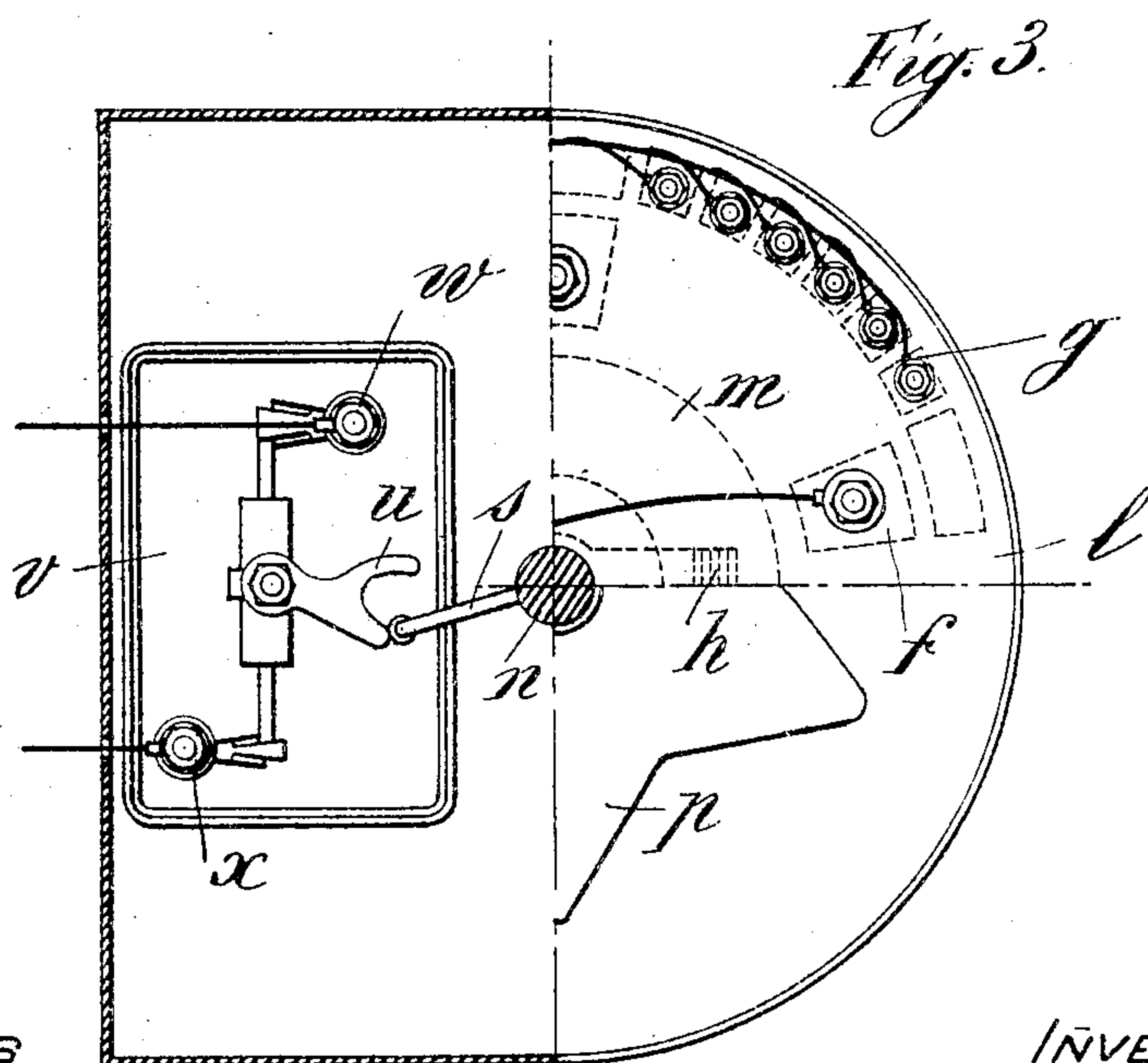
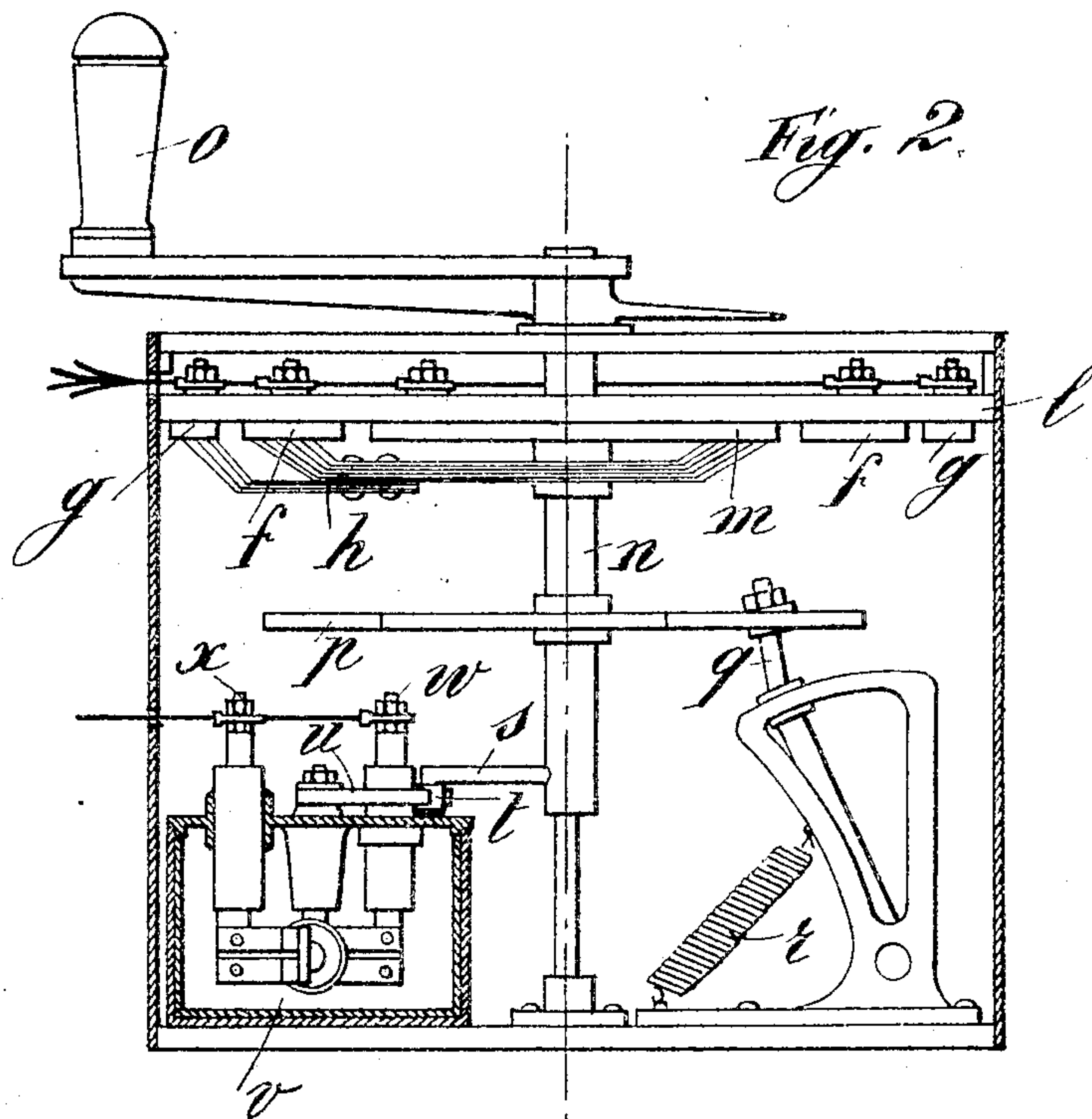
INVENTOR
Giorgio Finzi,
by his attorney,
Charles Dickenson.

G. FINZI.

ALTERNATING CURRENT REGULATOR.

APPLICATION FILED FEB. 11, 1904.

2 SHEETS—SHEET 2



WITNESSES
E. A. Allen
Walter Bates Fair

INVENTOR
Giorgio Finzi,
by his attorney,
Charles Dickinson

UNITED STATES PATENT OFFICE.

GIORGIO FINZI, OF MILAN, ITALY.

ALTERNATING-CURRENT REGULATOR.

No. 807,545.

Specification of Letters Patent.

Patented Dec. 19, 1905.

Application filed February 11, 1904. Serial No. 193,066.

To all whom it may concern:

Be it known that I, GIORGIO FINZI, electrical engineer, a subject of the King of Italy, residing at 24 Piazza Castello, Milan, in the Kingdom of Italy, have invented certain new and useful Improvements in Alternating-Current Regulators, of which the following is a specification.

In the regulation of electric circuits feeding the translating devices the change from one voltage to another is of frequent occurrence. Apart from those cases in which it is possible to effect the regulation of the voltage at the source of current (regulation of the excitation) and from that in which the regulation is obtained at the cost of expenditure of energy (regulation by switching in resistances) the regulation both in the case of continuous and alternating current may be obtained by interrupting and closing the main circuit at suitable points; but by this means the contact-surfaces are subjected to considerable attacks by the sparks formed on the interruption of the main current. This defect is frequently overcome in switches (controllers) for electric vehicles by means of the magnetic blow-outs, which, however, do not come into question in the case of alternating currents, or by not permitting the collector to leave one contact-piece until it has reached the next, by which means, although the interruption of the main circuit is obviated, still two contact-pieces are momentarily short-circuited, between which there exists a difference of potential.

The object of this invention is the employment on alternating-current transformers of a regulation of this latter kind in which no interruption of the main circuit takes place, and the object has been to minimize the short-circuit current in such a manner that it cannot detrimentally affect the transformer or cause sparking, which will attack the contact-pieces, as when interruption takes place.

Upon constructional grounds it is not possible to multiply the gradations of voltage, and consequently the number of contact-pieces *ad infinitum*, as might otherwise appear to be desirable from the standpoint of the diminution of the short-circuit current. Further, it is not possible simply to insert resistances between contact-pieces and collectors such that even with a small number of gradations the desired diminution of the

short-circuit current may be obtained, because in this way too much energy would be lost by heating. If, however, we are content with a smaller number of voltage gradations—five, for example—a switch (controller) with five contact-pieces is obtained which by means of connections presenting but very inconsiderable resistance may be connected to suitable points of the transformer-winding, the said connections being calculated for being constantly traversed by the main current. If now there are inserted between the said five main keys six other auxiliary keys also connected with the intermediate points of the winding by the intermediary of suitable resistances in such a manner that the brush will invariably remain in contact with two keys, (not more and not less,) and if, further, matters are arranged in such a manner that the brush is not able to remain on one of the auxiliary keys, but is conducted back to the main keys, it will be possible to proceed from one working voltage to the next without interrupting the main circuit without considerable loss by Joule effect and without producing prejudicial short-circuiting currents. In doing this the said resistances must be selected in such a manner that the short-circuit current (which is to pass through two such resistances in series apart from the moment at which a main and an auxiliary contact are short-circuited) does not exceed a given strength and so that no notable fall of voltage takes place in the main current, which, according to the position of the brush, will either traverse a single resistance of this kind or two arranged in parallel. It should here be stated that the resistances are only traversed by the main current for short periods separated one from the other, so that in calculating them their radiating-surfaces for heat does not come into consideration, but only their heat capacity, so that in practice conductors of relatively small cross-section and also small longitudinal development may be employed. It should of course also be understood that the difference of voltage between two adjacent contacts should not exceed a given maximum value; otherwise the production of heavy sparking could not be avoided, however the resistances inserted were calculated. Should the lowest voltage obtained in the distributing-circuit have a relatively high value with respect to the fall in voltage

between two successive gradations of the switch, it would be necessary in order to pass from the first main key to zero to dispose of a large number of auxiliary keys. In this case it would be better to interrupt the circuit directly by means of an ordinary switch, the manipulation of which could be combined with that of the handle of the key-switch, (controller.)

In the accompanying drawings, Figure 1 illustrates diagrammatically a constructional form of the invention. *a* is a choking-coil—that is to say, one with a transformer or autotransformer—acting as voltage equalizer and connected to the points *b* and *c* of the line. The point *c* is directly connected to the translating device—for example, the motor *d*. The conductors *e* proceed from suitable points of the choking-coil *a* to the main contact *f* of the collector. Between two successive main contacts *f* auxiliary contacts *g* are arranged. Upon these latter the brush *h* is not able to remain. They are in communication with intermediate points in the winding of the choking-coil by means of resistances *i*. The brush is also in communication with the other pole of the line. The switch *k* serves to interrupt the input-conductor of the choking-coil when the brush lies upon the main key of the switch, which corresponds to the lowest working voltage.

Figs. 2 and 3 show a constructional form of the invention corresponding to the diagram in Fig. 1. Upon the upper end of a metal box is arranged the plate *l*, of marble. Upon the under side of this plate are mounted the following parts: A metal ring *m*, connected to the line; the five main keys *f*, which correspond to the five working voltages and which are connected to the winding of the autotransformer by means of conductors the cross-section of which is calculated for the main current and which proceed from the upper side of the plate *l*; twenty-four auxiliary keys *g*, six of which are interposed between each two main keys and which are arranged outwardly relatively to these latter. These auxiliary keys are connected by means of conductors, likewise proceeding from the upper side of the plate *l* and of suitable resistance, to appropriate points of the winding of the autotransformer. A shaft *n*, driven by the crank *o*, carries the brush *h*, which forms the connection between the ring *m* and each one of the keys *f* and also temporarily between *m* and one of the keys *g*. By means of the ratchet-wheel *p*, which is also mounted on the shaft *n* and which is submitted to the influence of the lever *q*, acted upon by the spring *r*, the brush *h* is prevented from remaining on the auxiliary keys *g*, but is, on the contrary, compelled to remain constantly in contact with one of the main keys *f*. The shaft *n* is also provided with a finger *s*, ending in a vertical nose *t*.

By means of the fork *u* this nose actuates an oil-switch *v*, interposed between the terminals *w x* of the autotransformer, and which only interrupts the circuit when the collector comes into contact with the main key *f* of lowest potential. Upon the scale over which the handle *o* slides the positions corresponding to the five main keys and also to the interruption of the circuit by the switch—that is to say, six different positions are indicated.

An apparatus of this kind may be utilized in all cases in which it is desired to regulate the voltage of alternating currents along the line. It is especially applicable for use with single-phase alternating-current motors the velocity of which in their employment for driving vehicles must be variable. In the case of motor-vehicles driven by one or more motors the working voltage of which is intended to vary within the ratio of one to two—for example, between one hundred and two hundred volts—the regulation of which should be possible both from the front and rear platforms a switch (controller) of the kind described above would be extremely suitable. A switch of this kind should be provided on each platform in connection with a transformer, each of which is designed for one-half of the total output—that is to say, for the total current and for half of the necessary maximum voltage. The primary windings *y* of the two transformers should be arranged in series. The secondary windings *z* should be arranged in the manner indicated in the diagram Fig. 4 or in some similar manner. The controller on the rear platform should be placed upon the key corresponding to the maximum voltage—that is to say, the lowest voltage required for running the motor, (one hundred volts in the foregoing example.) The higher potentials (from one hundred to two hundred volts) and also the interruption of the circuit would then be effected by the manipulation of the controller on the front platform. If a single transformer is to be provided, (for example, beneath the vehicle,) the procedure would be similar, one half of its secondary winding being connected with each of the platform-controllers.

It will of course be understood that the switch described above may equally well be employed with an ordinary transformer as with an autotransformer provided with a single winding; that the switch and the transformer may constitute a whole or they may be separate; that the actuation may take place either by hand or by means of relays; that the interrupter may be of any suitable kind or when the lowest working voltage is not far removed from zero it may be dispensed with altogether, and, finally, that the method of regulation described is equally suitable for polyphase and for single-phase currents.

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

1. The combination of a switch having main and auxiliary keys with an alternating current, variable voltage, non-sparking transformer, the winding of the transformer being divided into a number of main divisions the ends of which are connected to said main keys by means of conductors of low resistance; said conductors; subdivisions of said main divisions, the ends of the subdivisions being connected to auxiliary keys; conductors of relatively high resistance for said auxiliary keys; and a brush; whereby the short-circuit current arising in the manipulation of the brush is diminished.

2. The combination of a switch having main and auxiliary keys with an alternating current, variable voltage, non-sparking transformer, the winding of the transformer being divided into a number of main divisions the ends of which are connected to said main keys by means of conductors of low resistance; said conductors; subdivisions of said main divisions, the ends of the subdivisions being connected to auxiliary keys; conductors of relatively high resistance for said auxiliary keys; and a brush; whereby the short-circuit

current arising in the manipulation of the brush is diminished; and means which prevent the brush from remaining in permanent contact with the auxiliary keys.

3. In vehicles driven by alternating electric currents and having a platform at each end, the combination of a switch, adapted for the maximum voltage which corresponds to the minimum working voltage and mounted on one platform; of a similar switch mounted on the other platform; and electrical connections, substantially such as described, between the two switches; and means which cause the switch that is in the temporarily-rear platform to remain at said minimum voltage while the switch on the then front platform serves to effect the regulation between said voltage and the maximum working voltage and also the interruption of the circuit.

In testimony whereof I have hereunto set my hand, in presence of two subscribing witnesses, this 15th day of December, 1903.

GIORGIO FINZI.

Witnesses:

H. P. SMITH,
MICHELE H. DRAGO.