(No Model.)

5 Sheets—Sheet 1.

M. LEVY.

APPARATUS FOR CONTROLLING ELECTRIC CURRENTS.

No. 286,833. Patented Oct. 16, 1883.

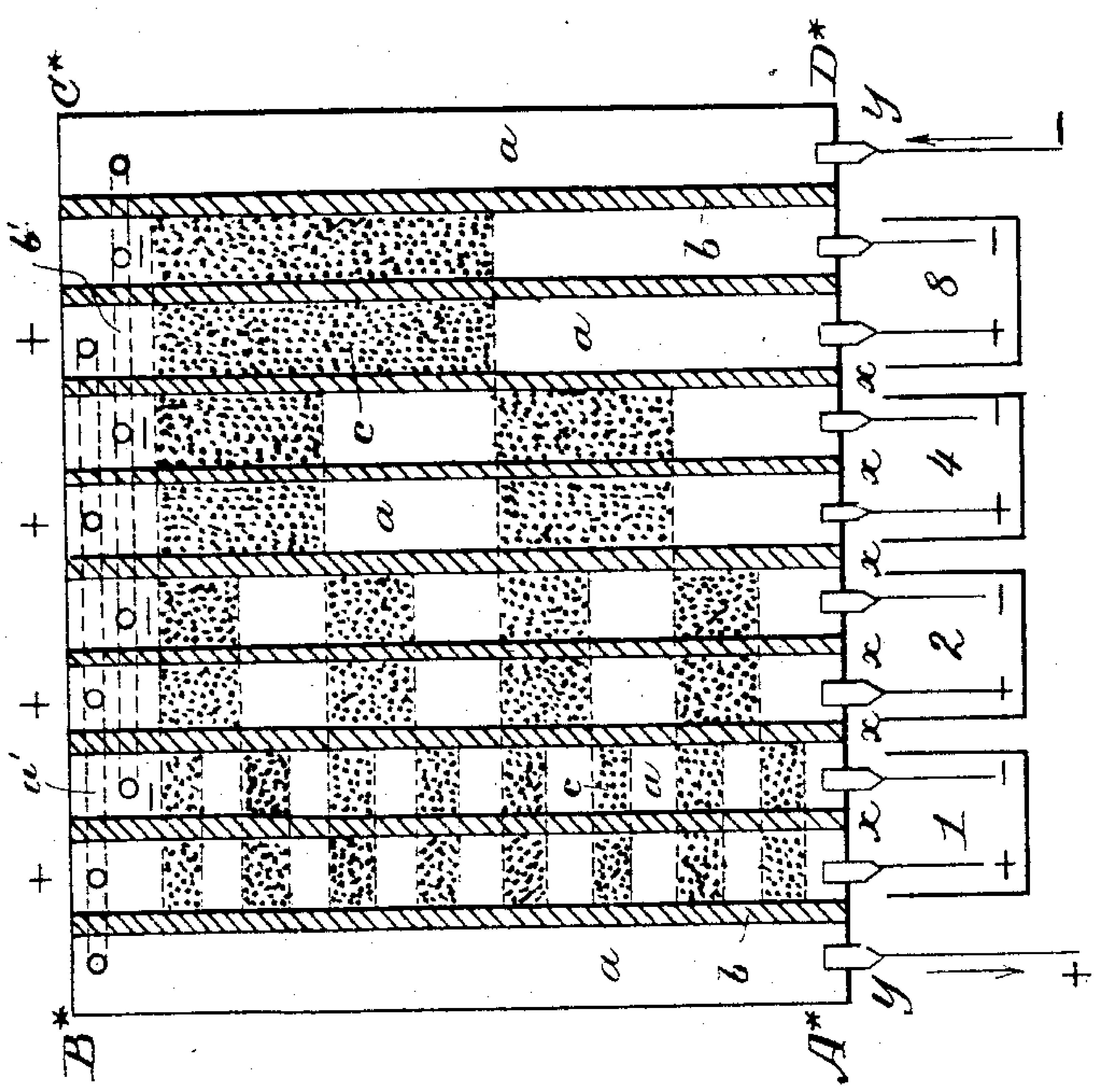


Fig. 2

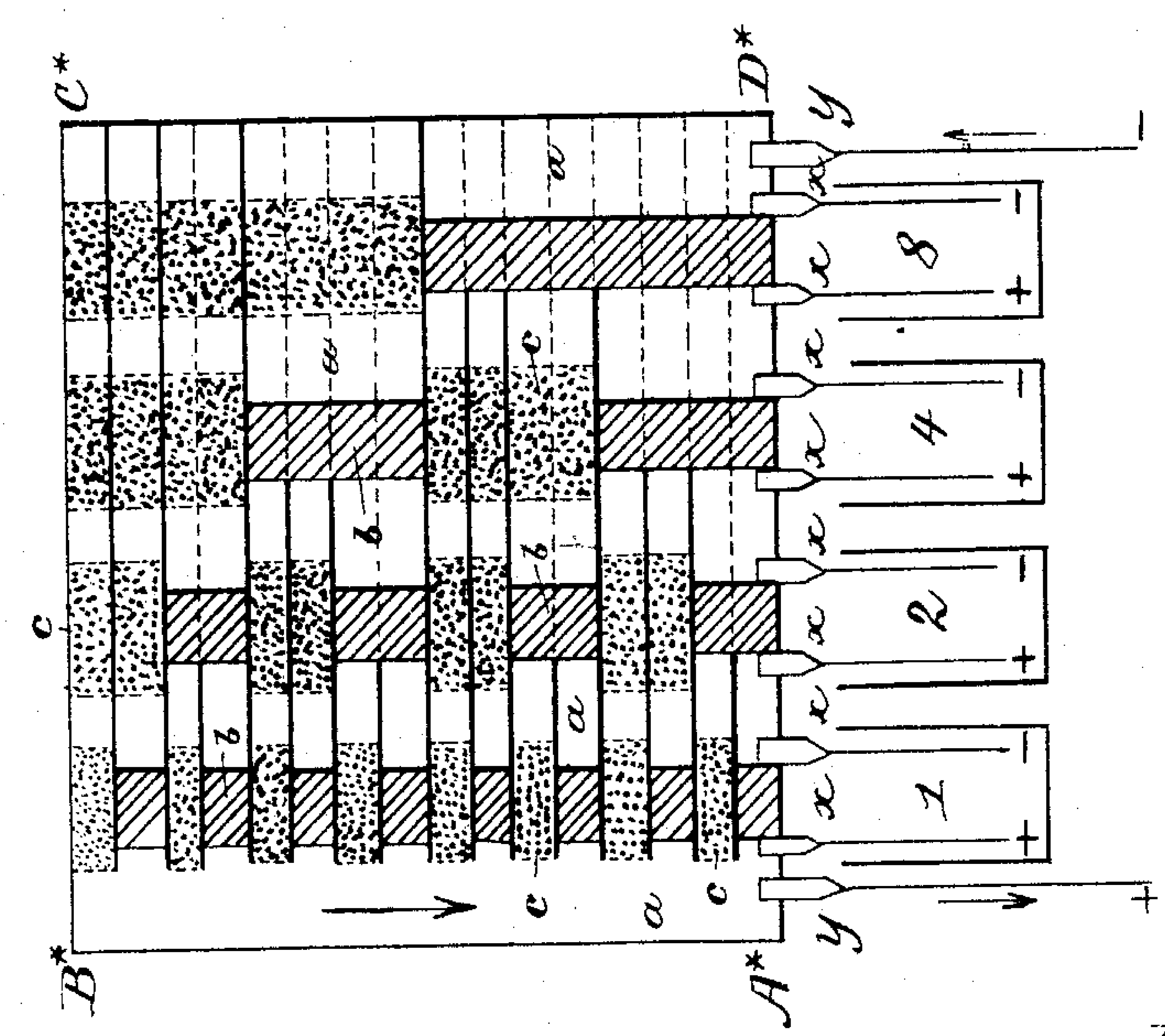


Fig. 1

Witnesses:

E E Masson

C. J. Hedrick

Inventor:

Maurice Lévy by

A Pollok

his attorney.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 5 Sheets—Sheet 2.

M. LEVY.

APPARATUS FOR CONTROLLING ELECTRIC CURRENTS.

No. 286,833. Patented Oct. 16, 1883.

Fig. 4.

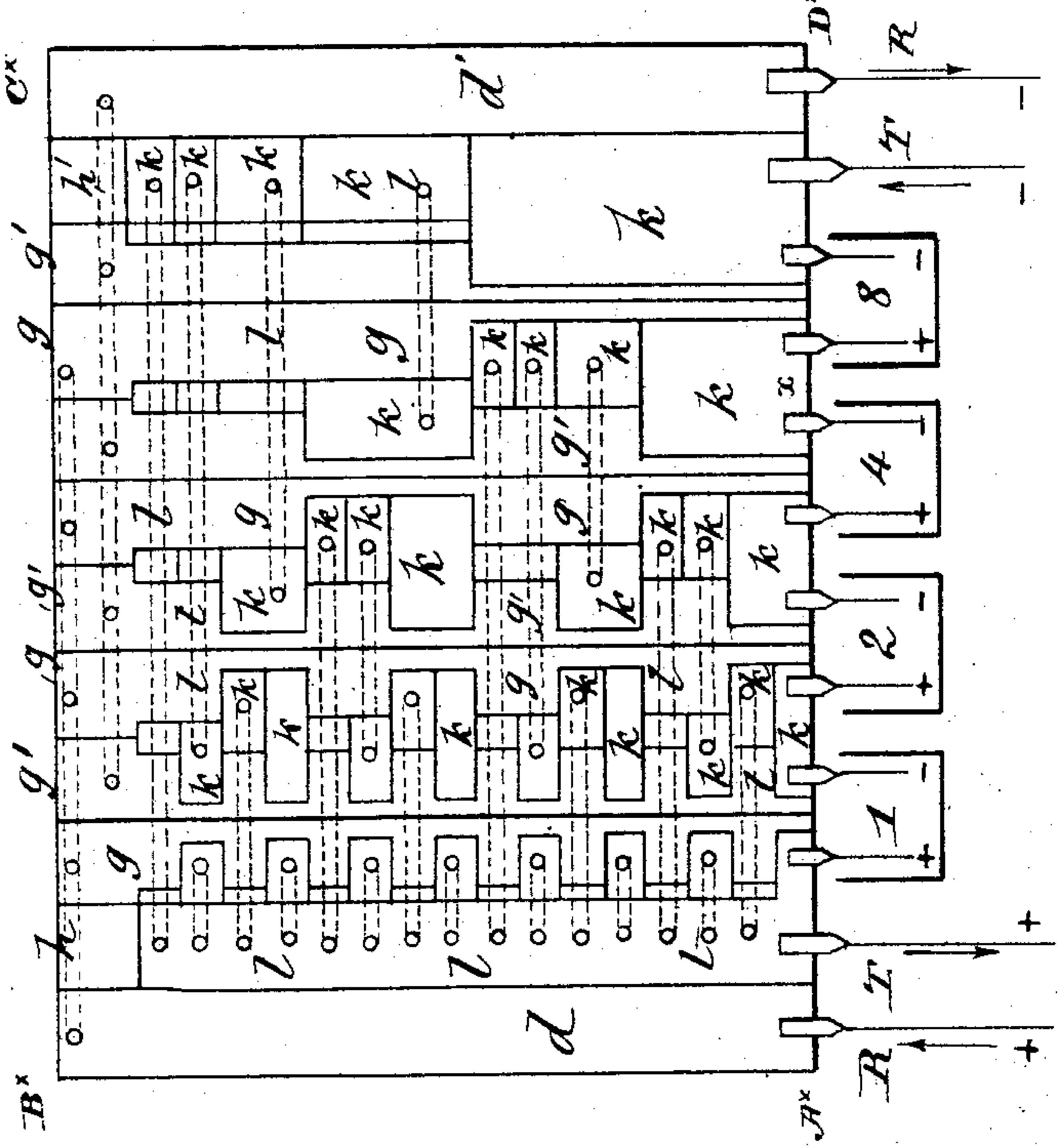
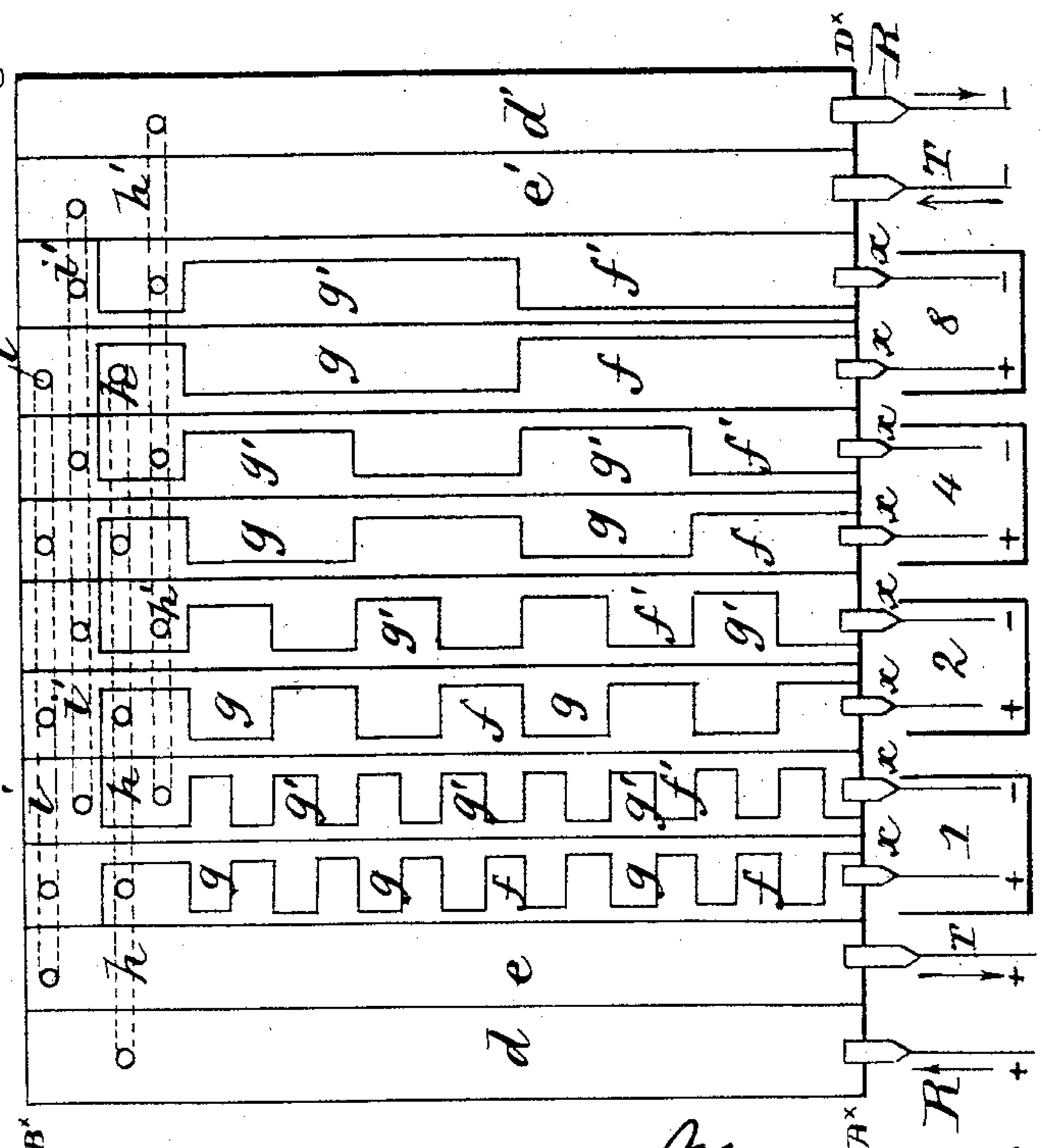


Fig. 3.



Witnesses:
E. E. Masson
C. J. Hedrick

Inventor:
Maurice Levy by
A Pollok
his attorney.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.)

5 Sheets—Sheet 3.

M. LEVY.

APPARATUS FOR CONTROLLING ELECTRIC CURRENTS.

No. 286,833. Patented Oct. 16, 1883.

Fig. 6.

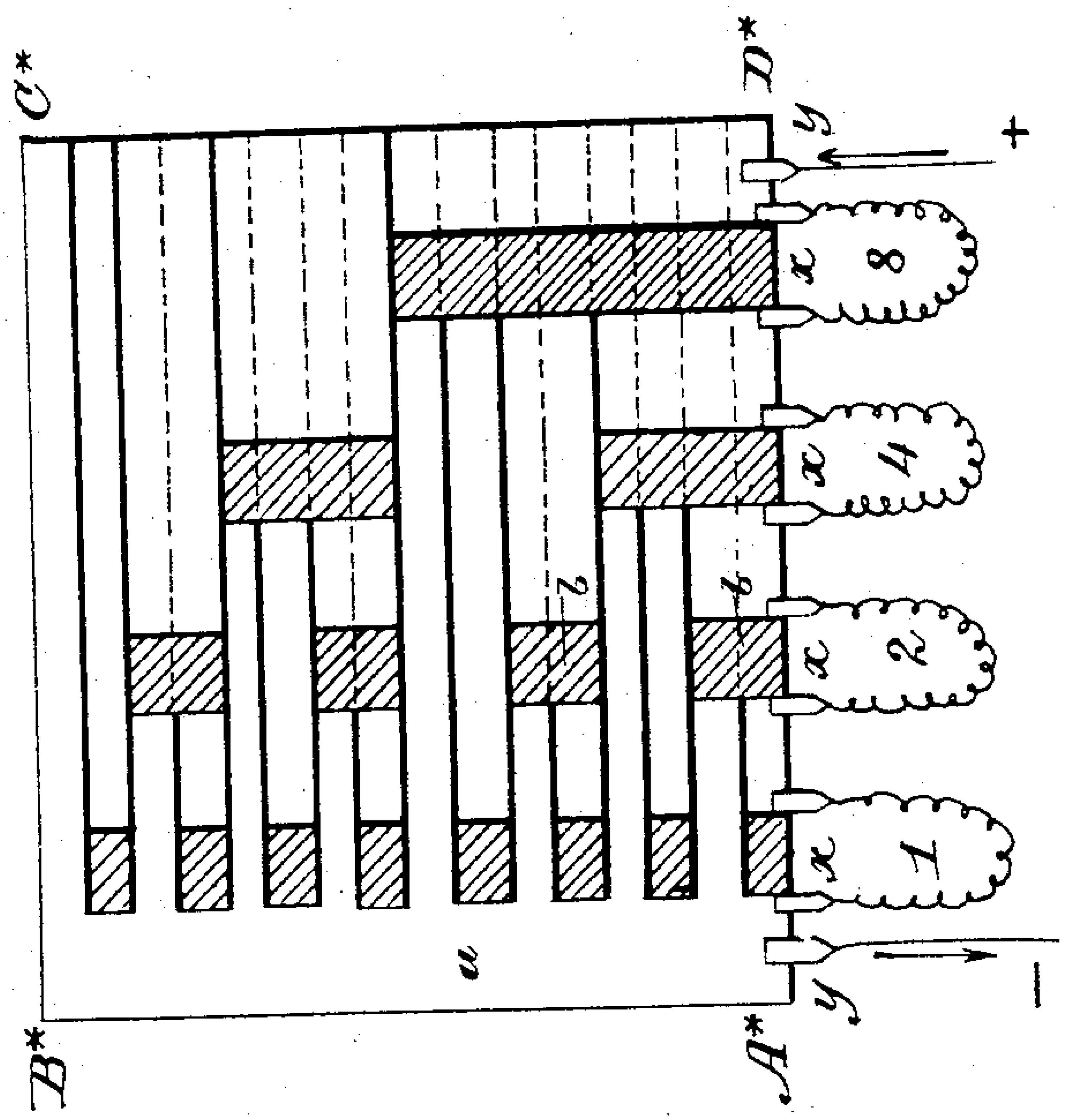
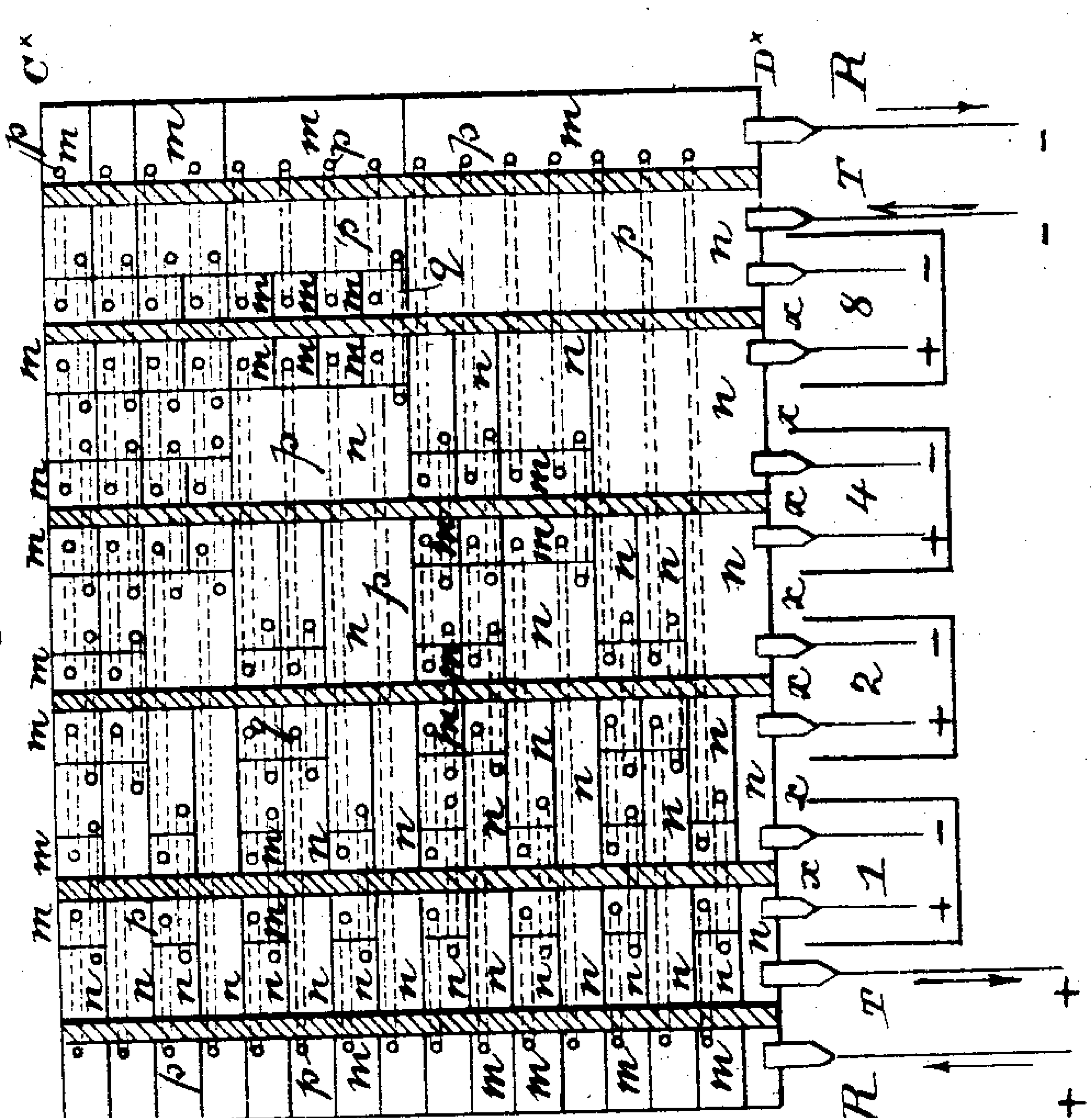


Fig 5



Witnesses:

E. E. Masson

C. J. Hedrick

Inventor:

Maurice Lévy by

A. Pollok

his attorney.

N. PETERS. Photo-Lithographer, Washington, D. C.

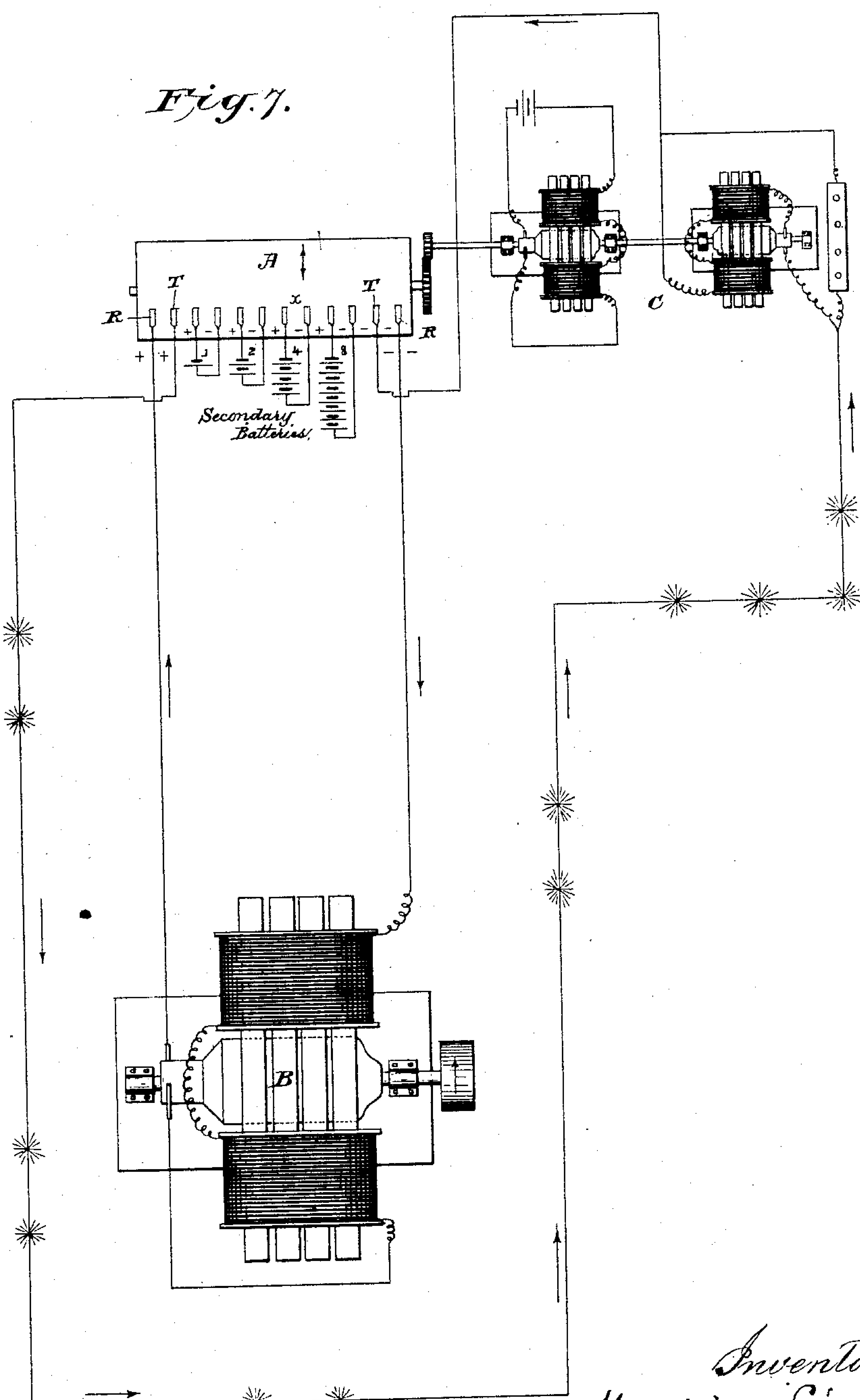
(No Model.) 5 Sheets—Sheet 4.

M. LEVY.

APPARATUS FOR CONTROLLING ELECTRIC CURRENTS.

No. 286,833. Patented Oct. 16, 1883.

Fig. 7.



Attest:
Geo. T. Smallwood.
C. J. Hedrick

Inventor:
Maurice Lévy by
A. Pollok
his attorney.

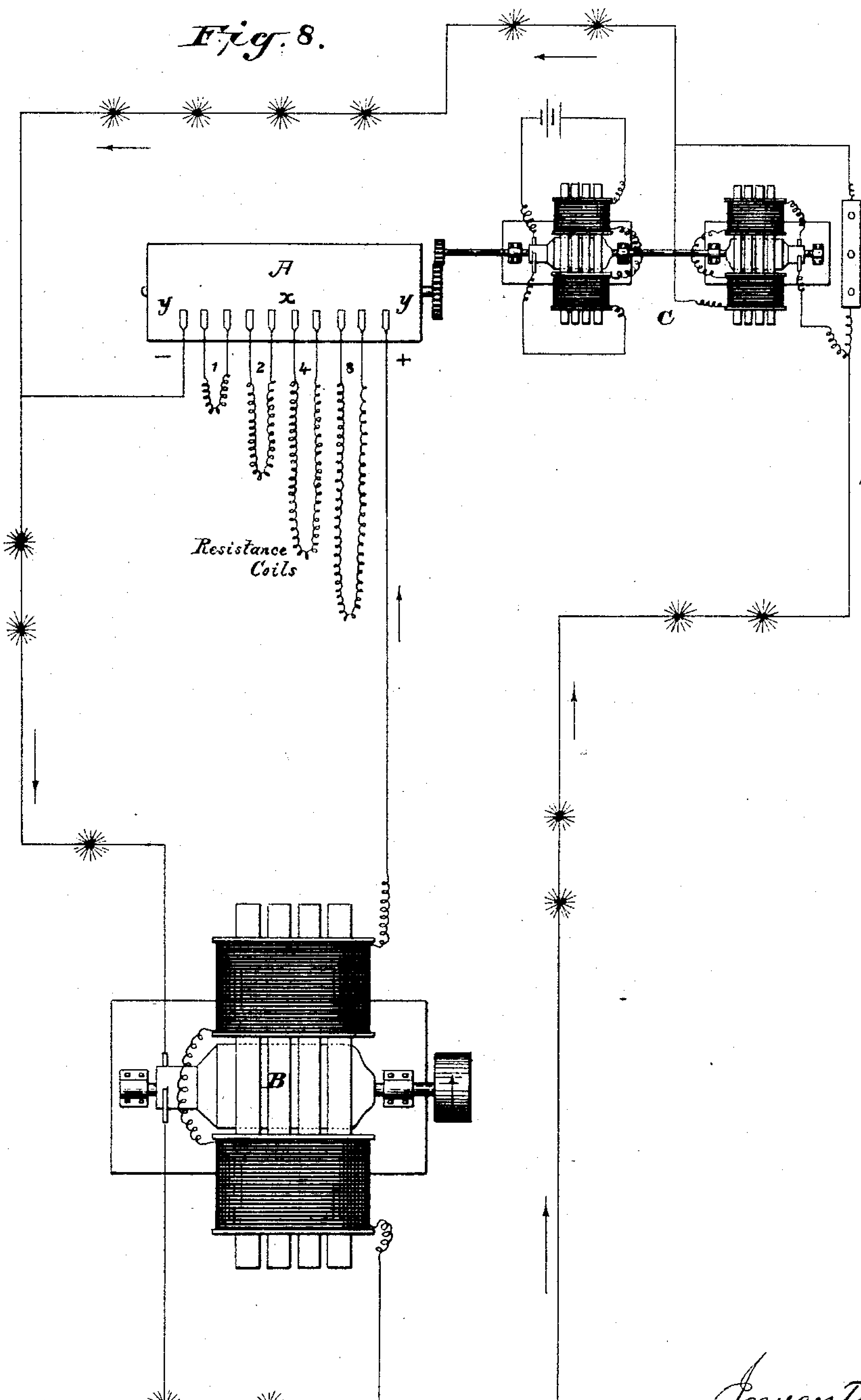
(No Model.) 5 Sheets—Sheet 5.

M. LEVY.

APPARATUS FOR CONTROLLING ELECTRIC CURRENTS.

No. 286,833. Patented Oct. 16, 1883.

Fig. 8.



Attest:
Geo. T. Smallwood.
C. J. Hedrick

Inventor:
Maurice Lévy by
A. Pollok
his attorney.

UNITED STATES PATENT OFFICE.

MAURICE LEVY, OF PARIS, FRANCE.

APPARATUS FOR CONTROLLING ELECTRIC CURRENTS.

SPECIFICATION forming part of Letters Patent No. 286,833, dated October 16, 1883.

Application filed June 21, 1883. (No model.) Patented in France January 21, 1882, No. 146,988; in Belgium March 6, 1882, No. 57,253; in Austria July 11, 1882, and in England August 2, 1882, No. 3,689.

To all whom it may concern:

Be it known that I, MAURICE LEVY, of Paris, in the Republic of France, have invented a new and useful Improvement in Switches and other Apparatus for Controlling the Current in Electrical Systems, which improvement is fully set forth in the following specification.

This invention has reference to a new construction of switches or communicators for connecting and disconnecting electrical circuits; also, to a new arrangement of electrical generators or resistances or other electrical apparatus; also, to a new construction of resistance-coils, and to a new combination of switches and generators with an electrical governor or current-regulator.

The improved switch or commutator comprises a series of switch-plates and a series of springs or contact devices so arranged and combined with insulators that by the movement of the switch-plates under the springs or contact devices, or of the latter over the former, the loops or branches connected with the several springs or contact devices are alternately connected in and cut out of circuit, and the number of loops or branches in circuit at the same time is progressively increased by a series of successive and alternate increments and decrements, or is decreased in like manner.

The new arrangement of generators, resistances, or other electrical apparatus consists in dividing a of series such apparatus into groups, sets, or individuals, which increase throughout the series in a certain ratio, either in their number or in their electro-motive force, resistance, capacity, or some other unit. Thus if the apparatus be galvanic batteries and the series is based upon number, the first group would contain one or more cells, the second double the number, the third double the second or four times the first, and so on. If the series is based on electro-motive force, the generators of each group or set, or each individual generator, would be of a number of volts, say, double the preceding and half that of the succeeding group, set, or individual. If the series be based on resistance, then the number of ohms would, in the successive individual resistances or sets of resistances, increase in a similar ratio. This arrangement in a geometrical ratio of two is that preferred, and is itself a part of the invention; but other ratios—arithmetical, geometrical, or partly one and partly the other—may be adopted. The generators, resistances, and other apparatus are combined with a switch or commutator, such as first described, for connecting in and cutting out the different groups, sets, or individuals in the proper order. Thus if the arrangement be a geometric ratio of two, the switch or commutator would (moving in one direction) successively connect in the first group, set, or individual, then cut out the first and connect in the second, then connect in the second with the first, then cut out both and connect in the third, and so on, so that there would be a regular and progressive increase in the number of cells or other apparatus in circuit in their electro-motive force, resistance, or other property, by adding at each change a given quantity to the preceding. By moving the switch or commutator in the reverse direction, there would be a regular decrease instead of an increase.

The improvement in switches or commutators also consists in a combination or arrangement of devices whereby the generators or other apparatus, when cut out of one circuit, are automatically connected in another. These switches are particularly advantageous in systems employing secondary batteries, they being used to transfer the batteries from the charging to the working circuit, or vice versa, according to the exigencies of the occasion.

The new construction of resistance-coils consists in making them of fine wire and placing them in a vacuum.

The new combination of switches, generators, and electric governors or current-regulators will be hereinafter set forth, as also certain particular constructions and combinations of parts in the different apparatus, which also form part of this invention.

In the accompanying drawings, Figures 1, 2, 3, 4, 5, and 6 show in detail the construction and operation of different forms of the improved switches or commutators, together with the new arrangement of cells and resistance-coils; and Figs. 7 and 8 are diagrams illustrating the combination of these switches with circuits, a generator or generators, and an automatic governor or current-regulator.

Fig. 1 illustrates a switch or commutator, and an arrangement of galvanic cells, whereby any number of cells from one to the whole number connected with the switch or commutator may be included in an exterior circuit. A* B* C* D* is the development on a plane surface of the cylindrical switch or commutator. The body of the switch or commutator is of wood or equivalent non-conducting material; and it is covered with plates *a*, of copper or other conducting material, except the shaded portions *b*, which therefore represent non-conducting surfaces. The copper is covered on the dotted portions *c* with a coating of insulating material, but otherwise is bare. The heavy lines indicate spaces between the copper plates, which are filled with insulating material. The numerals 1 2 4 8 indicate groups of cells connected in tension and in number corresponding to the numerals thereon. The poles of each group are connected with springs *x x*, which bear against the surface of the switch or commutator. The latter, it will be seen, is divided longitudinally, according to the number of cells, and circumferentially according to the number of the groups. The springs *y* are connected with the exterior circuit. In the position shown all the cells are connected in tension. If the switch or commutator be moved in the direction of the arrow thereon, the number of cells in circuit will be successively diminished by one until finally all are cut out. The first step cuts out group 1, the springs *x* of that group then resting upon insulating material *c*, leaving 2, 4, and 8 (equal to fourteen cells) in circuit. The next step cuts out group 2, but restores group 1, making thirteen cells in circuit. The next step again cuts out group 1, leaving twelve cells in circuit. The fourth step cuts out group 4, but restores groups 1 and 2, leaving eleven cells in circuit, and so the operation proceeds. By properly placing the switch or commutator any desired number of cells may be included in the exterior circuit. The commutator may be moved by hand or automatically by a suitable regulator. The number of groups and the number of cells may be indefinitely increased. This arrangement is designed for connecting cells in tension, and therefore the cells of the several groups have been described as connected in tension, but the cells of each group could be connected in quantity, and the groups then connected in tension.

Fig. 2 illustrates an arrangement for connecting any desired number of cells in quantity or multiple arc. As before, there are groups of one, two, four, and eight cells; but now the cells of each group are supposed to be themselves connected in quantity instead of tension. The switch or commutator A* B* C* D*, as before, is made of wood, covered with copper *a*, which is itself in places covered by insulating material *c*. The copper strips, which extend around the switch or commutator, comprise two end strips, against which the springs *y y* bear, and intermediate strips, (two to each group of cells,) against which the springs *x* bear. The intermediate strips are connected alternately with the two end strips by conductors *a′ b′*, let into the wood. Thus all the positive poles of the cells are connected with one end strip, and all the negative poles with the other end strip, except, of course, where the said cells are cut out by the interposition of the insulating material *c* on the copper strips between the latter and the springs *x* when the poles are connected with neither. The number of cells connected in quantity or derivation depends upon the position of the switch or commutator. As shown, the fifteen cells are in circuit. By turning the switch or commutator in the direction of the arrow, the number is reduced one cell at a time until all are cut out. The cells may be of primary or secondary battery; or other generators of electricity may be connected with the switch or commutator. When secondary batteries are employed, it is desirable that the cells, except when in use for discharging, be placed in a charging or regenerating circuit.

Switches or commutators for connecting any desired number of cells in the working-circuit, and for placing them in a charging-circuit when cut out of the former, are shown in Figs. 3, 4, and 5. Three cases present themselves: first, when the groups of all the cells are connected in quantity in both circuits; second, when they are connected in quantity in one circuit and in tension in the other, and, third, when they are connected in tension in both. The cells composing the groups may, besides, be themselves connected either in tension or quantity. Fig. 3 illustrates the switch or commutator for use in the first case. The wooden base is covered with circumferential strips of copper *d d′*, *e e′*, *f f′*, *g g′*. These strips are connected by conductors *h h′ i i′*, let into the wood, and arranged as shown at the top of the figure, but are otherwise insulated from each other. There are two pair of strips, *f f′* and *g g′*, to each group of cells, and two pair of end strips, *d d′* and *e e′*. The end strips, *d d′ e e′*, are simply placed side by side, and they are in continuous electrical connection, the one pair, *d d′*, with the poles of one circuit—say the charging or regenerating circuit—through the springs R, and the other pair, *e e′*, with the poles of the other (or working-circuit) through the springs T. Of the intermediate strips, one strip of each pair *f f′* is interlocked with a strip of a corresponding pair, *g g′*, so that the spring *x* alternately makes contact with the one or the other. The strips *f* are all connected with the end strip *d* by the wires *h*, the strips *f′* with the end strips

d' by the wires h', the strips g with the end strip e by the wires i, and the strips g' with the end strip e' by the wires i'. The result is in substance as follows: The strips f are in constant electrical connection with one—say the positive—pole of the charging or regenerating circuit, and are connected with or disconnected from the pole of like name (or positive pole) of the several groups of cells, according to the position of the switch or commutator. The strips f' are in constant electrical connection with the opposite or negative pole of the same (charging or regenerating) circuit, and are connected with or disconnected from the pole of like name (or negative pole) of the several groups of cells. The strips $g\ g'$ are in like manner the one set in constant electrical connection with the positive pole of the working-circuit, and, as occasion may require, in connection with the positive poles of the several groups of cells, and the other set in constant electrical connection with the negative pole of the working-circuit, and in connection, as occasion may require, with the negative poles of the several groups of cells. The interlocking strips are so arranged that the number of cells in circuit increase or decrease progressively as the commutator is turned in one direction or another. As the cells are disconnected from the circuit, they are connected in with the other circuit, so that each cell is either charging or discharging.

If the groups of cells are to be connected in one circuit—say the working-circuit—in tension and in the other (or charging-circuit) in quantity, the arrangement shown in Fig. 4 is adopted. The "quantity-strips" $g\ g'$ are constructed as in Fig. 3, and are connected by the wires $h\ h'$ with the end strips $d\ d'$. The place of the strips $f\ f'$ is supplied by the plates k, which are placed between lateral projections on the strips $g\ g'$, and are connected by the wires l with the end strips $e\ e'$ or with each other, so that the groups of cells in the working-circuit at any one time are connected in tension. It is obvious that if it be desired to have the groups of cells in tension in the charging-circuit and in quantity in the working-circuit, it would only be necessary to change the connection of the poles of the circuits with the springs R and T.

If the groups of cells are to be connected in tension in both circuits, the switch or commutator shown in Fig. 5 is used. Its body is covered with the copper plates $m\ n$, which are connected by wires p and q, but are otherwise insulated from one another. The plates m are so joined that the cells in electrical connection therewith are in one circuit through the contact of springs x and R. The plates n, on the other hand, establish the connection of the cells with the other circuit through the springs x and T. The operation is obvious from inspection of the drawings.

Instead of connecting in a circuit cells of battery or other generators of electricity, the switch or commutator can be used to connect in resistances. These could be substituted without change for the cells in connection with the switch or commutator, Fig. 1; but since the short-circuiting of the resistance is not attended with any disadvantages—such as loss of energy by the short-circuiting of a galvanic battery—the insulating material c on the copper strips in Fig. 1 may be omitted, the construction and combination being then as shown in Fig. 6.

It is obvious by this apparatus very great changes can be made in the resistance. For example, if necessary, the resistance may be graduated as well by thousandths or hundredths of an ohm as by ohms, and may be varied from a hundred ohms to a hundredth of an ohm; but in order that the apparatus may be practically used to the best effect, it is desirable to obtain in a small compass very great resistances, or resistances graduated by very small quantities. For this purpose very fine wires placed in a vacuum are employed. Thus in a very small box in which a vacuum can be maintained light resistance-coils of fine platinum wire having a resistance, respectively, of 1, 2, 4, 8, 16, 32, 64, and 128 ohms, and by the improved commutator, a resistance graduated by ohms can be obtained—from one ohm to two hundred and fifty-five ohms.

An analogous system of resistances placed in the air and graduated by hundredths of an ohm, and composed of six resistances, can be used in combination with the foregoing, and thus a resistance graduated by hundredths of an ohm can be obtained—from one hundredth up to two hundred and fifty-five ohms.

In Fig. 7 a secondary-battery system is shown. A is the switch or commutator, of either of the forms shown in Figs. 4 and 5. 1, 2, 4, and 8 are the groups of secondary-battery cells; x, the contact-springs connected with the poles of the groups; R T, the poles of the charging and working circuit, respectively; B, a dynamo-electric machine of ordinary construction in the charging-circuit, and C an electric regulator in the working-circuit, in which are also represented a number of lights. The electric regulator shown consists of two motors having their armatures mounted on the same shaft and arranged to act in opposition. One motor is energized by a battery in a local circuit, and the other by a portion of the current from the working-circuit. The motor-shaft is geared or otherwise connected with the shaft of the switch or commutator A. The strength of the motors and the connection with the switch or commutator is such that when a current of normal strength is on the working-circuit the motor excited thereby is just balanced by the other; but when said current rises above the normal it overcomes the resistance of the other and revolves the switch or commutator in the direction required to cut out the battery-cells, and when it falls below the normal the counterbalancing motor has the greatest power and revolves the switch or commutator in the opposite direction. When, therefore, the current is normal, the armatures of both motors are stationary, being in equilibrium, and any deviation therefrom is corrected by a transfer of cells from the charging to the working circuit, or vice versa. The operation would be the same if primary cells or other generators were used instead of secondary batteries; but in such case there would be no need of the charging-circuit, and it could be omitted. The switch might then be such as shown in Fig. 1. The working-circuit shown has the lights or translating devices in series. Therefore a switch or commutator which will connect the cells in series is employed. If the translating devices be connected in derivation, the switch for varying the number of cells in derivation, as shown in Fig. 3, may be used, or, if there be no charging-circuit, that shown in Fig. 2 would be employed. The regulator would also be excited in a derivation or branch.

In Fig. 8 the dynamo-electric machine B supplies directly the working-circuit, and is excited in a derivation of said circuit, which includes the switch or commutator A, being connected with the contact-springs *y*. A series of resistance-coils, 1 2 4 8, are connected with the springs *x* of the switch or commutator, as described with reference to Fig. 6. The regulator C is connected with the main circuit and operates the switch or commutator to cut out the resistance-coils, and thus increases the current in the field-coils of the dynamo when the current on the main circuit falls below the normal, and to connect in the resistance-coils and diminish the current exciting the dynamo when the current on the main line rises above the normal.

The regulator C, as shown, is described in Letters Patent of the United States No. 273,291, granted to me on the 6th day of March, 1883. The other regulators shown in said patent could be used instead of it, if desired; or other regulators of ordinary or suitable construction adapted to operate the improved switches or commutators could be used.

The regulators of the improved type described in my aforesaid patent, and exemplified by the regulator C, are therein shown combined with the motor for driving the dynamo-electric machine or machines and operating to control the supply of fluid to said motor. They are herein shown as applied to the operation of a switch or commutator, and it is obvious that they could be used to operate switches or commutators of any known or suitable construction. This combination of the regulators of the type illustrated by regulator C with switches or commutators generally controlling a circuit, as also the combination of the improved switches or commutators with electric regulators generally, is included in this invention, as well as the specific combination of the improved switches or commutator with the regulators of the counterbalanced motor type.

It is obvious that the improved switches or commutators, and the arrangement of cells, resistances, or other apparatus, as described, as well as the combination just indicated, are capable of a very large number of applications other than illustrated by the diagrams, Figs. 7 and 8.

Having now fully described my said invention and the manner of carrying the same into effect, what I claim is—

1. A switch or commutator comprising a series of switch-plates, combined with a series of springs or contact devices, and arranged, substantially as described, so that a progressive movement of said switch or commutator increases or decreases the number of loops or branches in circuit by successive and alternate additions and subtractions, the additions exceeding the subtractions when the switch is moved in one direction and being exceeded by them when moved in the opposite direction, as set forth.

2. The series of electrical apparatus—such as galvanic cells, resistances, or the like—divided into groups, sets, or individuals increasing in the geometric ratio of two, in combination with a switch or commutator for connecting and disconnecting said apparatus, as described, so as to increase or decrease the apparatus in circuit in arithmetical ratio, according to the direction in which the switch or commutator is moved, as set forth.

3. The combination of the series of electric apparatus—such as galvanic cells, resistances, or the like—divided into groups, sets, or individuals increasing in geometric ratio, with the switch or commutator for connecting and disconnecting said apparatus, so as to increase or decrease in arithmetical ratio the apparatus in circuit, according to the direction in which the switch is moved, and an automatic governor or electric regulator connected with the said switch or commutator for operating the same, substantially as described.

4. The combination, with an electric regulator comprising a motor and counterbalancing mechanism, of the improved switch or commutator comprising a series of switch-plates and springs or contact devices, mechanism for conveying the motion of said motor to said switch or commutator, and electrical connections including the switch in the same circuit with said motor, substantially as described.

5. The combination, with a switch or commutator for controlling an electric current, of an automatic governor or electric regulator comprising a motor excited in circuit, and counterbalancing mechanism applied to the shaft of said motor for holding the same stationary in equilibrium so long and so long only as the current is normal, substantially as described.

6. The combination of a series of electrical

apparatus divided into groups, sets, or individuals increasing in geometric ratio, a switch or commutator for connecting and disconnecting said apparatus, so as to increase or diminish those in circuit in arithmetic ratio, and an automatic governor or electric regulator comprising a motor and counterbalancing mechanism applied to the shaft of the motor, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

MAURICE LEVY.

Witnesses:
EUG. DUBAIL,
GUSTAV LAPOT.