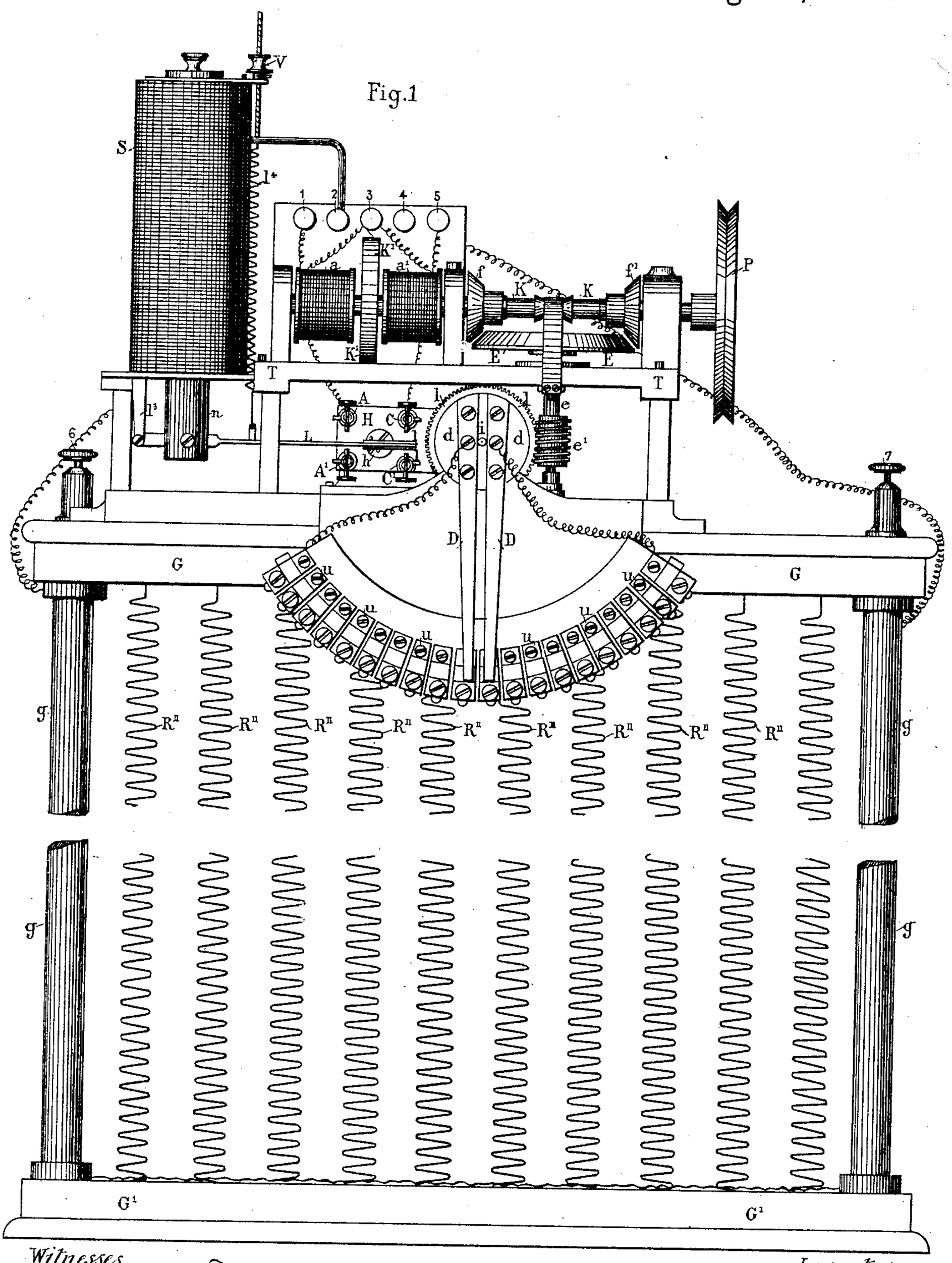
(No Model.) 6 Sheets—Sheet 1.

R. THURY.

AUTOMATIC CURRENT REGULATOR.

No. 435,332. Patented Aug. 26, 1890.

Fig. 1



Witnesses
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(No Model.) 6 Sheets—Sheet 2.

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AUTOMATIC CURRENT REGULATOR.

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Fig. 2.

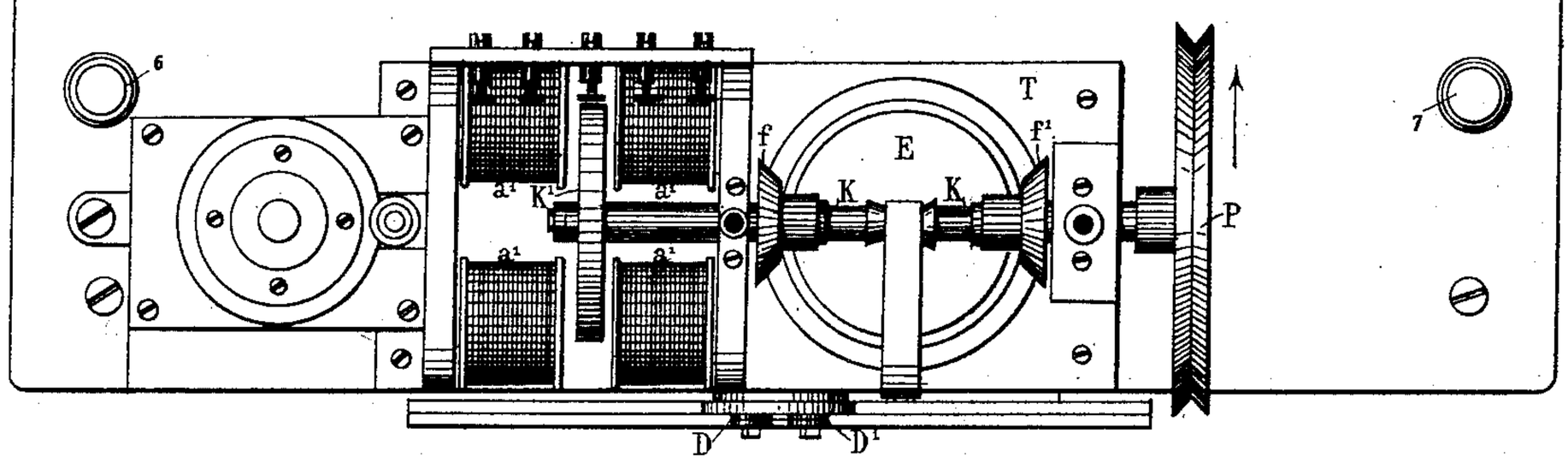


Fig. 3.

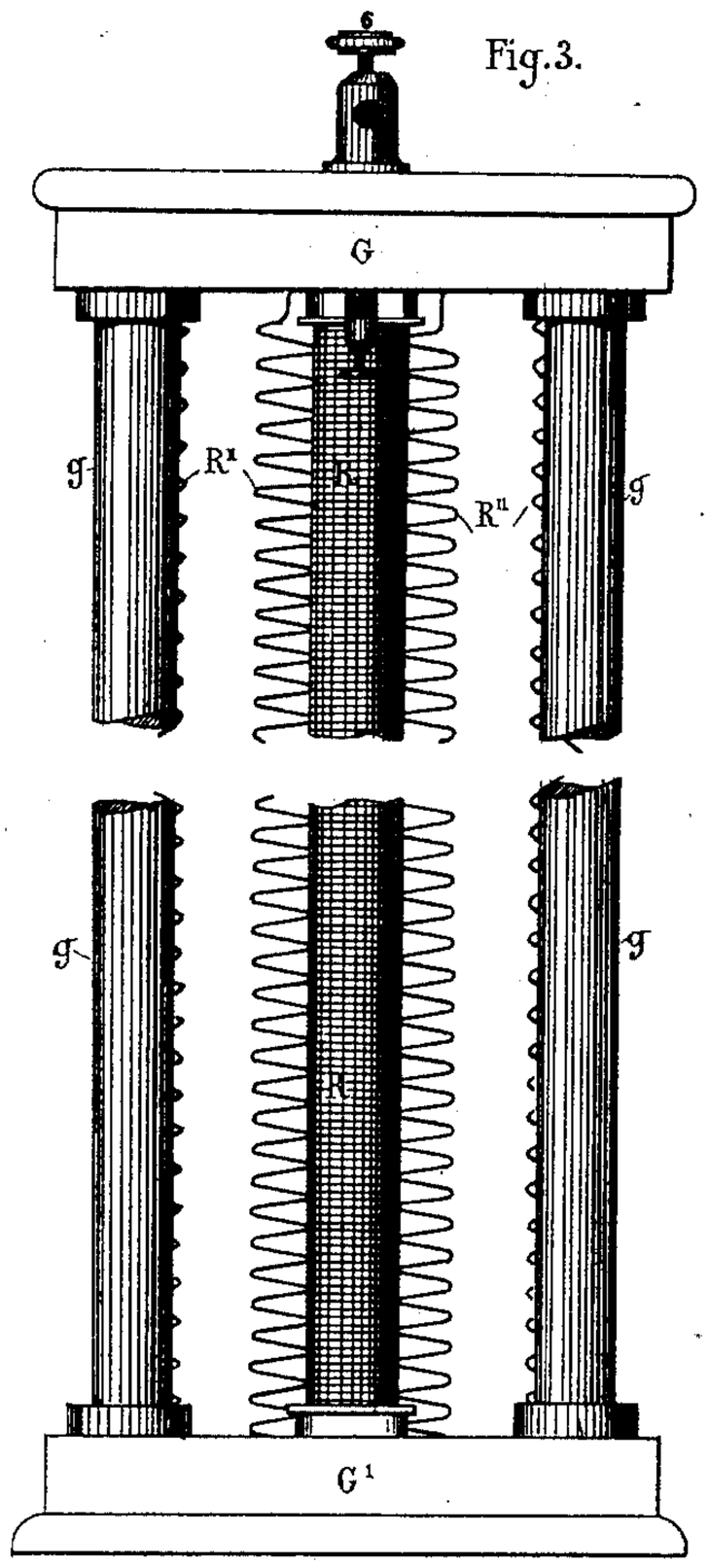
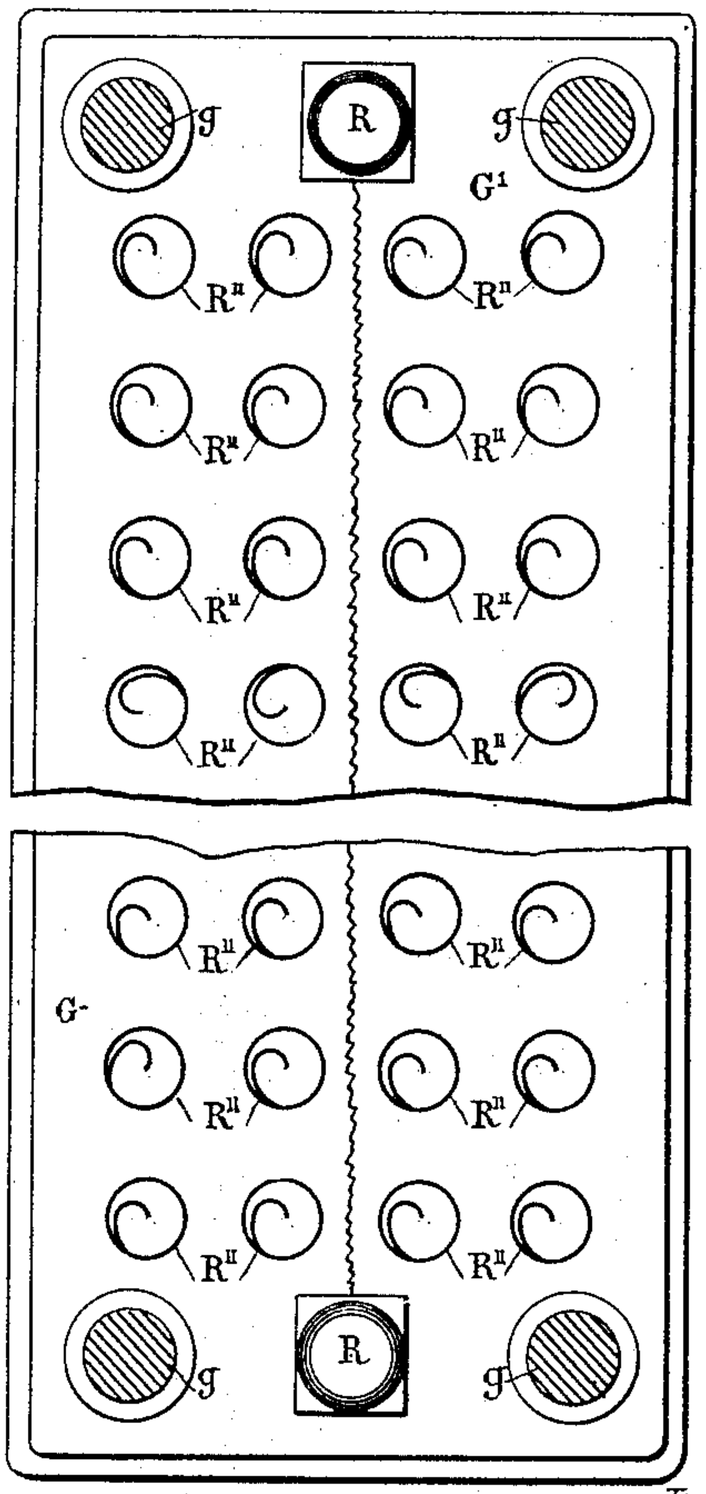


Fig. 4.



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6 Sheets—Sheet 3.

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AUTOMATIC CURRENT REGULATOR.

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Fig. 5.

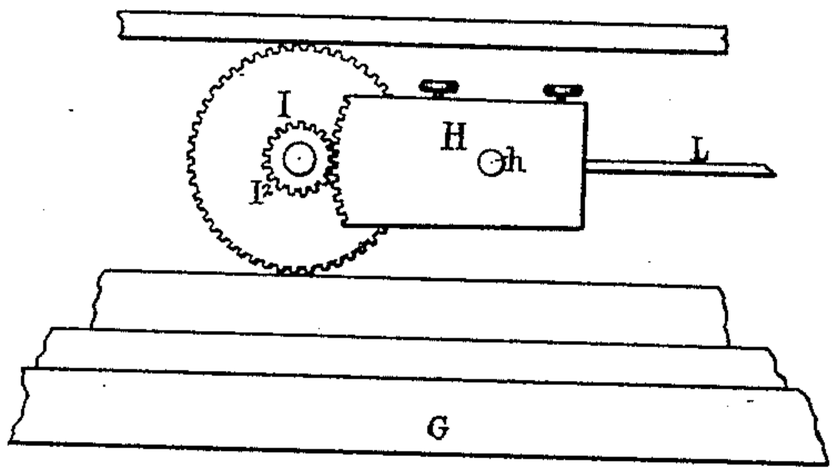


Fig. 6.

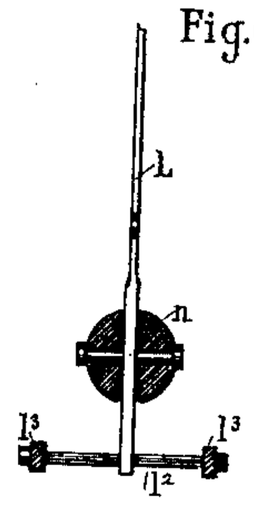
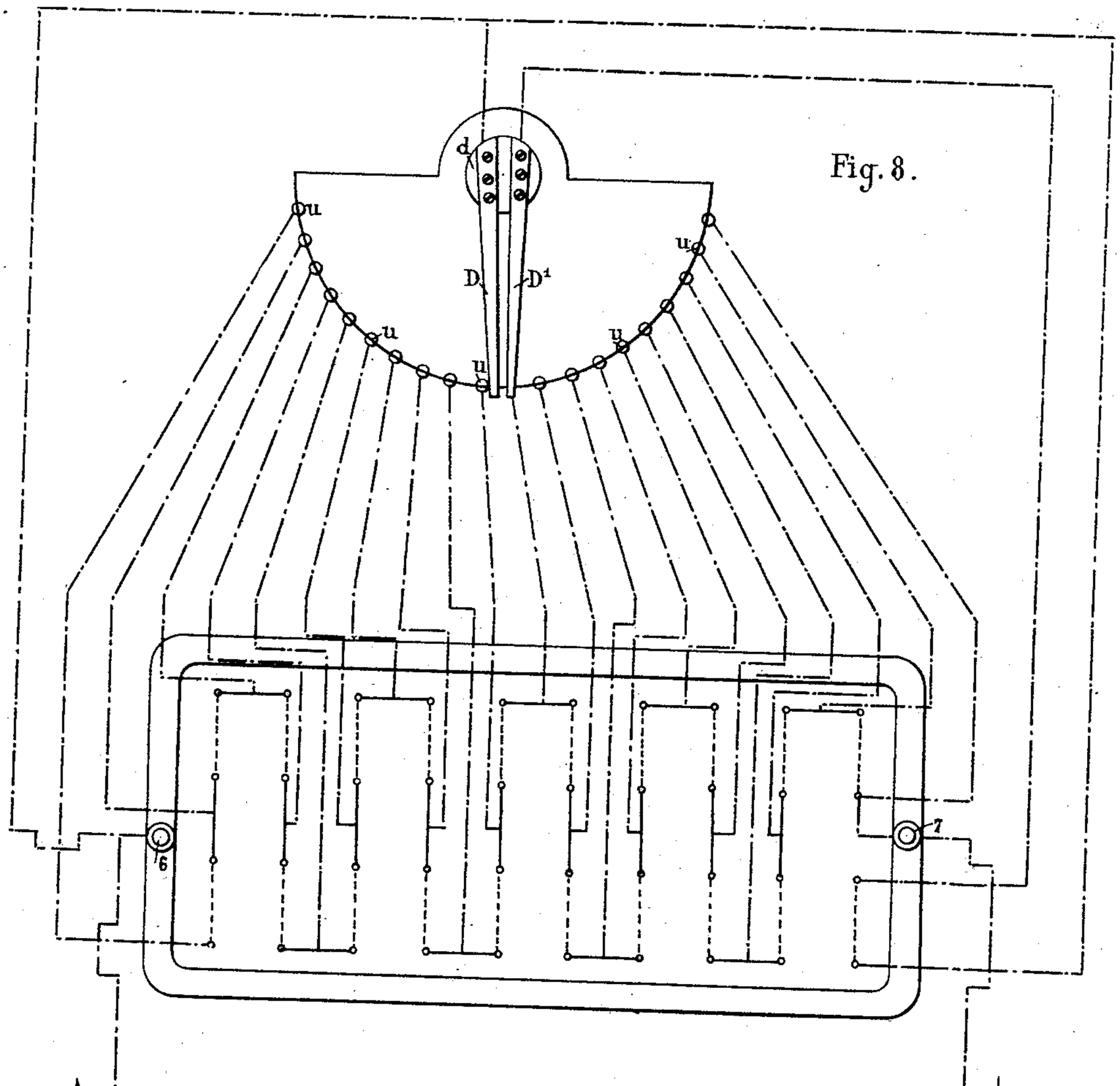


Fig. 8.



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(No Model.) 6 Sheets—Sheet 4.

R. THURY.

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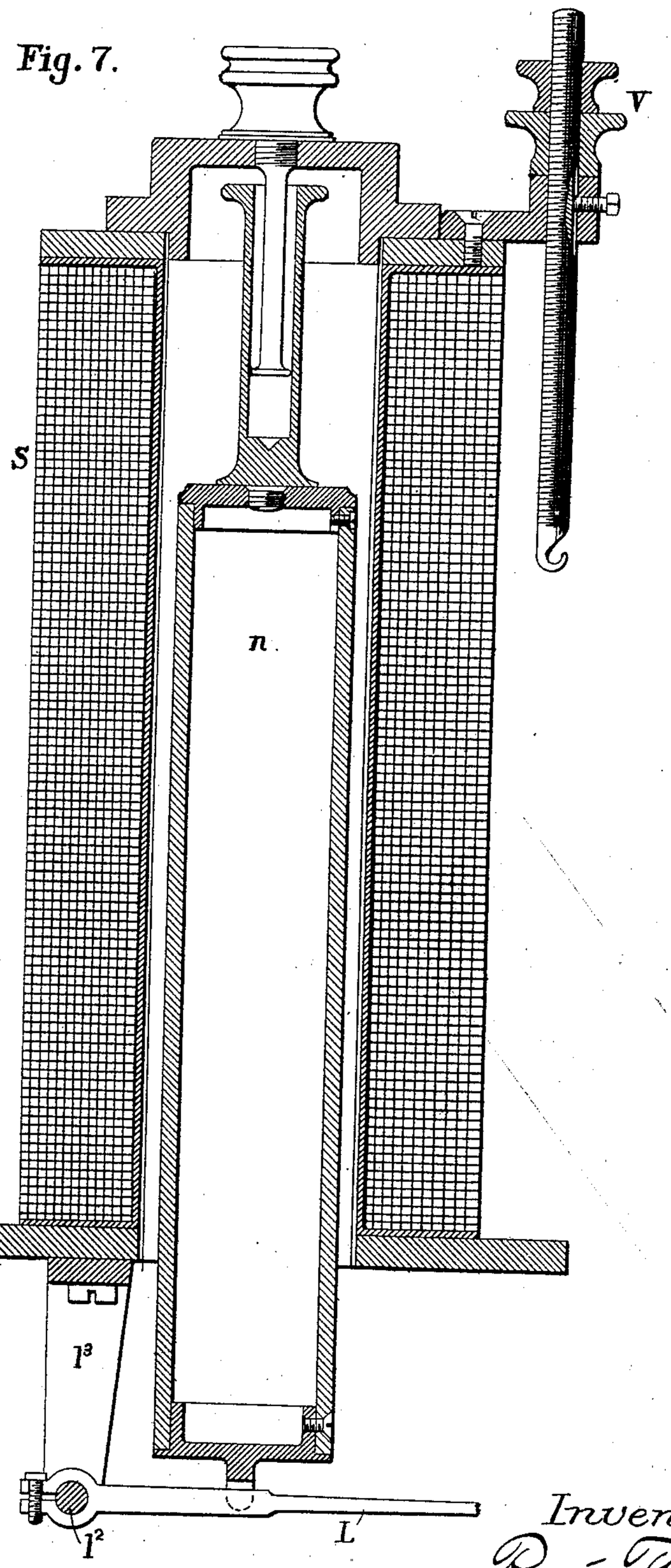
Fig. 7.



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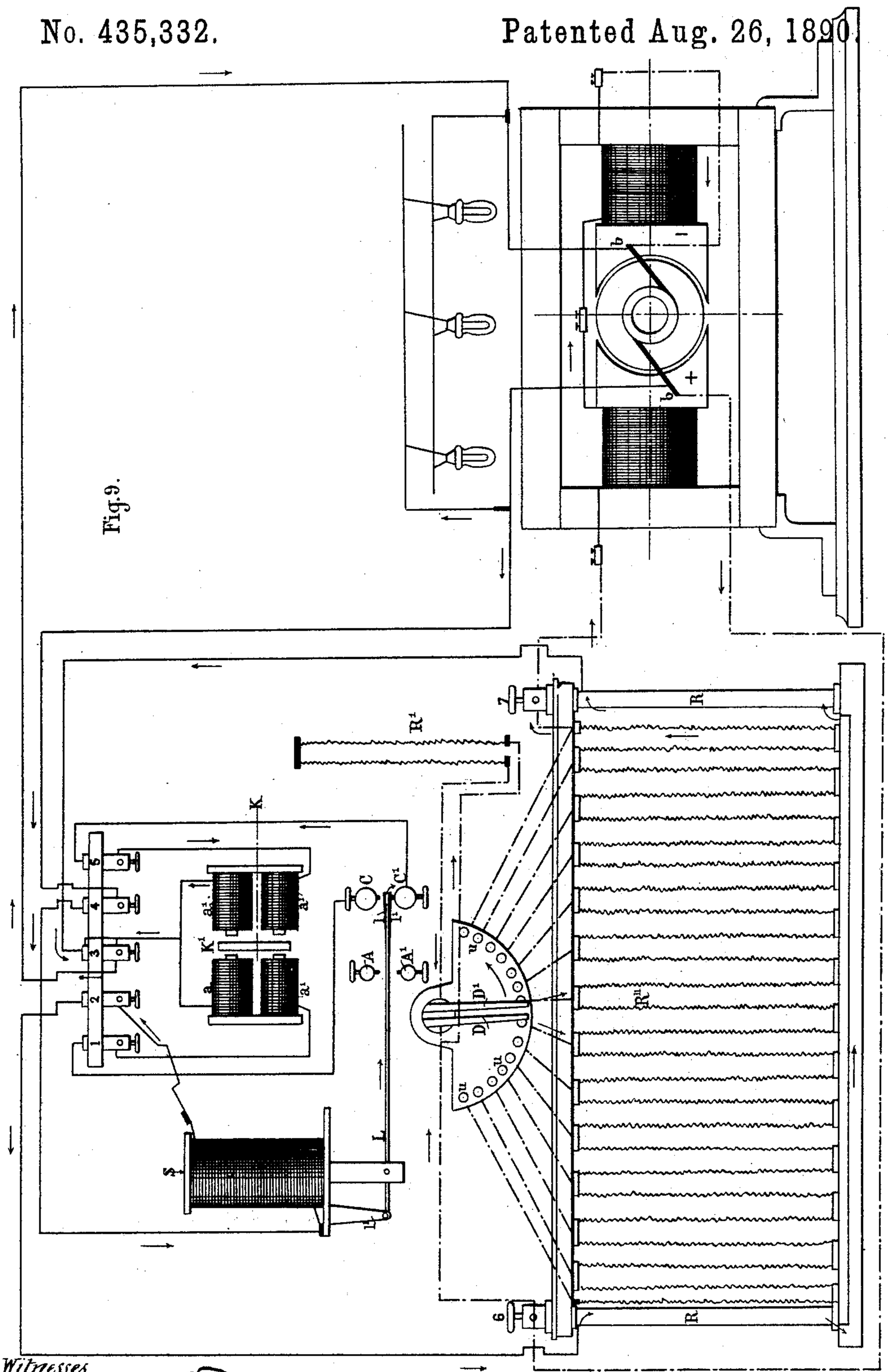
(No Model.) 6 Sheets—Sheet 5.

R. THURY.

AUTOMATIC CURRENT REGULATOR.

No. 435,332. Patented Aug. 26, 1890.

Fig. 9.



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(No Model.)

6 Sheets—Sheet 6.

R. THURY.

AUTOMATIC CURRENT REGULATOR.

No. 435,332. Patented Aug. 26, 1890.

Fig. 10.

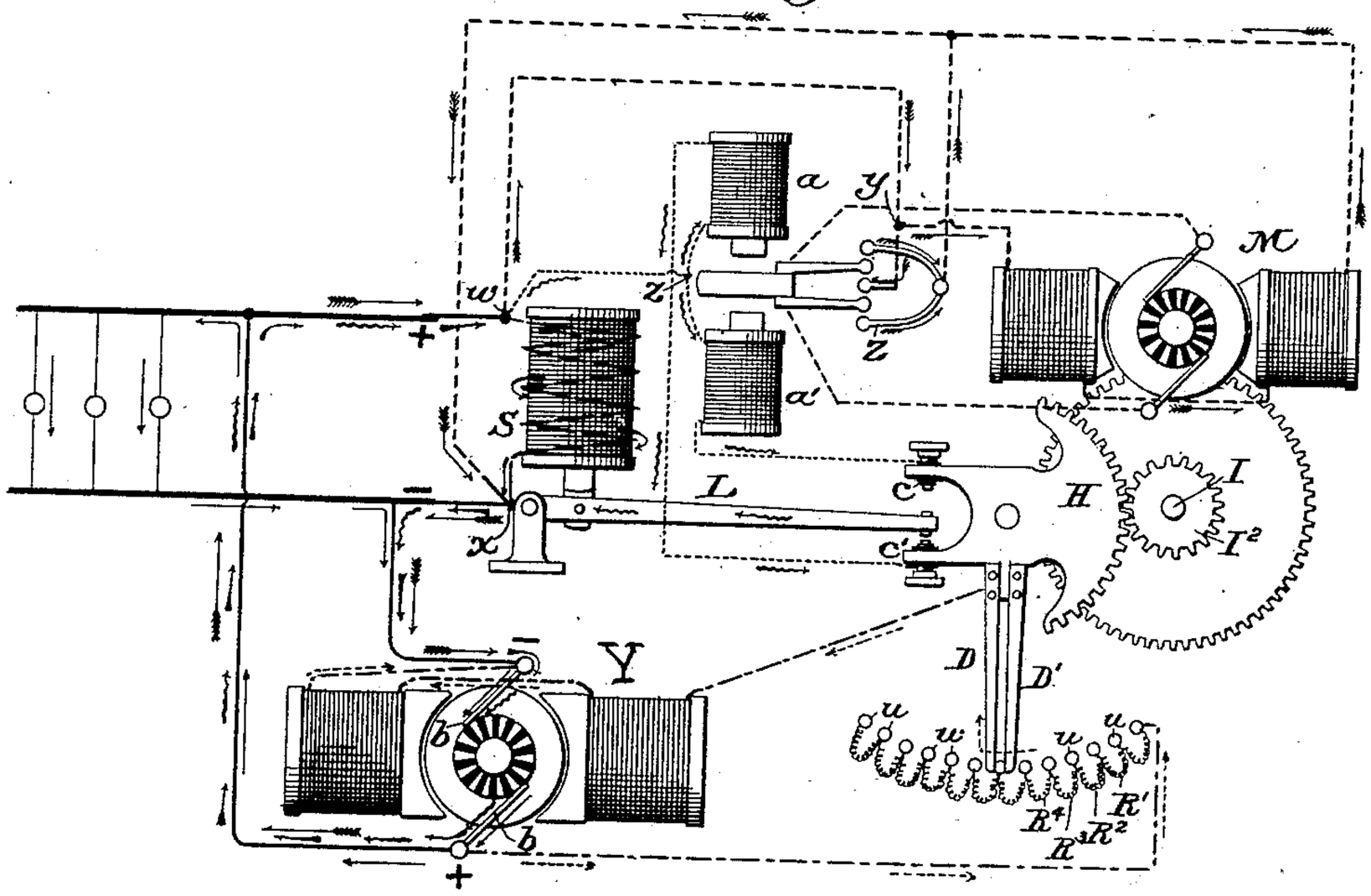
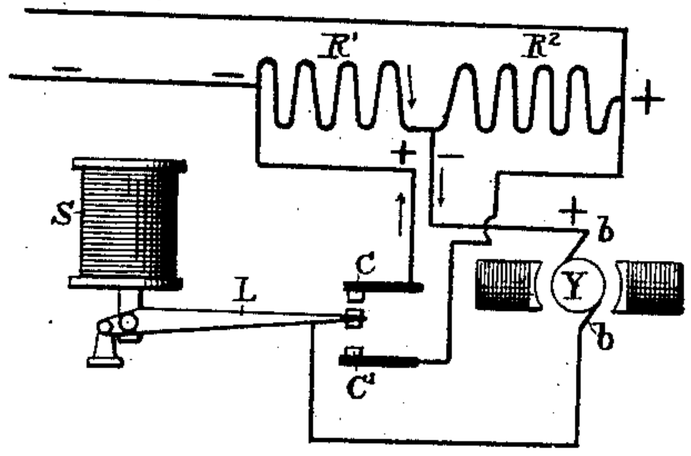


Fig. 11.



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UNITED STATES PATENT OFFICE.

RENÉ THURY, OF GENEVA, SWITZERLAND, ASSIGNOR TO CUENOD SAUTTER & CO., OF SAME PLACE.

AUTOMATIC CURRENT-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 435,332, dated August 26, 1890.

Application filed January 30, 1889. Serial No. 298,053. (No model.) Patented in France March 24, 1888, No. 189,561; in Belgium June 30, 1888, No. 82,396; in Spain October 2, 1888, No. 8,647, and in England October 16, 1888, No. 14,885.

To all whom it may concern:

Be it known that I, RENÉ THURY, a citizen of Switzerland, residing at Geneva, Switzerland, have invented certain new and useful Improvements in Automatic Current-Regulators, (for which I have received Letters Patent in France March 24, 1888, No. 189,561; in Belgium June 30, 1888, No. 82,396; in Spain October 2, 1888, No. 8,647, and in England October 16, 1888, No. 14,885;) and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

The present invention has for its object a combination of apparatus intended for the automatic regulation of electric currents.

I give to my new apparatus the name of "automatic current-regulator."

Up to the present it has been almost impossible to obtain a perfectly automatic regulation of electro-motive force where current is supplied to derivation circuits or of intensity where the supply is by a circuit in series. Generally it has been necessary to compensate by hand for the differences arising from irregularity in the speed of the dynamos or other causes.

The automatic regulators employed up to the present time present serious inconveniences in practice in consequence either of their delicacy or of their small sensibility, or of the slowness of their action, which causes periods of oscillation of intensity.

The object of my invention is to avoid these inconveniences by means of an apparatus which never overruns the point strictly required for regulation, and which at the same time possesses those qualities of solidity and sensitiveness which an apparatus of this sort should present.

My invention consists in the application of a rheostat controlled by a solenoid or equivalent apparatus by the aid of an external force from any source in such a manner that the position of the movable contact of the rheostat may be intimately dependent on that of the core of the solenoid—that is to say, that for any given position of the core there is a corresponding determinate position of the movable contact, as if the two were mechanically connected. The core of the solenoid is left entirely free in its movements, and operates only to direct a current into a relay or to an electric motor.

In order more fully to explain my invention, I will describe the annexed drawings, in which—

Figure 1 is a front view of the apparatus. Fig. 2 is a plan view; Fig. 3, a partial end view of the rheostat; Fig. 4, a partial horizontal section taken through the center of the same. Figs. 5 and 6 are detailed views of certain parts of the regulator. These figures are one-third of the actual size of the parts. Fig. 7 is a vertical section of the solenoid full size. Fig. 8 is a diagram illustrating the operation of the rheostat. Fig. 9 is a diagram illustrating the passage of the principal current and of the exciting-current in the apparatus. Fig. 10 is a diagram illustrating the manner of employing the current itself to actuate the apparatus by means of a motor and of a current-reverser. Fig. 11 is a diagram showing an arrangement which can be adapted to that indicated in Fig. 10.

In these figures, G is the upper table of the rheostat, and G′ the lower table.

Upon the table G is fixed the frame T, in which the different parts of the apparatus are mounted.

g g g g are four columns which support the upper table G.

S is a solenoid traversed by a current derived from the terminals *b b* of a dynamo-electric machine. This solenoid, which is of high resistance, attracts (more or less) a core of soft iron *n*, which is half contained within its interior. This core is freely suspended, as is shown in Fig. 7, and it controls a lever L, furnished at its extremity with a double contact *l l*. The lever or circuit-controller L pivots upon an axis l^2, mounted between the bearings l^3 l^3. (See Fig. 6.) It is supported by a coiled spring l^4, Fig. 1, which serves also

to adjust the lever, and consequently the apparatus, according to the tension to be maintained.

The solenoid, its core, and the lever L jointly constitute an electric indicator, the lever L acting as the pointer or index, but its purpose being to cause proper contacts to be made. This regulation is made by means of the nut V. In addition an endless cord gives motion to the grooved pulley P, which it turns in the direction of the arrow, Fig. 2. This pulley is fixed upon an axis K, on which are mounted two friction-cones *f f'*. This driving-axis, besides the movement of rotation, which is continuous, can be moved longitudinally, so as to alternately bring one or other of the friction-cones *f f'* into contact with the horizontal wheel E. This wheel is mounted upon the end of an axis *e*, furnished with an endless screw *e'*, Fig. 1. This wheel, and consequently the endless screw *e'*, turns in one direction or the other, according as it is driven by the friction-cone *f* or by the cone *f'*. The longitudinal movement of the axis K is determined by the attraction of two electro-magnets *a a* and *a' a'*, attracting alternately a disk armature K', mounted upon the end of the axis K. The wheel E by means of the screw *e'* drives a toothed wheel I, mounted upon an axis *i*, upon the anterior end of which is fixed a disk *d*, upon which are the blades D D, forming the movable contact of the rheostat. Upon the axis *i* behind the wheel I is fixed a small toothed wheel or pinion I^2, Fig. 5, which gears with the plate or toothed lever H, pivoting at *h*. Upon this plate are fixed two adjustable contacts C C' and two stops or abutments A A', also adjustable. The two contacts C C' have their counterpart upon the lever or circuit-controller L of the solenoid at *l l*.

R' R'' are resistances, of which a variable number can be put into the exciting-circuit of the dynamo by means of the double blade D D. The diagrams, Figs. 8 and 9, indicate clearly the passage of the currents in the apparatus. The exciting-current is represented by dotted lines. The derived current upon the principal circuit is represented in Fig. 9 by continuous lines. In these figures the arrows indicate the direction of the current. The exciting-current, led away from one of the brushes of the dynamo, reaches the apparatus by the terminal 6. From there it goes to the part D of the double blade or movable contact of the rheostat and passes, according to the position of this blade, to the contacts *u*, either directly by the resistance R'' or by the resistance R' and the resistance R'' to the field-magnets of the dynamo, and passing through the coils of these magnets it reaches the other brush. The current derived upon the principal circuit reaches the apparatus by the terminal 4, passes, first, into the solenoid S and the two large resistances R R in tension, and returns by the terminal 3 to the dynamo; secondly the current passes into the electro-magnets from the terminal 4 by the lever or circuit-controller L, one of the two contacts C C', the terminal 1 or 5, and the electro-magnets to the terminal 3 and the dynamo. The stops A A' are abutments serving to interrupt the current in the two extreme positions of the lever L. The current passes then, according to the position of the core *n* of the solenoid, and consequently of the lever L, either through the bobbins *a a* by C or by the bobbins *a' a'* by C'. In the first case the armature K' will be attracted by *a a*, putting the cone *f'* into gear with the wheel E, and thereby moving the lever H in one direction. In the second case it is *f* which will engage, moving the lever H in the other direction. Suppose now that, the tension falling, C' allows the current to pass into *a' a'*. Immediately the blade D D will move in the direction of the arrow, Fig. 9, thus cutting out resistance in the circuit of the field, and the tension will rise; but at the same time the lever H turns upon its center, and the contact C', falling, breaks contact, and H ceases to move. If the tension continues to fall, the contact C' is re-established, and immediately the lever H and the blade D D move in the same direction until the interruption is again brought about, and so on in either direction. The two levers L and H always assume relative positions, as if they were mechanically connected, and the contact D D can never pass beyond the point corresponding to exact regulation. The blade D D is formed in two parts connected by a supplementary resistance R', as is shown in Fig. 9, intended to divide the difference of action between one resistance R'' and the next. If one of the branches of the double blade D D is upon a contact *u* and the other upon the next contact, the current has two roads of equal resistance, and so is only weakened to the extent of a half.

Fig. 10 shows an arrangement intended to work in places which are not provided with motive power or where it is desired to utilize the current itself. The principle of the apparatus is the same. The position of the contact-lever follows exactly that of the lever of the measuring apparatus in consequence of the mobility of the contacts C C'. These last are arranged to control either directly or by the intervention of a relay composed of two magnets *a a'* a current-reverser Z, acting upon the armature of an electromotor, so that this turns in one direction or the other, according as C or C' establishes the contact.

The diagram, Fig. 10, indicates the connections of the circuit in the case of the regulation of the electro-motive force of the source of current Y. Under this arrangement the current is taken from the + plates or sections of the commutator of the generator Y by one brush *b*, passes thence by line to the lamps or other translating devices, and finally by the other brush *b* back to the — plates or sections of the commutator. A branch or shunt cir-

cuit from the first to the second of said brushes includes the rheostat and the field-coils of the generator Y, the current passing, as in the other arrangements, through a greater or lesser number of resistance-coils R′ R², &c., and thence by plate or block *u* and insulated blades D′ and D. The blades D′ D are carried by an oscillating block H, having a toothed segment meshing with a pinion I², carried by a shaft I, which bears also a gear-wheel, which receives motion from the shaft of the revolving armature of an electromotor M through any suitable connection. The block H carries two insulated contact points or screws C and C′.

S indicates a solenoid included in a branch of the line or working circuit and having its movable core connected with a lever or circuit-controller L, which as the core moves inward or outward or as the block H rocks in one or the other direction makes contact with one or the other of the two insulated contacts C C′ of said block H. The branch of the main circuit in which the solenoid S is included divides into three branches or forks at the point *w*, the first one including the solenoid, the second passing to the point *y*, where it again divides, one part going directly to the field-coils of motor M, and thence to the point *x*, where it rejoins the main line, the other part of said second branch going to the middle fixed contact of a current-reverser Z. The third branch of the shunt-circuit passes to the point *z*, where it also divides, one branch going to the coil of electro-magnet *a*, and thence to contact-point C′, and the other going to the coil of electro-magnet *a′*, and thence to the contact-point C. The upper and lower contacts of the current-reverser Z are of course insulated from the middle contact, but are electrically connected by suitable conductor with the return-wire from the field-coils of motor M back to the point *x*. With this arrangment of parts and circuits it results that if the current be weakened so as to permit the core of the solenoid S to move outward, and thus to lower lever L, which is an electric conductor, or if block H be oscillated through the rotation of the armature of motor M, or if the two parts move simultaneously or jointly so far as to establish contact between the lever or circuit-controller L and contact C′, a circuit will be completed through the coil of the electro-magnet *a*, which magnet, attracting the movable member of the current-reverser Z, will cause its insulated upper arm to make contact with the upper fixed contact of the current-reverser and its lower insulated arm to make contact with the fixed middle contact thereof. When this occurs, the current will pass from the point *w* by the second branch of the shunt or derived circuit to the middle fixed contact of the current-reverser, thence by the lower contact of the movable member of said reverser and by suitable conductor to the lower commutator-brush of the motor M, thence through one set of the commutator plates or sections and through the armature-windings to the other set of commutator-sections to the second brush, thence back to the upper contact of the movable member of the current-reverser, through the upper fixed contact thereof, to the return-line from the field-magnets of the motor M to the point *x*, and, finally, back to the — brush of generator Y. If, through the movement of lever L or oscillating block H, or through their joint movement, the lever or circuit-controller L makes contact with the point C, the magnet *a′* will be energized, the armature between the magnets *a* and *a′* will be attracted by the latter, and the movable contacts of the current-reverser carried by said armature will be caused to make contact, respectively, with the middle and lower of the fixed contacts of the current-reverser. This will cause the current to pass from point *w* to the middle fixed contact of the reverser, through the upper movable contact thereof to the upper commutator-brush of motor M, through the armature-windings to the lower commutator-brush, back to the lower movable contact of the current-reverser Z, to the middle fixed contact thereof, to the return-line from the field-magnets of motor M, to point *x*, and, finally, back to the generator.

Fig. 11 indicates an arrangement which admits of the suppression of the relays *a a′*. R′ R² are two resistances connected in series, from which two derived circuits are taken to feed the armature of the motor Y. They are of equal value. One of the connections is made at their point of junction and communicates with one of the brushes of the motor. The two other connections are made at the two free extremities and terminate in the inverter. The lever or circuit-controller L is connected to the second brush. The principal current, as the figure clearly shows, is directed at the same time upon the resistances and the inverter. Thus L, having at all times but one contact to effect, is entirely free to move, and may control the inverter directly.

I do not limit myself to the details of execution described.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In an automatic current-regulator, the combination of an electric indicator or circuit-controller provided with electric contacts, a rheostat provided with a movable contact, a motor for actuating said movable contact, a magnetic reversing device for determining the direction of movement of said movable contact, and a plate or block mechanically connected with said movable contact and bearing contact-points adapted by independent contact with the corresponding contact-points of the circuit-controller to direct an electric current through the magnetic reversing device in one or the other direction, whereby the contact-points of the circuit-con-

troller and of the plate or block are caused to move simultaneously toward each other, and the movable contact of the rheostat is caused to move directly in accordance with the movements of the circuit-controller.

2. In a current-regulator, the combination of a rheostat, mechanism for moving the adjustable contact thereof, an electric indicator under the influence of the current to be regulated, a magnetic relay for controlling the direction of movement of the movable contact, also under the influence of the current to be regulated, and a circuit-closer actuated by the indicator and serving to close a circuit through said relay in one or the other of two paths, and thereby to control the direction of movement of said movable contact without impairing the delicacy of action of the indicator.

3. In an automatic current-regulator, the combination of a rheostat having a movable contact, a motor serving to actuate said contact, a reversing clutch or gear interposed between the motor and the rheostat, an electric indicator, a magnetic relay connected with and serving to adjust the reversing clutch or gear to cause a movement of the rheostat-contact in one or the other direction, and a circuit-closer actuated by the indicator and serving to direct a current through the magnetic relay in one or the other of two paths, and thereby to control its action and through it the action of the reversing clutch or gear.

4. In an automatic current-regulator, the combination of a rheostat having a movable contact, an electric motor connected with and serving to actuate said contact, a current-reverser for controlling the delivery of current to the motor, and an electric indicator under the influence of the current to be regulated and serving to control the action of the current-reverser.

5. In an automatic regulator, the combination of a rheostat, a magnetic relay controlling the action of the rheostat, contacts carried by and movable with the movable contact of the rheostat, an electric indicator or circuit-controller under the influence of the current to be regulated, and contacts carried by a movable member of the indicator or circuit-controller, all substantially as set forth, whereby both sets of contacts are caused to move and the action of the apparatus is rendered quick and sensitive.

6. In combination with solenoid S and its core, lever L, carried thereby and provided with contact-points, a rheostat provided with a movable member, a plate or block H, mechanically connected with and adapted to be moved proportionately with the movable member of the rheostat, said block carrying contact-points corresponding to those of lever L, a motor for actuating the movable member of the rheostat, and a magnetic reversing device interposed between the movable member of the rheostat and the motor and controlled as to its action by the contacts of lever L and block H, substantially as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

RENÉ THURY.

Witnesses:

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C. A. RENEVIER.