(No Model.)

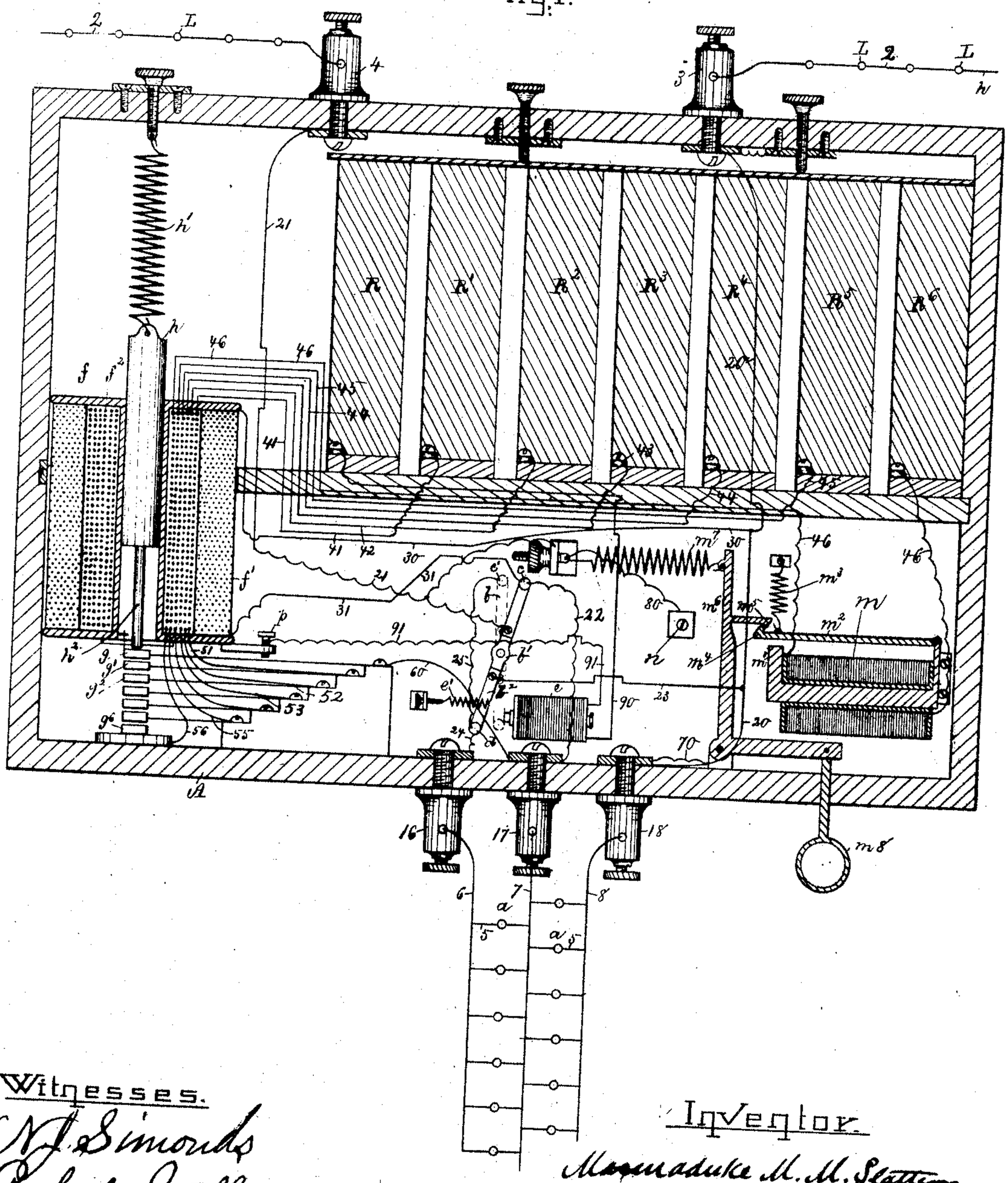
2 Sheets—Sheet 1.

M. M. M. SLATTERY.

APPARATUS FOR ELECTRICAL DISTRIBUTION.

No. 354,258. Patented Dec. 14, 1886.

Fig. 1.



Witnesses.

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(No Model.)

2 Sheets—Sheet 2.

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Fig. 2.

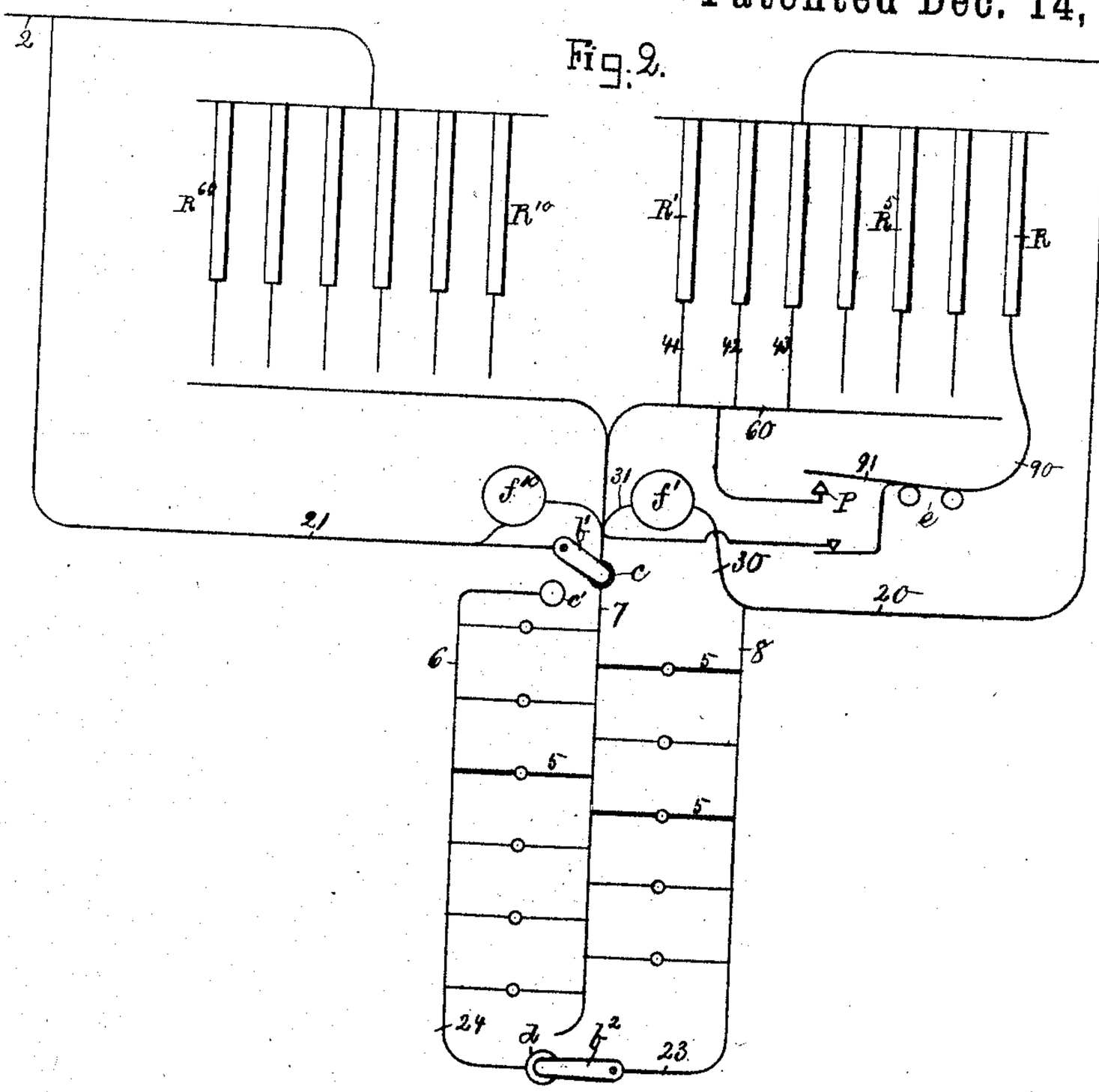
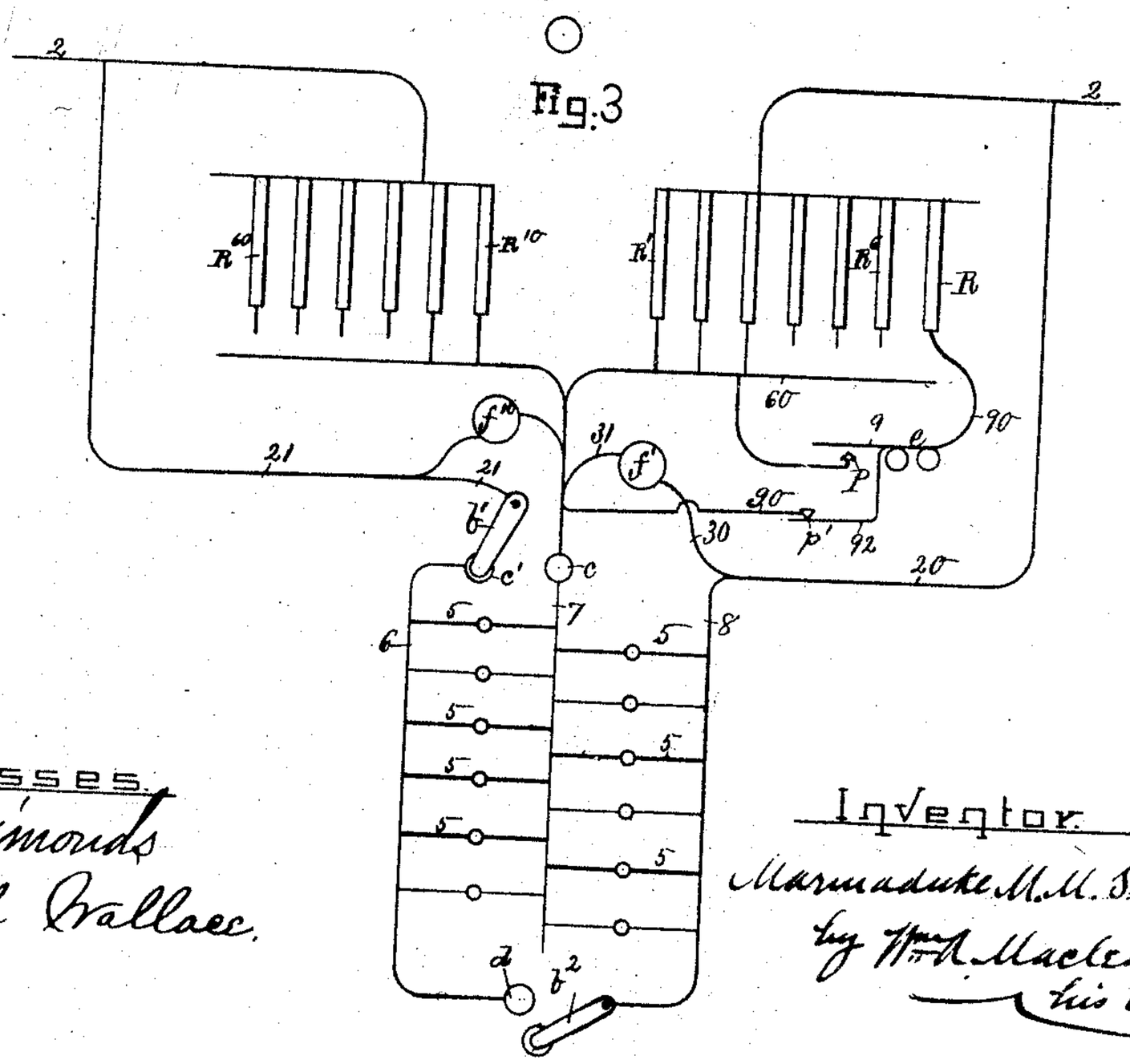


Fig. 3



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UNITED STATES PATENT OFFICE.

MARMADUKE M. M. SLATTERY, OF WOBURN, MASSACHUSETTS, ASSIGNOR TO THE SUN ELECTRIC LIGHT COMPANY, OF SAME PLACE.

APPARATUS FOR ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 354,258, dated December 14, 1886.

Application filed November 18, 1885. Serial No. 183,169. (No model.)

To all whom it may concern:

Be it known that I, MARMADUKE M. M. SLATTERY, of Woburn, county of Middlesex, State of Massachusetts, have invented a new and useful Improvement in Apparatus for Electrical Distribution, of which the following is a full, clear, concise, and exact description, reference being had to the drawings accompanying and forming a part hereof.

The object of this invention is to produce a convenient and economical distribution of electricity at long distances from the source of electrical energy and over an extended area.

The invention is embodied in an apparatus in which a main circuit or conductor, connected with a dynamo-machine or other suitable generator of electricity, and containing a series of arc lamps or other points or stations where the current is utilized, also has interposed in the circuit at one or more points, as may be desired, an apparatus from which the current is distributed in multiple-arc branches for operating incandescent lamps or other apparatus, as may be desired. The apparatus connected with the main circuit and controlling the distribution of the current therein, through the subsidiary or supplied branches, enables the current to be distributed through an indefinite number of lamps or other devices for using an electric current, the said lamps being either used separately in multiple arc—*i. e.*, one in each branch—or in a number of multiple-arc branches each containing two or more lamps in series. The connecting mechanism between the divided main or current-supplying circuit and the supplied branches interposed therein comprises appliances by means of which the strength of the current in the different branches is automatically retained substantially constant, whether one or more of the said branches are in use, and also appliances by which, when the last branch is removed from the circuit or the last lamp extinguished, the entire apparatus is automatically shunted out from the main circuit; and it also contains appliances by means of which the electro-motive force of the current used in the branches is automatically changed to accord with the number of lamps in use, while the current remains substantially constant in quantity, so that, after a certain maximum number of lamps, intended to operate each in a separate branch, have been brought into use, when more lamps are added the circuit will be automatically changed, so that each branch contains two lamps, placed in series in said branch, and the electro-motive force of the current used is double, while its quantity remains substantially unchanged. The number of branches between which the current divides is always the same, but each branch may contain one lamp, or a series of two or more lamps, according as the number of lamps in use is less or more than the number of branches.

Figure 1 is a diagram illustrating an apparatus for electrical distribution embodying this invention, some of the appliances governing the connections between the main circuit and the supplied branches being shown in elevation and some in section, those parts only being shown which are called into action when the number of lamps in use is not greater than the number of branches. Fig. 2 is a diagram representing the circuit arranged for six lamp branches and twelve lamps, when not more than six of the lamps are in use, each being in a separate branch; and Fig. 3, a diagram showing the same apparatus in the condition assumed when more than six lamps are in use, the current then dividing between six branches, each of which contains two lamps in series, or a resistance equivalent thereto.

The main circuit 2 is connected with a suitable source of electricity, preferably a dynamo-electric generator, producing a current of high electro-motive force and small quantity, these parts being substantially the same as commonly employed in a circuit of five or six miles length, containing arc lamps, some of which are indicated at L. At the points or stations upon the said circuit where it is desired to use the current for incandescent lamps or other apparatus employing a current of a similar character, the said main circuit is divided and its terminals connected with an apparatus such as shown in the drawings, the various devices of which may be included in a frame-work or case, A, having binding-posts 3 4, with which the main circuit at either side of the station is connected, and between which

the supplied branches and various appliances controlling their connection with the main circuit are interposed.

It will be assumed, for the purpose of illustration, that the quantity of the current is sufficient to supply six branches, and is normally of proper electro-motive force to maintain a single incandescent lamp in each of the said branches. The incandescent lamps *a* are shown as each in a separate branch, 5, between main or leading wires 6 7 8, binding-posts 16 17 18 on the main box A, and it will be seen that if the two outer leading-wires, 6 8, are connected with the main circuit at one side of the station, and the intermediate wire, 7, with the main circuit at the other side, each lamp *a* will be in a separate branch, the current passing through such branch from one or the other of the wires 6 8 to the wire 7, as shown in Fig. 2; but if the said wire 7 is disconnected from the main circuit and the wires 6 and 8 connected with the said main circuit at either side of the station, as shown in Fig. 3, the current will be practically divided between the branches 5, each containing two lamps in series, or resistance equivalent thereto, so that while the same quantity of current will be sufficient its electro-motive force will have to be doubled to keep the lamps with the same brilliancy as before. Thus the quantity of the current being sufficient to supply six branches, it is necessary, when a seventh branch is closed, or more than six lamps set in operation, to supply double the electro-motive force of current to the said lamps, and when, as the lamps are cut out one after another, the number becomes less than seven, the additional electro-motive force should be removed, and if the system is to be further extended the apparatus will be arranged to raise the electro-motive force when the thirteenth lamp is brought into action to three times that of the current when six or less lamps are in circuit, and so on.

The binding-post 18 and wire 8 are connected by wire 20 with the binding-post 3 and main circuit at one side of the station; and the binding-post 4, connected with the main circuit at the other side of the station, is connected by wire 21 with a metallic contact-plate, *b*, of a movable switch, *b'*, which contact-plate co-operates with two stationary contact-pieces, *c c'*, the former connected by wire 22 with the binding-post 17, so that when the said switch is in its full-line position the said wire 7 is connected by wires 22 21 with the main circuit at the binding-post 4.

The switch *b'* is provided with a second contact-plate, b^2, connected by wire 23 with the wire 20 and binding-post 3, and the plate b^2 of the switch co-operates with a contact-piece, *d*, connected by wire 24 with the binding-post 16, which, when the switch is in its full-line position, connects the binding-post 16 and wire 6 with the wire 23, so that when the switch *b'* is in its full-line position (which is its normal condition when less than seven lamps *a* are in circuit) the current from the main circuit entering at the binding-post 3 passes by wire 20 to the wire 8, and also by wires 23 24 to the wire 6, and then having passed to the wire 7 through such of the branches 5 as are closed, continues by wires 22 and 21 to the binding-post 4 and main circuit at the other side of the station. The binding-post 16 is also connected by wire 25 with the contact-piece *c'* for the part *b* of the switch, so that when the said switch is in the dotted-line position the wire 7 and connected wire 22 will be left in open circuit at *c*. The branch 23 will be open at the plate b^2, and the wire 21 will be connected through the plate *b* with the wires 25 and 6, so that the current entering at 3 will pass through the wire 20 to the wire 8, and then to the wire 6, through the branches a^5, containing two lamps *seriatim*, or the equivalent therefor, as will be described, and from the wire 6 by wires 25 and 21 to the binding-post 4.

The switch *b'* is operated by an electro-magnet, *e*, and a retracting-spring, *e'*, and normally remains in its full-line position when the said magnet *e* is demagnetized, thus placing the lamps *a* in separate branches, but is moved to the dotted-line position when the said magnet *e* is energized, as will be hereinafter described, which takes place when more than six of the lamps *a* are set in operation.

Assuming that less than six lamps are in operation and that the current consequently passes from the binding-posts 16 and 18 on the one side to the binding-post 17 on the other side, the current supplied to each branch is maintained substantially constant as one or more of the said lamps are thrown into or out of operatior, by the following appliances: A solenoid, *f*, has a coil, *f'*, of fine wire included in a branch of the main circuit, so that the current divides between the said coil and the branches 5, which are closed, the coil having one terminal connected by wire 30 with the wires 20 and binding-post 3, and its other terminal connected by wire 31 with the contact-piece *c* and wires 22, and through the plate *b* with the wire 21 and binding-post 4 when the switch *b'* is in its full-line position. The said solenoid also has several layers, f^2, of coarse wire, the number of layers corresponding to the number of lamps that may burn each in a separate branch, and each layer being connected at one end by wires 41 42, &c., through resistance $R' R^2$, &c., with the binding-post 3, and the other terminals of which are connected by wires 51 52, &c., with a series of circuit-closers, $g' g^2$, &c., consisting of flexible springs provided at their free end with contact-blocks, which are normally separated from one another, but placed in line, so that by pressing against the endmost one of the series it may be forced into contact with the next one, and then, by further pressure, the second may be forced into contact with the next, and so on. Above the series of contact-pieces forming parts of the circuit-closers $g' g^2$, &c., is a similar spring having a contact-piece, *g*, and con-

nected by wire 60 with the binding-post 17, so that when the said contact-piece comes in contact with the circuit-closer g' below it it closes the corresponding branch, 41 51, between the binding-posts 3 and 17, and as the contact-piece g is pressed downward farther the contact-pieces below it are successively forced together, and the said branches 42 52 43 53, &c., are successively closed. The resistance R' R^2, &c., in each of these branches is equivalent to that of a lamp, a, in one of the branches 5, so that these normally-open branches containing the resistance constitute substitutes for the lamps, and are automatically substituted for the lamp—that is, when a lamp branch is opened, a resistance-substitute branch is closed by the action of the core h of the solenoid f. The core h is connected with a retracting-spring, h', tending to draw it out from the solenoid, and having connected with it a pin, h^2, which, as the core moves into the solenoid on the contact-piece g, presses it toward the circuit-closers g' g^2, &c., so that they are brought successively into contact, closing the branches 41 42, &c., one after another.

The core h has a tolerably close fit in the central tube of the solenoid, and the pin h^2 moves with a close fit in an opening in the lower plate of the solenoid spool or bobbin, so that there is an air-cushion for the core h, preventing too sudden movement thereof. The operation of these parts governing the equal distribution of the current between the different lamps at any time in circuit is as follows: Suppose the maximum number of lamps intended to burn singly in separate branches—namely, six—are in operation, then the current passing from the binding-post 3 to the binding-post 4 divides between the six lamps and the fine wire f' of the solenoid f, and the portion passing through the solenoid is insufficient to move the core h far enough to press the contact-piece g into contact with the one g', although moved slightly toward it. If, now, one lamp a is open-circuited, more current will pass through all the branches, including that containing the fine coil f', which will be sufficient, acting in said coil to attract the core h and move the pin h^2 far enough to press the contact-piece g against the first circuit-closer, g', thereby closing the branch 41 51 through the resistance R' equal to that of the lamp which was cut out. This operation will cause the current to divide in the same ratio as before, between the lamps remaining in circuit and the fine wire f'; but although the attraction on the core h derived from this wire f' is thus lessened the said core has an additional attractive force derived from the single layer of coarse wire which is brought into action, and which is sufficient to neutralize the diminution in the attractive strength of the coil f', so that the core remains with the pin h^2 holding the contact-piece g in contact with the first circuit-closer, g', with the lamps that are in circuit, each receiving the normal proportion of current. If another lamp is switched out, the attraction of the coil f' is again increased, moving the core h farther into the solenoid, and closing, also, the second circuit-closer, g^2, through the branch 42 52, containing the resistance R^2 and additional layer of the coarse wire f^2, which, upon coming into circuit, makes up in its attraction on the core h for the diminution in the attraction of the fine coil f', as before described. If at any time a lamp should be switched into circuit, the attraction of the fine coil f' would be diminished and the core h retracted, cutting out one of the branches containing resistance equivalent to that of the lamp, and cutting out one layer of the coarse wire of the solenoid. When the last lamp is switched out, the rod h^2 will move forward until contact is made with the last one, g^6, of the series of circuit-closers, closing the branch 46 56, including the resistance R^6, and also including the coils of the magnet m, forming a portion of an automatic cut-out, by which the entire apparatus is shunted when the lights a are all extinguished.

The core of the magnet m is shown as bent at right angles, and its pole m' acts on an armature, m^2, in opposition to a retractor, m^3, which normally holds the said armature with a latch, m^4, thereon in engagement with a catch, m^5, on an arm, m^6, connected by wires 20 70 with the binding-post 3, and acted upon by the spring m^7, tending to move it against a contact-piece, n, connected by wires 21 80 with the binding-post 4, so that as soon as the circuit of the magnet m is closed by extinguishing the last lamp, as already described, its armature m^2 is attracted, the arm m^6 released and brought in contact with the piece n, closing the circuit directly between the binding-posts 3 and 4 over the wires 20 70 80 21. When it is desired to use the lamps again, the cut-out arm m^6 is restored into engagement with the armature m^2 by means of a handle, m^8, thus placing the binding-posts 16 17 18 and the branches connected between them in the circuit between the binding-posts 3 and 4, as before described, the current then dividing between such of the lamp branches as may be closed and the resistance branches, substituted for the lamps not in operation, and the fine coil f' of the solenoid f, as before described. When more than the maximum number of lamps intended to be used separately in single branches are set in operation, the current in the fine wire f' will be weakened, permitting the core h to be drawn farther out than it can be when only the said number of lamps is in operation, and this outward movement of the core h operates a circuit-closer, p, controlling the magnet e, previously described.

The magnet e is in a branch circuit, having one terminal connected by wire 90 through resistance R, which prevents it from receiving too large a portion of the current, with the wire 20 and binding-post 3, and having its other terminal connected by wire 91 with one member of the circuit-closer p, the other mem-

ber of which is shown as consisting of the spring of the contact-piece *g*, which, when the core *h* is abnormally retracted, as before described, closes the said branch. The energizing of the magnet *e* causes the switch *b'* to be moved from the full to the dotted line position, thus placing the wire 7 in open circuit, or disconnecting it from the main circuit and connecting the wires 8 and 6 with the binding-posts 3 and 4, so that the current passing between the said lines 8 and 6 or between the binding-posts 3 and 4 is divided the same as before, so that the same quantity of current is sufficient; but the branches contain twice the resistance that they did when six or less lamps were in circuit, so that the electro-motive force must be doubled, and the generator responds automatically to the call for increased electro-motive force in the usual manner, it being understood that the additional resistance at this particular station is but a small proportion of the entire resistance of the wire, and the consequent increase in electro-motive force is but a small percentage of the whole electro-motive force of the current.

Fig. 1 represents only the apparatus necessary to maintain a single lamp in each branch in operation, and when the number of lamps which may be required is greater than the number of lamp branches, or, for example, 12, the apparatus will be duplicated, as shown in Figs. 2 and 3—that is, substitute branches containing resistance R^{10} R^{20}, &c., are provided, and a solenoid, f^{10}, which is included in circuit between the wires 7 and 21. When the switch *b'* is in the normal position shown in full lines, Figs. 1 and 2, the second series of substitute branches and their controlling solenoid f^{10} are shunted, and the substitute branches R' to R^6 are successively opened as the lamp branches 5 are closed, until, finally, when six of the said branches are closed, all the substitute branches of the first series are opened, and when the seventh branch is closed, as shown in Fig. 3, the circuit-closer *p g* for the magnet *e* is closed and the switch *b'* moved by the said magnet, as before described.

In the new position of the switch *b'* (indicated in Fig. 3) the current is divided between the solenoid-coil *f'* and the branches 5 between the wire 7 and 8 and the substitute branches containing resistance R' to R^6, so that unless the six lamps first closed happen to be between the wires 7 and 8 there will be a readjustment of the substitute branches R' to R^6 effected by the movement of the core *h*. This movement would open the circuit-closer *p g* of the magnet *e*, and in order to retain the said magnet energized it has a second branch, 92, including the circuit-closer $p' g^0$, which is controlled by the core of the solenoid f^{10}, being of similar construction to the circuit-closer *p g* (shown in Fig. 1.) except that the contact *p* is on the other side of the spring, and is consequently closed when the core is attracted instead of when it is retracted, as shown in Fig. 1. Thus supposing that while the circuit remained as shown in Fig. 2 three branches were closed between the wires 7 and 8, the closed branches being indicated by heavier lines and three between the wires 7 and 6, all of the substitute branches containing resistance R' to R^6 would be open, then when the seventh branch was closed, for instance, between the wires 7 and 6, as shown in Fig. 3, the switch *b'* would be moved and there would be a readjustment of the resistance branches, there being a sufficient number of these between R' and R^6 closed to act as substitutes for the lamp branches open between the wires 7 and 8, and a sufficient number between R^{10} and R^{60} to compensate for the branches open between the wires 7 and 6.

What I claim is—

1. A number of multiple-arc branches each containing an incandescent lamp or device for using an electric current, combined with a series of normally-open substitute branches containing an equivalent resistance, and circuit-closers in said substitute branches, and a solenoid and core therefor controlling the said circuit-closers, the said solenoid having a coil continuously connected in a branch circuit, and a series of coils or layers of wire, one in each of the substitute branches, substantially as described.

2. A divided main current-supplying circuit and three conductors interposed therein, and multiple-arc branches between the said conductors, combined with normally-open substitute branches and circuit-connections between the main circuit and conductors interposed therein, and a switch controlling said connections, which, when in one position, connects two of the said conductors with one terminal of the divided main circuit and the third conductor with the other terminal thereof, and when in its other position connects two of the conductors with the opposite terminals of the divided main circuit, leaving the third conductor disconnected from the main circuit, substantially as and for the purpose described.

3. A main circuit and number of multiple-arc branches connected therewith, each containing an incandescent lamp or device for using an electric current combined with a series of normally-open substitute branches, one corresponding to each lamp branch, and being closed when the said lamp branch is open, combined with an electro-magnet in the substitute branch, which is the last one closed when the last lamp branch is opened, and a cut-out device controlled by the said magnet which connects the terminals of the main circuit, shunting all the branches when the said magnet is energized by the closing of the last substitute branch, substantially as described.

4. A number of multiple-arc working branches, each containing an incandescent lamp or device for using an electric current, combined with a number of normally-open substitute branches each containing an equivalent resistance, and circuit-closers in said substitute branches, and a solenoid and core therefor controlling the said circuit-closers, the said

solenoid having one coil continuously connected in a branch circuit and another coil connected in circuit with the substitute branches, substantially as described.

5. A divided main current-supplying circuit and number of working branch circuits arranged in multiple arc between the terminals thereof, and an equal number of normally-open substitute branches, all of substantially the same resistance, and means, substantially as described, by which a substitute branch is closed when a working branch is opened, there being always the same number of branches, between which the current divides, and a switch and actuating electro-magnet therefor by which the resistance in each branch may be multiplied without change in the number of branches, substantially as described.

6. A system of electric distribution, consisting of a number of local working-circuits arranged in multiple arc, and translating devices therein operated from a single main line, combined with normally-open substitute circuits containing resistance equal to that of the working-circuits, the said substitute circuits each having one terminal connected with one side of the local multiple-arc circuit and a series of multiple contact-pieces connected with the other terminals of the substitute circuits, and a solenoid and core movable therein co-operating with the said contact-pieces, as described, whereby the said substitute circuits are successively closed as the working branches are successively opened, substantially as and for the purpose set forth.

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Witnesses:
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