No. 776,144. PATENTED NOV. 29, 1904.

A. McGARY.

AUTOMATIC ELECTRIC REGULATOR.

APPLICATION FILED APR. 20, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1

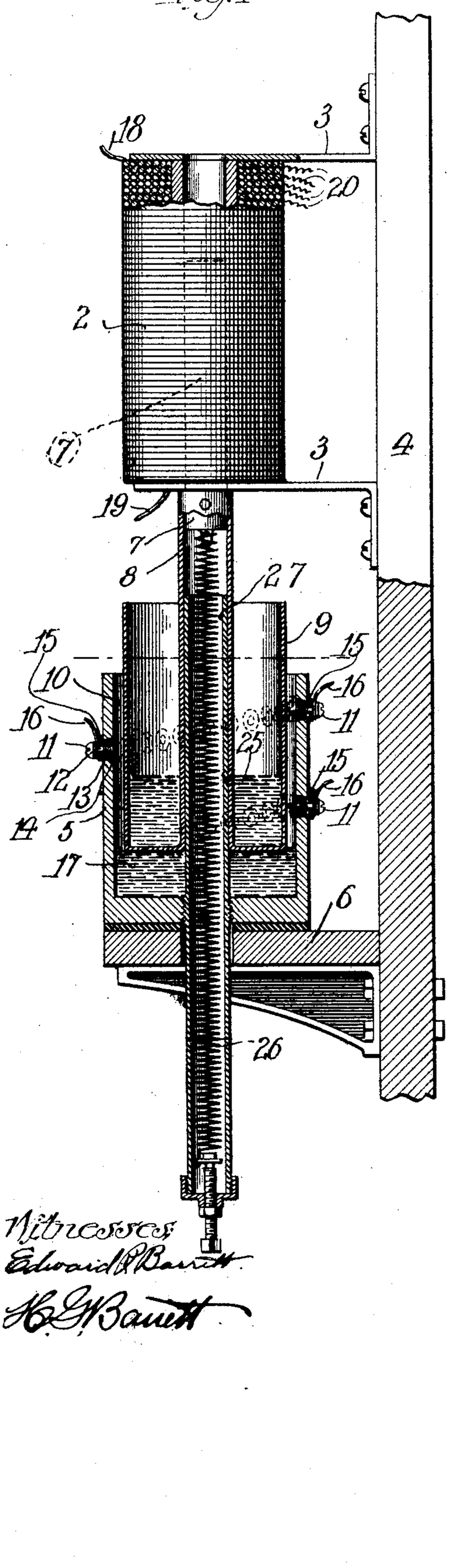
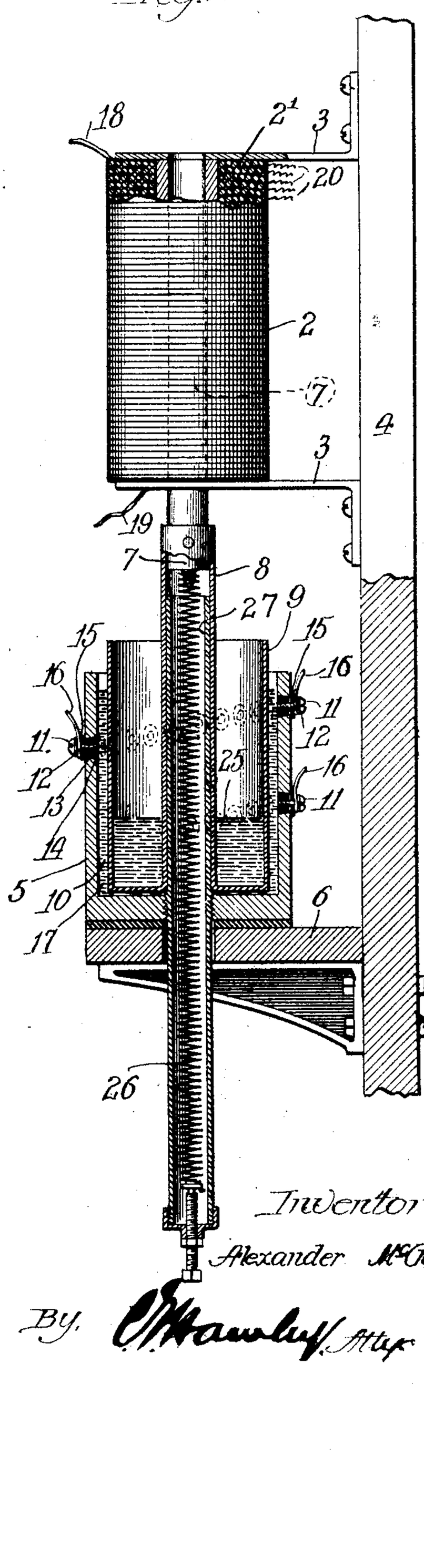


Fig. 2



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APPLICATION FILED APR. 20, 1903.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

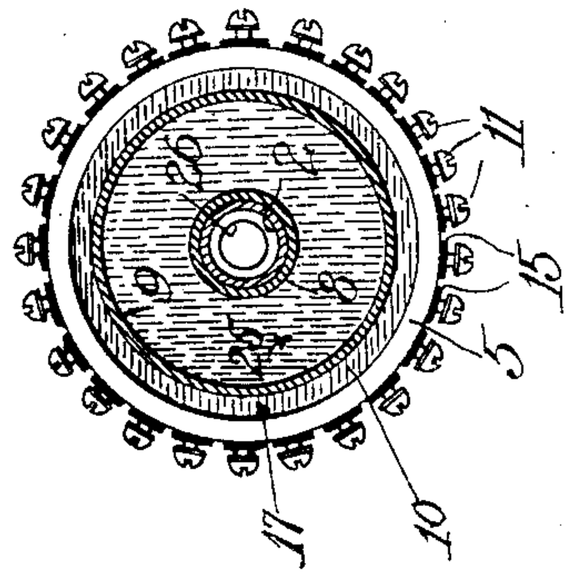
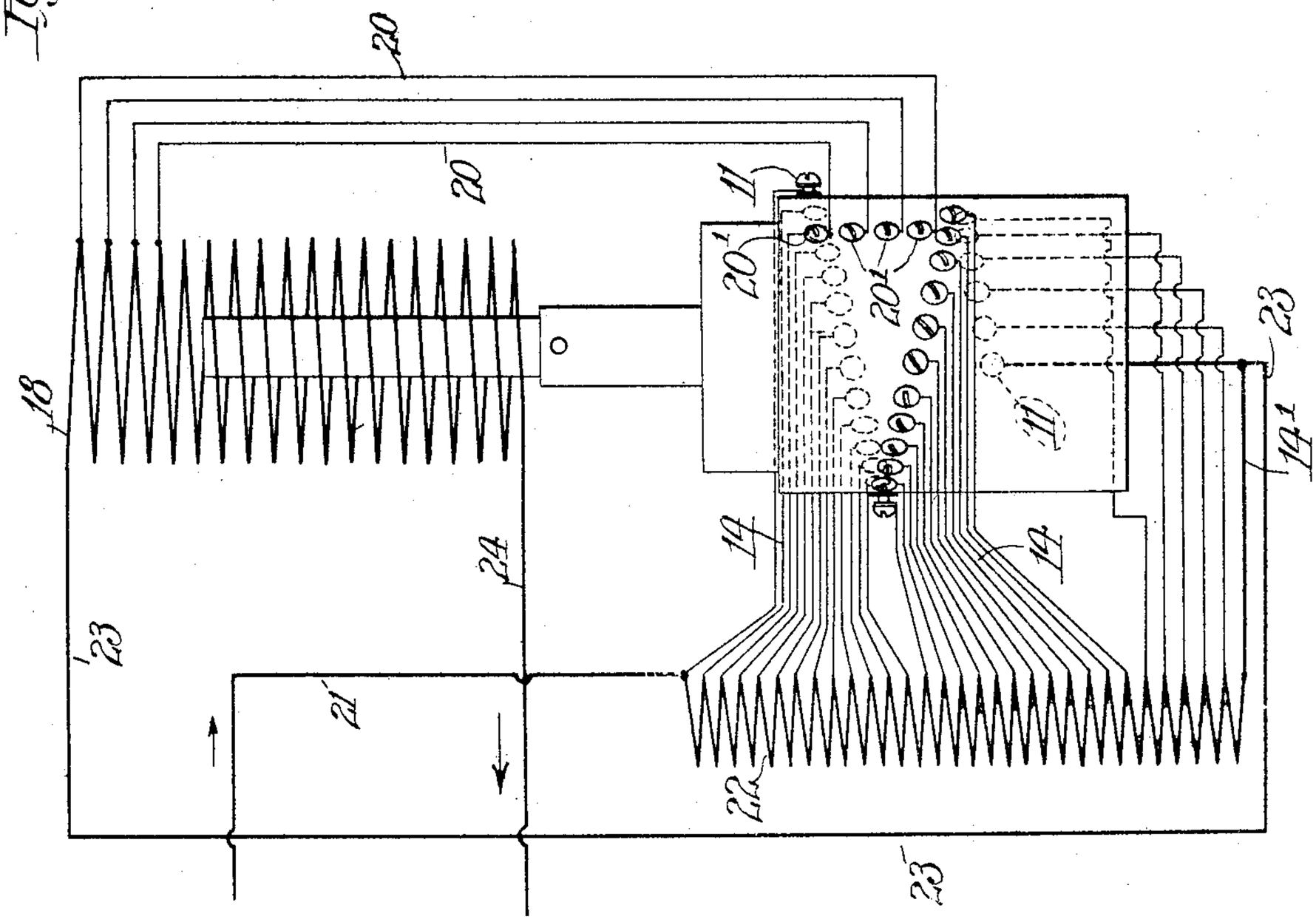


Fig. 4.



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No. 776,144. Patented November 29, 1904.

UNITED STATES PATENT OFFICE.

ALEXANDER McGARY, OF LAGRANGE, ILLINOIS.

AUTOMATIC ELECTRIC REGULATOR.

SPECIFICATION forming part of Letters Patent No. 776,144, dated November 29, 1904.

Application filed April 20, 1903. Serial No. 153,499. (No model.)

To all whom it may concern:

Be it known that I, ALEXANDER McGARY, a citizen of the United States, residing at Lagrange, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Automatic Electric Regulators, of which the following is a specification.

This invention relates to means for regulating the electromotive force or current upon circuits that are supplied with electricity from sources or other circuits wherein the potential, current, or electromotive force is subject to great variation, as instanced in car-axle lighting systems, in street-car headlight and interior lamp-circuits, in storage-battery charging-circuits depending on central or municipal circuits, and the like; and the invention has special reference to automatic regulators for electric circuits, which include storage batteries and electric lamps—arc or incandescent. Numerous and ingenious contrivances have been invented for controlling or governing the presence and introduction of resistance in such circuits for the purpose of maintaining a constant current or electromotive force upon the supplied circuit. Each of these devices, as I am informed, is characterized by a row or series of resistance terminals or contacts and a collector, sweep, or contact finger or arm, which is automatically actuated by mechanical means under magnetic control. Many have been complicated by the use of small electric motors which supply the mechanical force needed for the operation of the resistance-varying sweep or arm. Electric controllers or regulators that are built upon such lines of necessity include a large number of mechanical elements or parts and an equally-extended group of magnetic parts, all of which are frail and weak and which taken together constitute an electromagnetic mechanism of such complexity of functions and structures as to court failure and inaccuracy in operation. Furthermore, the parts of these complicated many-movement regulators frequently bind and refuse to perform their work because of the excessive temperature to which they are subjected by the highly-heated resistance-coils that are always placed in close proximity to the working parts of such regulators. Experience has demonstrated the unreliability of present-day controllers or regulators as a class, that they are difficult to keep in order, and are the most frequent sources of trouble in the battery and lamp circuits wherein they are used.

The object of my invention is to improve the operation of electric regulators and to greatly simplify the construction thereof and render their action more certain and reliable.

Another object of my invention is to provide an electric controller or regulator that shall admit of the subdivision of the resistance to any extent desired or required by the service to be performed by the translating devices in circuit.

I conceive that the chief difficulties encountered in the present controllers or regulators arise from and are attendant upon the employment of a rigid collector-brush or sweep in combination with rigid resistance-sections or contacts. These elements make it necessary to employ complex auto-driven mechanical elements that are short-lived, the efficiency of which varies with surrounding conditions, which are comparatively slow in operation, and which offer a varying frictional and mechanical opposition to quick, accurate movement in place of the uniform forces and conditions which the problem demands. Proceeding on this conception I have determined upon the elimination of the usual rigid or solid metal sweep or collector, as well as all of the mechanical and auxiliary electrical and electromagnetic elements and members found in other regulators, and in place thereof I have adopted a liquid current-collector for cooperation with the necessary resistance-coil terminals or contacts with a very simple and reliable electromagnetic device for actuating and controlling the movement of what I have thus termed the "liquid current-collector."

My invention, broadly considered, consists in a liquid container or receptacle having, preferably in its walls, the requisite number of resistance terminals or contacts, suitably insulated, and arranged at different points or elevations, in combination with a fluid, liq-

uid, or plastic substance, preferably mercury, in said receptacle, and a liquid-displacing device that is electromagnetically operated or controlled and which by its movement causes the liquid to rise or fall into contact with higher or lower terminals, as the case may be, said liquid being included in the electric circuit and having a suitable terminal in either said container or said displacing device or plunger, and, further, my invention consists in various constructions and combinations of parts and in circuit arrangements, all as hereinafter described, and particularly pointed out in the claims.

The invention will be more readily understood by reference to the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a vertical section of an automatic electric regulator embodying my invention. Fig. 2 is a similar view showing the displacing device or plunger in its lowest position. Fig. 3 is a horizontal section on the line *x x* of Fig. 1, and Fig. 4 is a diagrammatic view showing the circuits of the regulator.

As shown in the drawings, 2 represents a solenoid, supported by brackets 3, which extend from the backboard or slab 4.

5 is the measuring-pot or liquid-container supported upon but insulated from the bracket 6. The pot 5 is preferably arranged beneath the solenoid 2 and contains the central guide or standard 27.

7 is the solenoid-core, having on its lower end a tubular extension 8 to slide upon the standard 27. The extension 8 carries the displacing device or plunger 9, which is preferably a hollow cup of less diameter than the pot or container 5, a narrow annular space 10 being left between the plunger 9 and the inner walls of the pot 5.

The parts 5 and 9 may be of any desired cross-section or shape, and any convenient means other than the standard or post 27 may be used for guiding the plunger and the solenoid-core.

11 11 11 11 are the resistance-terminals. These are placed close together in an inclined or spiral row, stepping upward from the bottom of the pot to the top thereof. The pot-walls thus accommodate a very large number of resistance-coil terminals within a very small space measured vertically, and it is obvious that this construction enables me to use as many terminals as may be required for nice regulation by the fine subdivision of the resistance. The difference between the elevations of adjacent terminals or contacts may be as slight or as great as differing conditions require, yet with entire freedom from the usual difficulties pertaining to contact areas and insulation. The terminals may be of any desired design or pattern; but I preferably employ simple screws 12, that pierce the insulating-plugs 13, which fill the holes 14 in the walls of the pot, the ends of the screws being bare within the pot or container. The screws have washers 15 of insulating material.

16 16 represent the wires or connections leading to the resistance-coils.

The pot 5 is partially filled with a liquid 17, preferably mercury, which is a good conductor, and when the plunger falls or is depressed it displaces the mercury and drives it upward between the plunger and the walls of the pot or container, forcing the mercury into contact with the exposed or contact ends of the resistance-terminals. When the plunger is raised, the column of mercury falls and is thus withdrawn from contact with one or all of the terminals, according to the height to which the plunger is lifted.

18 and 19 are the main terminals of the solenoid, and 20 20 are the taps that are connected to the several upper coils or sections of the solenoid.

Referring now to Fig. 3, it will be seen that current enters over the main-circuit line 21, which is connected to the end or first terminal of the resistance 22. The lower end of the resistance is connected by the wire 14′ to the lowest terminal or contact 11 on the regulator-pot. From this terminal or from any point on the metal pot 5 a line 23 leads to the upper connection 18 of the solenoid. From thence the circuit is traced through the windings of the solenoid to the outgoing or working branch 24 of the supplied circuit. As shown, the resistance-terminal connections 14 connect respective terminals upon the pot and the coils or sections of the resistance 22. The highest terminal 11 is connected to the end of the resistance and line 21. As shown in Figs. 1 and 2, the cup-plunger 9 is loaded or weighted with a quantity of mercury 25, placed therein, and I may also employ a coiled spring within the post 27 to assist in depressing the plunger. I prefer in most cases to weight the plunger with mercury and to dispense with the spring; but either or both means may be used. At times when the solenoid is deënergized the plunger will be in its lowest position, as shown in Fig. 2, and the column of mercury will be elevated, as therein shown, so that it will be in electrical contact with all of the resistance-terminals 11. Thus at the instant when the circuit is energized the current will pass immediately from the line 21 to the mercury in the pot and from thence to the bottom terminal and to the solenoid, the resistance at that instant being all cut out. The solenoid will therefore be instantly and powerfully energized and acting upon the solenoid-core will lift the plunger 9 and allow the mercury in the pot to fall. When the plunger is lifted, it is obvious that a number of the upper terminals upon the pot will be

uncovered and left bare by the fall of the liquid, thereby interrupting the direct passage of the current from the line 21 to the body of mercury and forcing the current to traverse a number of coils or sections of the resistance 22 before reaching a coil having a terminal that is still covered by the mercury. From such a covered terminal the current finally reaches the mercury and finds a direct passage to the line 23, the remaining resistance being effectively cut out by the first direct mercury connection supplemented by the many avenues of escape afforded by the connections 14 of the lower terminals. A very strong current in the solenoid will produce a complete elevation of the plunger and by allowing the mercury to fall below all of the terminals will put all of the resistance into the circuit. The elevation to which the plunger will be raised and at which it will be held will depend upon the strength of the current in the solenoid, and this in turn is controlled by the quantity of effective resistance in the circuit. The device operates almost instantaneously with every fluctuation of the current or electromotive force upon the circuit wherein it is used, compensating therefor and resulting in a constant current, potential, or electromotive force, as the case may be, on the working branch 24 of the main circuit.

It will be noted that the greatest displacement of the mercury in the pot occurs at the time when there is the least resistance in circuit and that the solenoid has less weight to raise at the beginning of the stroke of the core than after it is partially elevated. The force of the solenoid, however, increases as the core enters it and its increased effectiveness is usually sufficient to compensate for the increased weight of the plunger when lifted. I, however, prefer to arbitrarily increase the strength of the solenoid as the plunger is lifted and to this end employ auxiliary solenoid-windings 2′, formed by tapping the coils of the solenoid at different heights. The taps 20 lead to auxiliary terminals 20′, provided in the wall of the pot and at different elevations. The lowest tap 20 leads to the uppermost terminal 20′ and the upper tap leads to the lower terminal 20′. The result of these connections is that when the mercury is elevated in the pot the upper coils of the solenoid will be practically short-circuited or weakened by being thrown into multiple arrangement, while upon the elevation of the plunger and when the solenoid needs assistance the terminals 20′, one or all, will be bared by the fall of the mercury, thereby restoring the corresponding coils to active series circuit in the solenoid to further compensate for the increased weight that must be lifted and sustained by the solenoid.

It is obvious that numerous modifications of my invention will readily suggest themselves to one skilled in the art, and I therefore do not confine my invention to the specific constructions, circuits, and arrangements herein shown and described.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In an automatic electric regulator a solenoid having a core, in combination with a cup-plunger directly coupled to and forming mechanically a part of said core, and concentric therewith, a liquid-pot containing said plunger, and a conducting fluid in said pot, substantially as described.

2. In an automatic electric regulator a solenoid provided with a plurality of taps, a liquid-pot, a series of auxiliary contact-points insulated in the walls of said pot and connected with said taps, a conducting fluid within said pot, and means for displacing said liquid within said pot, substantially as and for the purposes described.

3. In an automatic electric regulator, a liquid-pot provided with a spirally-arranged series of insulated contacts in its walls, auxiliary contacts at different elevations in said pot, a solenoid having taps connected with said auxiliary contacts, a conducting fluid in said pot, said solenoid operating to raise or depress the level of said liquid within said pot, substantially as and for the purpose specified.

4. An automatic electric regulator, comprising a solenoid having a core, a pot containing a conducting liquid, a plunger directly coupled to said core and operable in said pot, and an inclined series of independent resistance-terminals insulated in the walls of said pot, substantially as described.

5. In an automatic electric regulator, a solenoid provided with taps, a core in said solenoid, a liquid-cup, a plunger in said cup and coupled to and forming, mechanically a part of said solenoid-core, a series of independently-insulated resistance-terminals spirally placed at varying heights in the walls of said cup, independently-insulated auxiliary terminals in the walls of said cup connected with said solenoid-taps, and a conducting liquid in said cup, substantially as described.

6. An automatic electric regulator, comprising a pot, in combination, with a plurality of stepped resistance-terminals insulated on the walls of said pot and arranged spirally thereon, a suitably-guided plunger for operation in said pot, a solenoid and a solenoid-core coupled to and concentric with said plunger, substantially as described.

7. An automatic electric regulator, comprising a pot or container, a conducting liquid therein, a plunger, the solenoid having its core concentric with and forming mechanically a part of said plunger, a resistance, a plurality of resistance-coil terminals, having contacts within said pot and insulated from one another, and a circuit branch electrically con-

nected with said conducting liquid and including said solenoid, substantially as described.

8. The automatic electric regulator, comprising a pot or vessel, in combination, with the resistance-terminals arranged at different elevations in said pot, a body of mercury in said pot, a cup-plunger operable directly by electromagnetic means and reversible by gravity in said pot, and a load of mercury in said plunger, substantially as described.

9. An automatic electric regulator, comprising a liquid pot or container, in combination, with a plurality of resistance-terminals having exposed contacts at different elevations in said pot, a conducting liquid provided in said pot, a plunger for displacing said liquid, the spring operating upon said plunger to depress the same and an electromagnetic device for withdrawing said plunger, substantially as described.

10. An automatic electric regulator, comprising the liquid-container, in combination, with a plurality of resistance-terminals of varying elevation, the conducting liquid in said pot, the displacing-plunger, the solenoid having a core coupled to said plunger, the auxiliary terminals in said pot and the solenoid-taps connected with said auxiliary terminals, substantially as described.

11. An automatic electric regulator, comprising a metallic liquid-pot, in combination with a plurality of resistance-terminals having exposed contacts at different elevations in said pot and independently insulated in the walls thereof, a conducting liquid in said pot, a plunger for displacing said liquid, depressible by gravity, and an electromagnetic device for raising said plunger, substantially as described.

12. In an automatic electric regulator, in combination, a pot, a conducting liquid in said pot, a plunger in said pot, depressible by gravity, for raising the level of said liquid, a solenoid for raising said plunger and thereby depressing the level of said liquid, a resistance in circuit with said solenoid, and a plurality of spirally-arranged resistance-terminals having bare contacts, exposed to said liquid in said pot, substantially as described.

In testimony whereof I have hereunto set my hand, this 14th day of April, 1903, at Chicago, Illinois, in the presence of two witnesses.

ALEXANDER McGARY.

Witnesses:
C. G. Hawley,
George H. Kelly.