No. 704,371. Patented July 8, 1902.

# T. M. PUSEY.

## VOLTAGE REGULATOR.

(Application filed Aug. 5, 1901.)

(No Model.) 2 Sheets—Sheet 1.

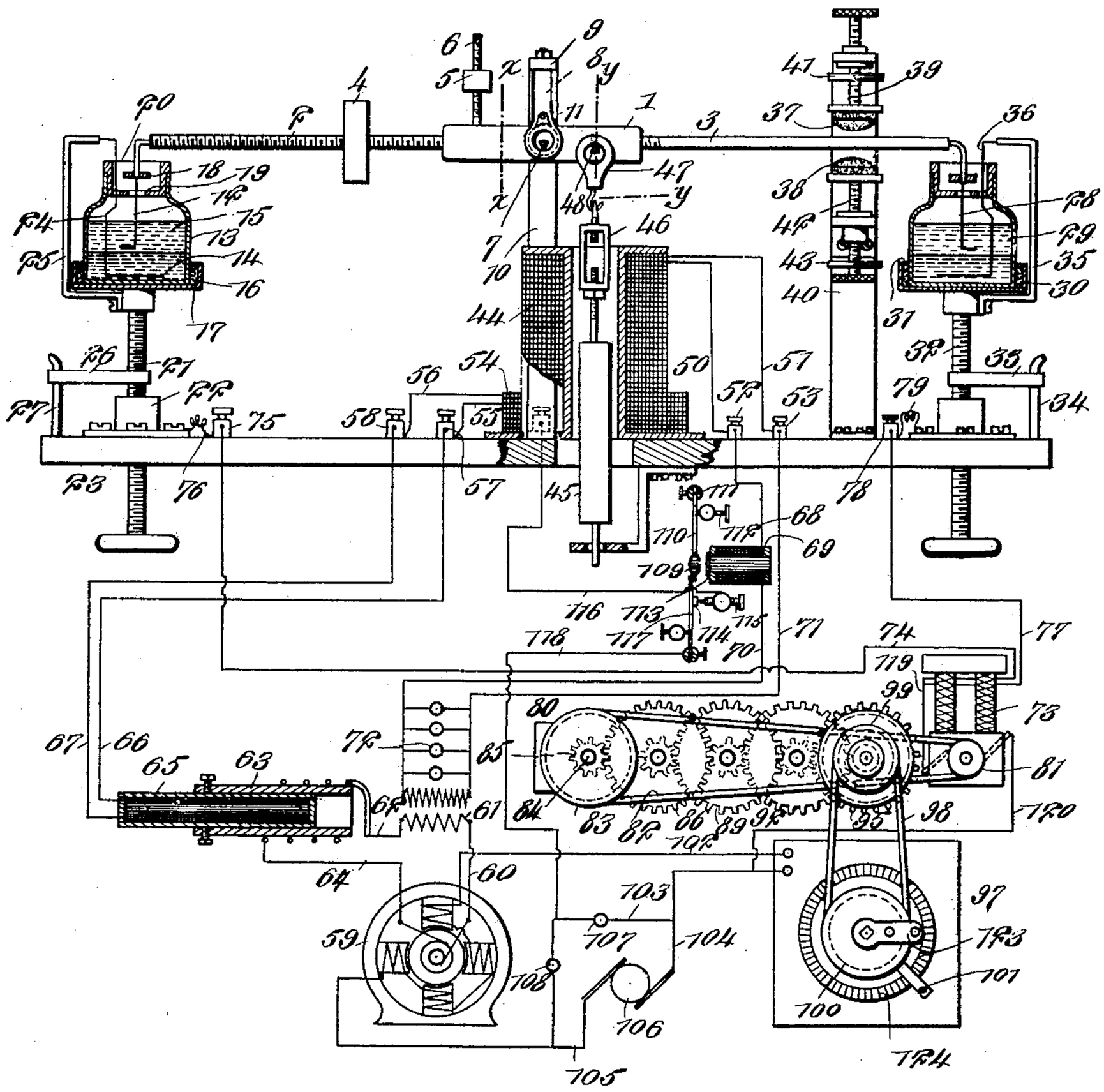

Fig. 1.

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(No Model.) 2 Sheets—Sheet 2.

Fig. 2.

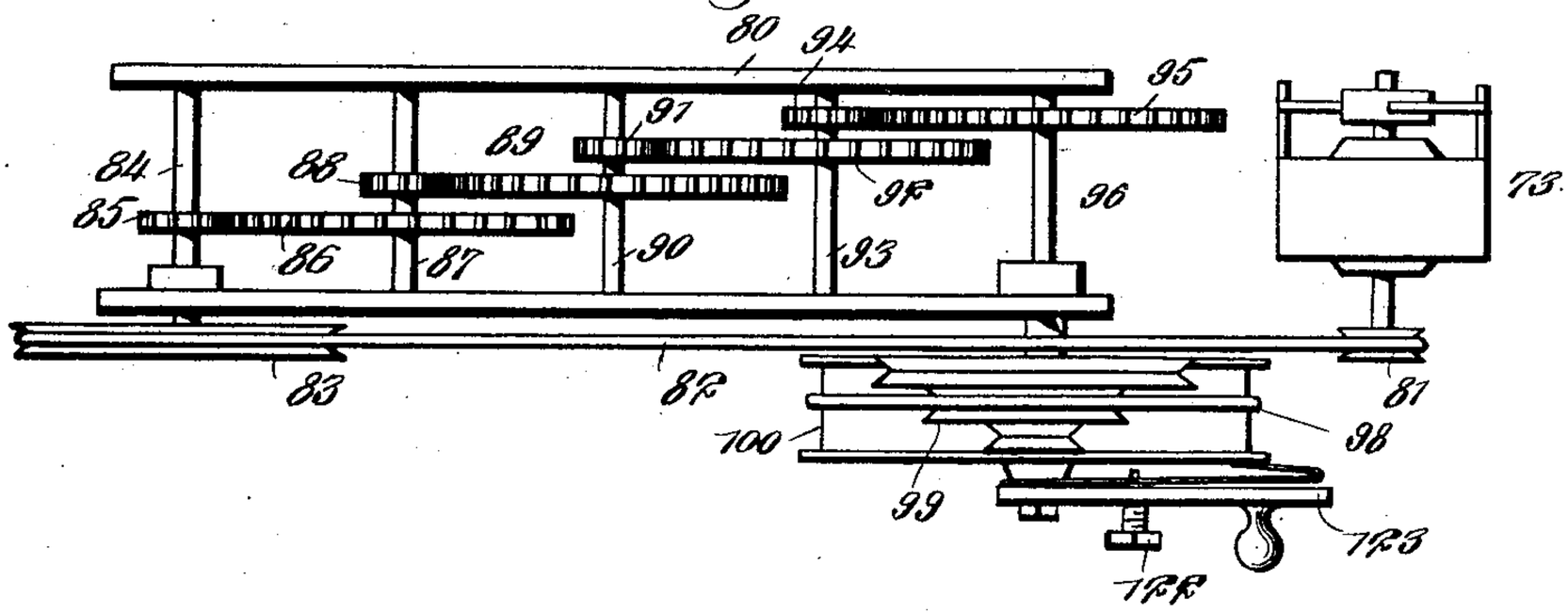
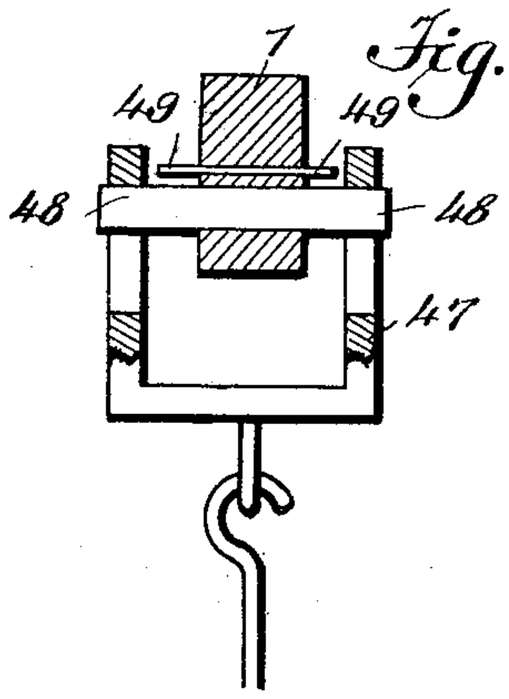



Fig. 4.



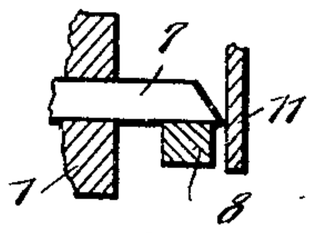




Fig. 5.

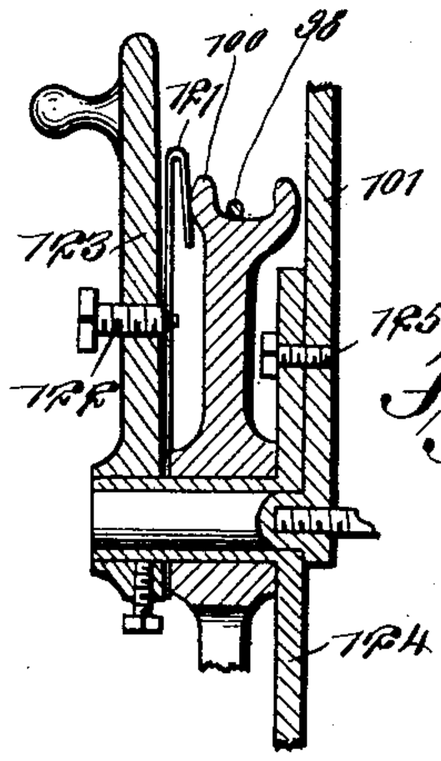



Fig. 3.

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# UNITED STATES PATENT OFFICE.

THOMAS M. PUSEY, OF KENNETT SQUARE, PENNSYLVANIA.

## VOLTAGE-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 704,371, dated July 8, 1902.

Application filed August 5, 1901. Serial No. 70,961. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS M. PUSEY, a citizen of the United States, and a resident of Kennett Square, in the county of Chester and State of Pennsylvania, have invented a new and Improved Voltage-Regulator, of which the following is a full, clear, and exact description.

This invention relates to improvements in voltage-regulators for dynamos or generators; and the object is to provide a simple means for automatically regulating the voltage, and thus providing a practically even circuit-current for lamps or other purposes.

I will describe a voltage-regulator embodying my invention and then point out the novel features in the appended claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

Figure 1 is a partial side elevation and partial diagrammatic view of a voltage-regulator embodying my invention. Fig. 2 is a plan view of a controlling-motor employed. Fig. 3 is a sectional view of a portion of a rheostat employed. Fig. 4 is a section on the line *y y* in Fig. 1, and Fig. 5 is a section on the line *x x* in Fig. 1.

The balance-beam of the device comprises a central portion 1, from which arms 2 and 3 extend. The arm 2 is screw-threaded, and adjustable thereon is a counterweight 4, by means of which the resistance of the beam may be regulated as desired. A weight 5 is mounted on a screw 6, extended upward from the beam at one side of its fulcrum, and by turning the weight 5 one way or the other the center of gravity of the beam may be elevated or depressed. The beam has at its central portion trunnions 7, which have bearings in a yoke 8, suspended from a horizontal arm 9 on a standard 10. As clearly indicated in Fig. 5, stop-plates 11 are hinged to the opposite members of the yoke, so as to prevent any lateral movement of the trunnions, and it will be noted in said Fig. 5 that the ends of the trunnions are reduced in thickness or inclined, so that the frictional engagement of the trunnions with said plates 11 is reduced to a minimum.

Carried on one end of the beam is a platinum point 12, movable in a vessel 13, within which acidulated water 14 is placed—such, for instance, as a few drops of sulfuric acid—to increase the conductivity. Upon the acidulated water is placed an oil 15, such as coal-oil. One object of this oil being on the acidulated water is to prevent the water from evaporating. Another object is to condense any steam that might arise due to the heat generated by a current of electricity when the contact 12 comes in contact with the upper surface of the water, as will be hereinafter described, and the oil acts, further, as an insulator between the contact-point and the water when the said contact-point is elevated above the surface of the water, and still another object in placing oil over the water is that much less movement is required of the contact 12 to make and break the circuit. This is due to the coöperation of the adhesion of the oil and acidulated water to the contact 12 and to the buoyant forces of the rising gases due to the decomposition.

The vessel 13 is placed in a cup-shaped holder 16, consisting of metal or other suitable material, and arranged between the wall of this holder 16 and the vessel 13 is a packing 17, of cardboard or similar material, that will absorb any moisture that may flow over the top of the vessel 13. As a further means of preventing an overflow of liquid I provide a stopper-plate 18, mounted on the contact 12 or near its upper end and serving as a valve for engaging with a valve-seat 19, formed in the bottom of a cup 20, placed in the mouth of the vessel 13. The holder 16 is mounted on a vertically-adjustable post 21. This post is screw-threaded and engages with an interior thread of a sleeve 22, mounted on the base 23. A platinum contact 24 extends from the bottom of the vessel 13 and upward through the mouth thereof and connects with a current-carrying arm 25, attached to the post 21. By means of the post 21 the distance between the surface of the water in the vessel 13 and the contact 12 may be regulated as desired. To prevent an accidental rotation of the post 21, I employ a brake consisting of an elastic band 26, engaging around said post and with a fixed post 27 on the base 23.

Attached to the opposite end of the beam 1 is a platinum contact 28, movable in a vessel

29, which contains acidulated water and oil, as does the vessel 13, and this vessel 29 is mounted in a holder 30, within which is placed a packing 31, of absorbent material. This holder 30 is mounted on an adjustable post 32, similar to the post 21, and held from accidental rotation by an elastic band 33, extended around said post 32 and around a fixed post 34. The post 32 is in electrical connection with the acidulated water by means of a current-carrying arm 35, extended from the post, and from the upper end of which a platinum contact 36 extends downward into the acidulated water.

To prevent a swinging movement of the ends of the beam 1 too far downward and to prevent the ends from coming in contact with the vessels 13 and 29, I employ cushions 37 38, arranged, respectively, above and below one end of the beam. The cushion 37 is attached to a screw-rod 39, adjustable in brackets on a standard 40 and held as adjusted by an elastic band 41. The cushion 38 is supported on a screw-rod 42, adjustable in a bracket on the standard 40 and held as adjusted by an elastic band 43.

Mounted on the base 23 is a helix 44, of which the core 45 is movable, this core being suspended from the beam 1. As here shown, the core has a screw-rod connection with a link 46, the upper end of which has a screw-rod connection with a yoke 47, engaging with bearing-points 48 on the beam. By means of the screw-rod connections with the link 46 the degree of movement of the core may be adjusted or regulated to the strength of the current passing through the helix. Lateral movement of the yoke 47 relatively to the beam 1 is prevented by pins 49, extended outward from the sides of said beam 1 and adapted to engage lightly against the inner surfaces of the yoke members. This construction is plainly shown in Fig. 4. The terminals of the helix 44 are connected by wires 50 and 51 with binding-posts 52 and 53. Surrounding the lower portion of the helix 44 is what I term a "weakening" helix 54, the object of which will hereinafter appear. The terminals of this helix 54 are connected by wires 55 and 56 with binding-posts 57 and 58.

From one brush of an alternating generator 59 a wire 60 leads to a transformer 61, and from this transformer a wire 62 continues and is coiled around a tube 63, and the opposite end of this coil is connected by a wire 64 with the opposite brush of the generator. Adjustable in the tube 63, and therefore more or less acted upon by the coils surrounding said tube, is an induction-coil 65, from the terminals of which wires 66 and 67 extend, respectively, to the binding-posts 57 and 58, and consequently to an electrical connection with the helix 54. From the binding-post 52 a wire 68 leads to one end of a circuit-closing electromagnet 69, and from the other end of said magnet a wire 70 leads to the transformer 61, while from the other end of the transformer a wire 71 leads to a connection with the binding-post 53. The wires 70 and 71 for a circuit have electrically-controlled devices—such, for instance, as lamps 72.

Arranged within a shunt-circuit is a motor 73, which has reverse windings. From one end of the windings a wire 74 extends to a binding-post 75, which is in electrical connection, through a wire 76, with the post 21, and consequently with the contact 24. From the other winding of the motor a wire 77 leads to a binding-post 78, which is connected by a wire 79 with the post 32, placing it in electrical connection with the platinum contact 36. The motor 73 is designed to impart motion to a controlling-gear 80 from a pulley 81 on the end of the shaft of the motor 73. A band 82 extends to a connection with a pulley 83 on a shaft 84, arranged within the controlling-gear frame. On this shaft 84 is a pinion 85, meshing with a gear-wheel 86 on a shaft 87, which supports a pinion 88, engaging with a gear-wheel 89 on a shaft 90, and on this shaft 90 is a pinion 91, engaging with a gear-wheel 92 on a shaft 93, which bears a pinion 94 for operating a gear-wheel 95 on the shaft 96, designed to operate the rheostat 97, the movement being caused by a band 98, engaging with a pulley 99 on the shaft 96 and passing around a pulley 100, having connection with a regulating-arm 101 of the rheostat. From the rheostat wires 102 103 extend to the field of the generator 59, and arranged in a shunt 104 105, leading from the wires 103 103, is an exciting-dynamo 106. Also arranged in the wire 103 are resistance-pumps 107 108.

Coacting with the electromagnet 69 is an armature 109, consisting of fine soft-iron wire wound on the end of a spring yielding arm 110, depending from a lug 111 and limited in its movement toward the electromagnet by a stop-screw 112. Over the end of the magnet is placed a pad 113, of cloth or other suitable material, and which is designed to prevent the armature 109 from coming in direct contact with the core of the magnet, and thus arresting the minimum vibration of the armature due to the alternating of the current in the magnet. While normally the armature stands in its attracted position in relation to the magnet, it is designed at a certain time to break contact between the contact-plate 114 and a contact-point 115. From this contact-point 115 a wire 116 leads to an electrical connection with the standard 10, and consequently through the contacts or electrodes carried by the beam 1. The contact 114 is mounted on a spring yielding arm 117, and from this arm 117 a wire 118 leads to a connection with the wire 103.

The operation is as follows: It will be here understood that the object of the circuit-closing magnet 69 is to prevent any current from flowing through the wire 118 and the electrical connections to the motor 73 when there is no current flowing through the helix 44, thus preventing the motor from running un-

til all the connections are properly made, or in case the circuit through the helix 44 should in any way be broken the circuit-closing magnet 69 would prove a safeguard to the whole device. It will be further understood that the spring-arm 110, carrying the armature, is constantly quivering or having minimum vibration, also that the end of the spring-arm 110 does not touch the end of the spring-arm 117 until the armature 109 is released by its magnet. As the pressure of voltage of the generator 59 increases beyond a desired point the increased current flowing from the transformer 61 through the wire 70, the magnet 69, the wire 68, binding-posts 52, wire 50, helix 44, wire 51, post 53, and wire 71 back to the transformer 61 will draw the core 45 upward, thus causing the beam 1 to rock and engage the contact 12 in the acidulated water 14, and then the circuit will be closed and the current will flow through the wire 118, the spring-arm 117, contact-point 115, wire 116, standard 10, yoke 8, and through the beam, the platinum point 12, acidulated water 14, platinum contact 24, arm 25, post 21, and thence through the wire 76 to the binding-post 75, wire 74, field-magnet of the motor 73, wire 119, armature of the motor 73, wire 120, wire 103, resistance-lamps to the generator, thus completing the circuit. This will cause the motor 73 to run in one direction, and through the medium of the band 82 and the motor 80, the pulley 99, the band 98, the pulley 100, a spring 121, a thumb-screw 122, an arm 123, carrying said thumb-screw, a disk 124, which is secured to the switch-arm 101 and the rheostat by means of a screw 125, will cause the switch-arm 101 to rotate. This will cause a less amount of electricity to flow through the exciting-dynamo 106, the wires 104 103, the rheostat 97, and wire 102, and consequently through the field-magnets of the alternating generator. This will of course decrease the voltage of the generator and cause a less amount of current to flow through the helix 44, and when the rheostat-arm 101 has moved to the proper place of resistance, and thus regulated the voltage of the generator to its proper point of pressure, the strength of the helix 44 will be diminished and allow the core 45 to descend, consequently permitting the beam 1 to break its connection with the acidulated water in the vessel 13, and now the motor 73, the train of gears in the motor 80, and the rheostat-arm will stop.

It might be well to state here that the wire 103, containing the lamp 108 and the lamp 107, is used as a shunt to the exciting-dynamo.

As above stated, the motor 73 has two windings in the field-magnet which are in opposite directions to each other, or, in other words, so arranged as to cause the currents to flow in mechanical opposition, and thereby rotate the motor in opposite directions.

When the voltage of the generator falls below the desired point, the helix 44 will lose some of its strength and cause the contact 28 to descend into the acidulated water within the vessel 29, thus closing the circuit through the wire 118, the spring 117, the contact 115, the wire 116, the standard 10, the yoke 8, the beam 1, the contact 28, the acidulated water within the vessel 29, the contact 36, the arm 35, the post 32, and thence through the wire 77 and one of the coils of the field-magnet of the motor 73, the wire 119, the armature of the motor, the wire 120, the wire 103, and the lamp 107. When in this condition, the motor 73 will run in the opposite direction from that it did in the first instance, and thus move the train of gears and the switch-arm of the rheostat in the opposite direction from that mentioned in the first instance. When the switch-arm 101 shall have moved to the proper resistance and the voltage of the generator has raised to its proper pressure, the increased current flowing through the helix 44 will cause the finger or contact 28 to break circuit with the acidulated water, thus causing the motor 73 to stop.

The arm 123 is secured to the end of a sleeve supporting the disk 124, and it is obvious that the rheostat-arm 101 may be turned manually and independently of the gearing comprised in the motor 80, so that the spring 121 will slide on the wheel 100. The tension of this spring 121 may be regulated by the set-screw 122. The quantity of current flowing through the helix formed by the wire 62 of the main conductor controls the induced current flowing through the coil 65, the wire 67, the binding-post 58, the wire 56, the helix 54, the wire 55, the binding-post 57, and the wire 66. The current in the helix 54 flows in mechanical opposition to that flowing in the helix 44, thus tending to weaken said helix 44, and this will cause the voltage of the generator 59 to rise and compensate for the loss due to the increased current or amperage on the main line according to the amount of current or amperage flowing through the main conductor or wire 62, and in this way the voltage at the terminals of the lamps 72 is kept practically even. By moving the induction-coil 65 in or out of the tube 63 a greater or less amount of current may be introduced in the coil formed by the wire 52.

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

1. In a voltage-regulator, a generator, a helix arranged in circuit with the generator, a rheostat for the generator, a circuit for operating the rheostat, a balance-beam controlled by the helix and having contacts at its ends, liquid-containing receptacles, conducting liquid in the receptacles and in connection with the rheostat-operating circuit, adjustable cushions above and below one end of the beam, and an adjustable counterweight on the beam, substantially as specified.

2. In a voltage-regulator for a generator, a helix arranged in circuit with the generator, an electromagnet in the circuit normally hold-

ing a rheostat-controlling circuit open, a rheostat in a circuit with the main generator, electrically-controlled means for operating the rheostat, an induction-coil, an exciting-coil for the induction-coil and in circuit with the generator, and a helix surrounding the first-named helix and having connection with the induction-coil, substantially as specified.

3. A voltage-regulator in connection with a generator, comprising a helix in circuit with the generator, a rheostat for the generator, a motor for the rheostat, shunt-circuit from the exciter-circuit in which the motor is arranged, a balance-beam controlled by the helix, said balance-beam being in the shunt-circuit, contacts carried by the balance-beam, and contacts arranged in the shunt-circuit and adjustable relatively to the first-named contacts, substantially as specified.

4. In a voltage-regulator, a generator, a rheostat for the generator, a motor for controlling the rheostat, a shunt-circuit from the exciter-circuit in which the said motor is arranged, a helix arranged in circuit with the generator, a balance-beam arranged in the shunt-circuit and controlled by said helix, contacts carried by said beam, liquid-containing vessels into which said contacts extend, supports for said vessels, means for adjusting the supports vertically, contacts fixed in the vessels and in said shunt-circuit, and an electromagnet in the main circuit of the generator for controlling the motor-circuit, substantially as specified.

5. In a voltage-regulator for a generator, a shunt-circuit from the exciter-circuit, means arranged in said shunt-circuit for operating a rheostat for the generator, means for closing said shunt-circuit, comprising a balance-beam having contacts at its ends coacting with fixed contacts, a supporting-yoke for said beam, fulcrum-points on the beam supported in said yoke, and means carried by the yoke for limiting the lateral movement of said points relatively to the yoke, substantially as specified.

6. In a voltage-regulator for a generator, a helix, an electromagnet arranged in circuit between said helix and said generator, a transformer in a circuit with the generator, an induction-coil controlled by a circuit from the generator, a helix surrounding the first-named helix and in electrical connection with the induction-coil, and contacts arranged in the shunt-circuit and controlled by the first-named helix for regulating the voltage of the generator, substantially as specified.

7. In an electrical regulator, a liquid-containing receptacle, a liquid conductor in the receptacle, a contact fixed in the receptacle, a contact movable into and out of the liquid conductor, a vertically-adjustable post, a cup-shaped holder on said support for receiving the receptacle, and a packing arranged between said cup-shaped holder and the receptacle, substantially as specified.

8. In an electric regulator, a liquid-containing receptacle, a liquid conductor in the receptacle, a non-conducting liquid on the conducting liquid, a fixed contact in the vessel, a contact movable in the non-conducting liquid and into and out of the conducting liquid, a screw-post or support, a brake for holding said post as adjusted, a metal cup on said post for receiving the receptacle, and an absorbent material between the receptacle and said cup, substantially as specified.

9. In an electric conductor, a vessel for holding liquid, a conducting liquid in the vessel, a fixed contact extended into the liquid, a contact movable into and out of the liquid, and a valve or stopper carried by the movable contact for closing the opening of the vessel, substantially as specified.

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

THOMAS M. PUSEY.

Witnesses:
MATTHEW R. DAVIS,
CHAS. C. HADLEY.