G. A. BURNHAM.

AUTOMATIC VOLTAGE REGULATOR.

APPLICATION FILED SEPT. 7, 1909.

988,441.

Patented Apr. 4, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

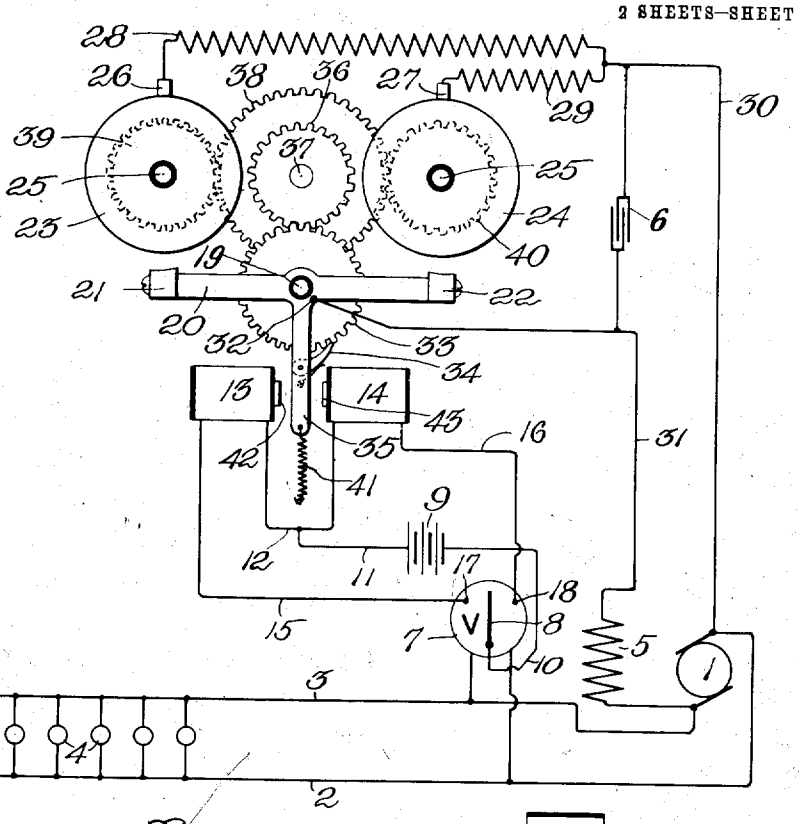
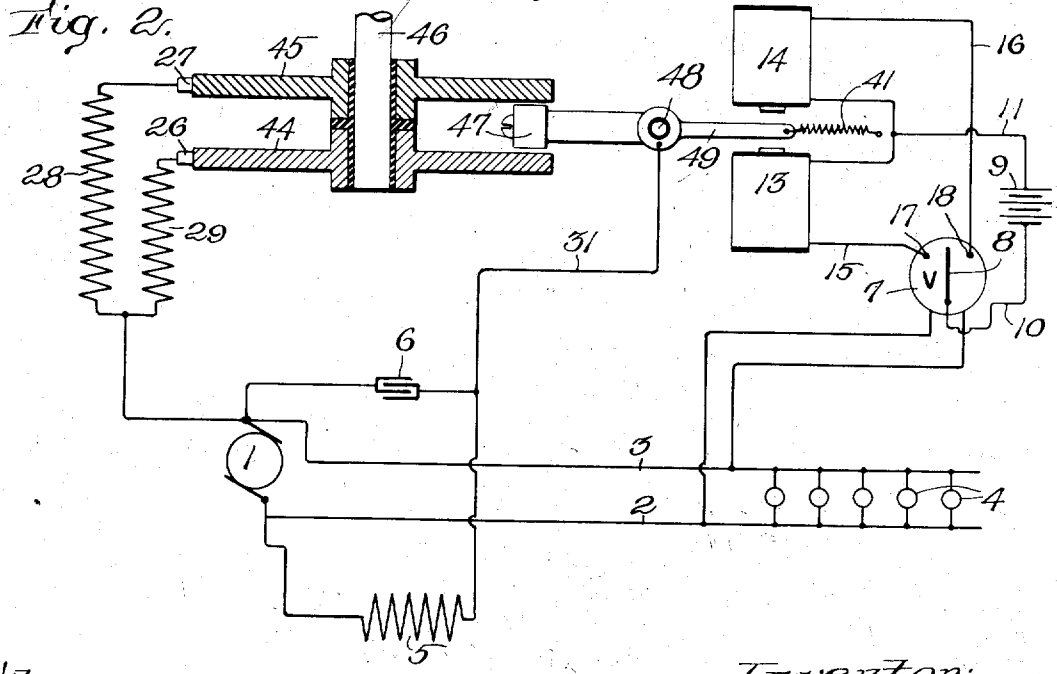


Fig. 2.



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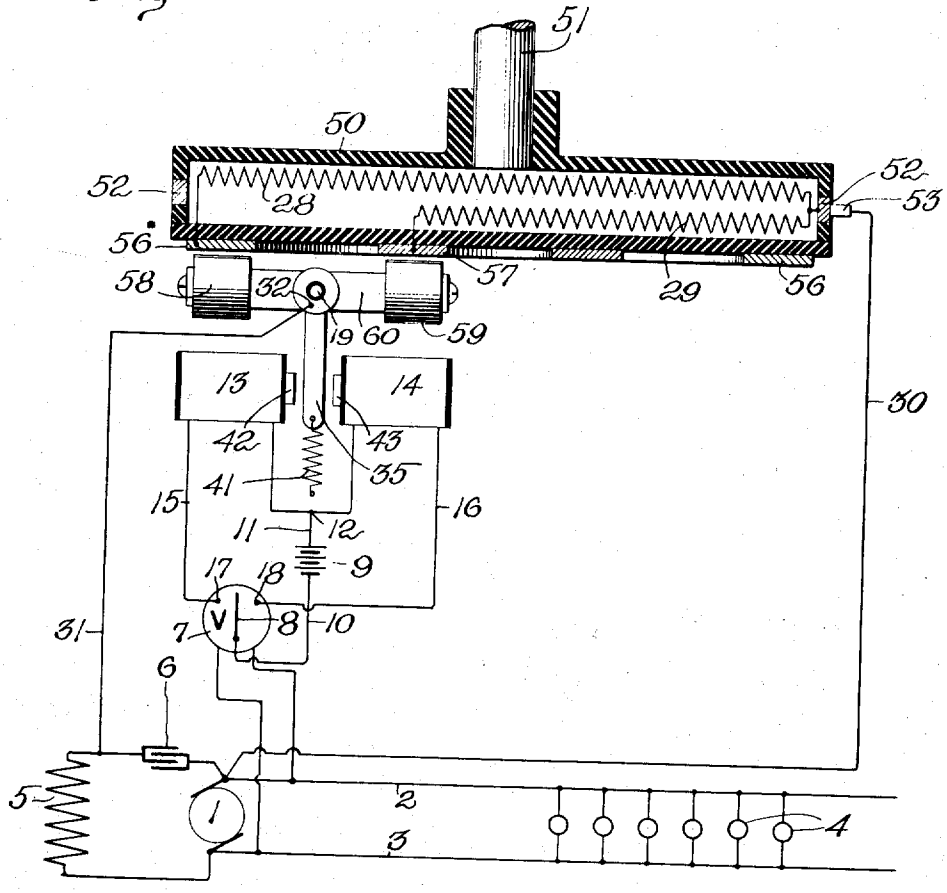
2 SHEETS—SHEET 2.

Fig. 5.



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AUTOMATIC VOLTAGE-REGULATOR.

988,441. Specification of Letters Patent. Patented Apr. 4, 1911.

Application filed September 7, 1909. Serial No. 516,428.

To all whom it may concern:

Be it known that I, GEORGE A. BURNHAM, a citizen of the United States, residing at Essex, in the county of Essex and State of Massachusetts, have invented an Improvement in Automatic Voltage-Regulators, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention is a voltage regulator, whose object is to provide such a high degree of efficiency that the introduction of the regulator into a working system will not be liable to interfere with the continuity of service. Up to the present time it has frequently been the case that the introduction of a voltage regulator would render the operation of the system more uncertain than it was without the regulator, because of the possibility, and in fact liability, of the regulator's refusing to work at a critical moment on account of the freezing of the contacts. Accordingly, my invention aims to provide a regulator which practically eliminates the tendency to impair or destroy the continuity of service, and I accomplish this by introducing means which is responsive to changes in voltage in the main line to cut in resistance into the field circuit in such a manner that it is practically impossible for the make-and-break device to stick, bug, or freeze, irrespective of whether the interruptions are rapid or slow. I provide a moving and preferably rotating contact or pair of contacts, coöperating with a reciprocating contact or pair of contacts, having relative frictional engagement. The result is that my voltage regulator has a high degree of efficiency as to certainty and continuity of action and practical immunity from breakdowns.

In the drawings, Figure 1 is a view partly in plan and partly diagrammatic of a preferred embodiment of the invention; and Figs. 2 and 3 are similar views showing modified constructions.

It will be understood that my mechanism is adapted to a variety of uses and wiring arrangements, and that I have herein shown the same in connection with a generator and its circuit, merely as a means of making the invention clearly intelligible. As shown, the generator to be regulated is indicated at 1 connected in usual manner to feed wires 2, 3 supplying current to a load 4, said generator having a usual field 5. Across the circuit 2, 3 is connected a voltmeter 7 whose needle 8 connects with any suitable source of supply, as a battery 9, by means of a wire 10, the wire 11 from the opposite end of the said source of supply branching at 12 to the solenoids 13, 14, the opposite ends of whose windings connect by wires 15, 16 to the contacts 17, 18 of the voltmeter, all in usual manner. Pivoted to rock at 19 is a conductor bar or lever 20 which constitutes a vibrating contact member provided at its opposite ends with brushes 21, 22 arranged to coöperate alternately with rotary contacts 23, 24 fast on insulated pivots 25. Brushes 26, 27 connect from the rotary contacts 23, 24 respectively with resistances 28, 29 connected by a wire 30 in series with the field 5 of the generator 1, said circuit being completed from the opposite side of the generator by a wire 31 to the contact lever 20 at 32. The condenser 6 is shown as connected across from the wire 30 to the wire 31. To rotate the contacts 23, 24, I mount loosely on the pivot 19 of the oscillating contacts 21, 22, a ratchet gear 33 actuated by a pawl 34 mounted on any adjacent moving part, as for instance on a stem 35 extending rigidly from the lever 20. Said ratchet gear 33 engages a pinion 36 on a shaft 37 which also carries a gear 38 in mesh with gears 39, 40 fast on the shafts 25 of said rotary contacts, whereby the latter are driven. The stem 35 is of magnetizable material, held by a spring 41 and adapted to be attracted to one side or the other by the cores 42, 43 of the adjacent electromagnets 13, 14.

In the construction shown in Fig. 2, two concentric disks or rotary contacts 44, 45 are mounted on a continuously driven shaft 46, said disks being shown as composed of conductor material. Coöperating therewith is a single contact 47 pivotally mounted at 48 and provided with a stem or reciprocator 49 of magnetizable material corresponding in construction and function to the same part 35 in the preferred construction, the resist-

ances 28, 29 being external of these rotary members 41, 45. In the construction shown in Fig. 3, instead of the two wheel-like contacts previously described, a hollow or box-like rotary member 50 is provided on a motor driven shaft 51 the same as in Fig. 2 and containing the two resistances 28, 29 connecting to a peripheral contact ring 52 engaged by a brush 53 of the wire 30. At their opposite ends said resistances connect to face rings 56, 57, engaged by contacts 58, 59 of a rock bar 60, the same in construction and operation as the corresponding parts already described with reference to the construction of Fig. 1. In each instance the vibrating member has two contact surfaces which engage alternately the coöperating two separate contacts which are connected to the respective resistances. In Figs. 1 and 3, these two surfaces are at the ends of the centrally pivoted vibrating cross bar or head of the vibrating member, in the form of two conducting blocks, whereas in Fig. 2 these two surfaces are formed by the opposite sides of the single intermediate block 47. By providing these two separated or distinct surfaces, one coöperating with one rotating portion and the other coöperating with the other rotating portion of the coöperating contact parts, neither surface is called upon to do an excessive amount of work, the work being divided between the two, and hence the life of the contacts is increased.

In operation, the rotary contacts operate to bring a new make-and-break surface in position at each movement of the reciprocating contact or contacts, so that the apparatus continues to operate uniformly and without liability to stick or freeze. The rotary contacts of all three embodiments of my invention are moved, in each instance, previous to contact with the vibrating member so as to bring a new surface into contact-making position, said previous movement in Fig. 1 being a step-by-step movement, and in Figs. 2 and 3 being a continuous movement of the rotary member or members. In Fig. 1 the step-by-step movement is accomplished directly in connection with the vibrating member or other contact, while in Figs. 2 and 3 the continuous rotating is accomplished by an externally driven continuously rotating shaft. The double-ended vibrating contact member of Figs. 1 and 3 has the advantage of prolonging the life of the instrument, inasmuch as the two contacts divide the work between them, and the same is accomplished by the operation of the double-sided block 47 in Fig. 2. Whenever there is a variation in potential in the main circuit 2, 3, there results a corresponding movement in the voltmeter 7 causing the needle 8 to move to the right or left, thereby energizing one or the other of the solenoids 13, 14 so as positively to move the contact lever 20 in a corresponding direction, bringing its contact or contacts into engagement with the rotary contacts 23, 24, as the case may be, of the make-and-break device. This cuts in one of the resistances 28, 29 and cuts out the other, correspondingly changing the value of the field flux. The provision of the two resistances 28, 29 of different values in connection with the means described for cutting out one and cutting in the other, or vice versa, results in a further advantage. The values of said resistances is either too high or too low to give normal voltage at the generator. By introducing the resistance 29, as distinguished from short-circuiting the resistance 28, I am able materially to reduce the tendency of sparking at the break between the reciprocating contact and one or the other of the rotary contacts, as the case may be.

As the mechanism shown in Fig. 1 is the preferred mechanism, as defined in this specification, I have not herein claimed the features which are specific to Figs. 2 and 3, the same being claimed in my application Serial No. 584,725, filed Sept. 30, 1910.

Having described my invention, what I claim is:

1. In a voltage regulator, two relatively movable contact members, having a relative movement into and out of contact position and a transverse movement for bringing a new surface into contact position, and mechanism to move one contact with relation to the other in said transverse direction previous to their relative movement into contact with each other and while the contacts are separated, and then to move one of said contacts into contact with the other.

2. In a voltage regulator, two relatively movable contact members, having a relative movement into and out of contact position and a transverse movement for bringing a new surface into contact position, and mechanism to move one contact with relation to the other in said transverse direction after the separation of said two contact members to bring a new surface into contact position and then to move one of said contacts into contact with the other.

3. In a voltage regulator, two relatively movable contact members, having a relative movement into and out of contact position and a transverse movement for bringing a new surface into contact position, and mechanism to move one contact with relation to the other in said transverse direction previous to their contacting movement and to move one of said contact members into contact with the other in the time interval between two transverse movements.

4. In a voltage regulator, a rotatable contact member and a vibrating contact mem-

ber, and mechanism to rotate said first named contact member previous to contact with the vibrating member and while the contacts are separated to bring a new surface into contact position, and bring said vibrating contact member into engagement with said rotatable contact member.

5. In a voltage regulator, a rotatable contact member and a vibrating contact member, and mechanism to rotate said rotatable contact member after the separation of said two contact members to bring a new surface into contact position and bring said vibrating contact member into engagement with said rotatable contact member.

6. In a voltage regulator, a rotatable contact member and a vibrating contact member, and mechanism to rotate said rotatable contact member previous to contact with the vibrating member and to move the vibrating member in the time interval between two rotary movements.

7. An automatic voltage regulator, comprising a rotary contact mechanism having two rotary contact portions insulated from each other, a separate resistance for each portion, and a movable contact member movable to make contact alternately with one of said portions and then with the other to render said resistances alternately effective.

8. An automatic voltage regulator, comprising a rotary contact mechanism having two rotary contact portions insulated from each other, a separate resistance for each portion, a movable contact member movable to make contact alternately with one of said portions and then with the other to render said resistances alternately effective, and means operated by said movable contact member for actuating said rotary contact mechanism.

9. An automatic voltage regulator, comprising an intermediately pivoted contact member, electromagnetic means for rocking said member on its pivot, a coöperating contact mechanism having separated contact portions to coöperate with the opposite ends of said pivoted contact member as the latter rocks on its pivot, a high resistance in series with one of said contact portions and a low resistance in series with the other of said contact portions.

10. An automatic voltage regulator, comprising an intermediately pivoted contact member, electromagnetic means for rocking said member on its pivot, a coöperating contact mechanism having separated contact portions to coöperate with the opposite ends of said pivoted contact member as the latter rocks on its pivot, a high resistance in series with one of said contact portions, a low resistance in series with the other of said contact portions, said two contact portions being movable with reference to the pivoted contact member for bringing new contact surfaces into operative relation with the pivoted contact member, and moving mechanism actuated by the rocking movement of said pivoted contact member to move said two contact portions.

11. An automatic voltage regulator, comprising an intermediately pivoted contact member, electromagnetic means for rocking said member on its pivot, a coöperating contact mechanism having separated contact portions to coöperate with the opposite ends of said pivoted contact member as the latter rocks on its pivot, a high resistance in series with one of said contact portions, a low resistance in series with the other of said contact portions, said two contact portions having rotary movement with reference to the pivoted contact member for bringing new contact surfaces into operative relation with the pivoted contact member, and moving mechanism actuated by the rocking member of said pivoted contact member to rotate said two rotary contact portions.

12. An automatic voltage regulator, comprising an intermediately pivoted contact member, electromagnetic means for rocking said member on its pivot, a coöperating contact mechanism having separated contact portions to coöperate with the opposite ends of said pivoted contact member as the latter rocks on its pivot, a high resistance in series with one of said contact portions, a low resistance in series with the other of said contact portions, said two contact portions having rotary movement with reference to the pivoted contact member for bringing new contact surfaces into operative relation with the pivoted contact member, and a pawl and ratchet mechanism actuated by said rocking member to rotate said rotary contact portions.

13. In a voltage regulator, a contact member having two operative contact surfaces, two contacts to coöperate alternately with said respective surfaces, mechanism including means operatively related to one of said two contacts for raising the voltage controlled by said regulator and including means operatively related to the other of said two contacts for lowering the said voltage, and operating means for said contacts.

14. In a voltage regulator, a common vibrating contact member, two contacts, mechanism including means operatively related to one for raising the voltage controlled by said regulator and including means operatively related to the other for lowering the voltage, and means for moving said vibrating contact member into alternate engagement with said two contacts.

15. In a voltage regulator, two separate contacts, mechanism including means connected with one of said contacts for raising

the voltage being regulated, and including means connected with the other of said contacts for lowering the said voltage, and a third contact member having two contact surfaces to coöperate alternately with the aforesaid separate contacts.

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

GEORGE A. BURNHAM.

Witnesses:
M. J. SPALDING,
EDWARD MAXWELL.