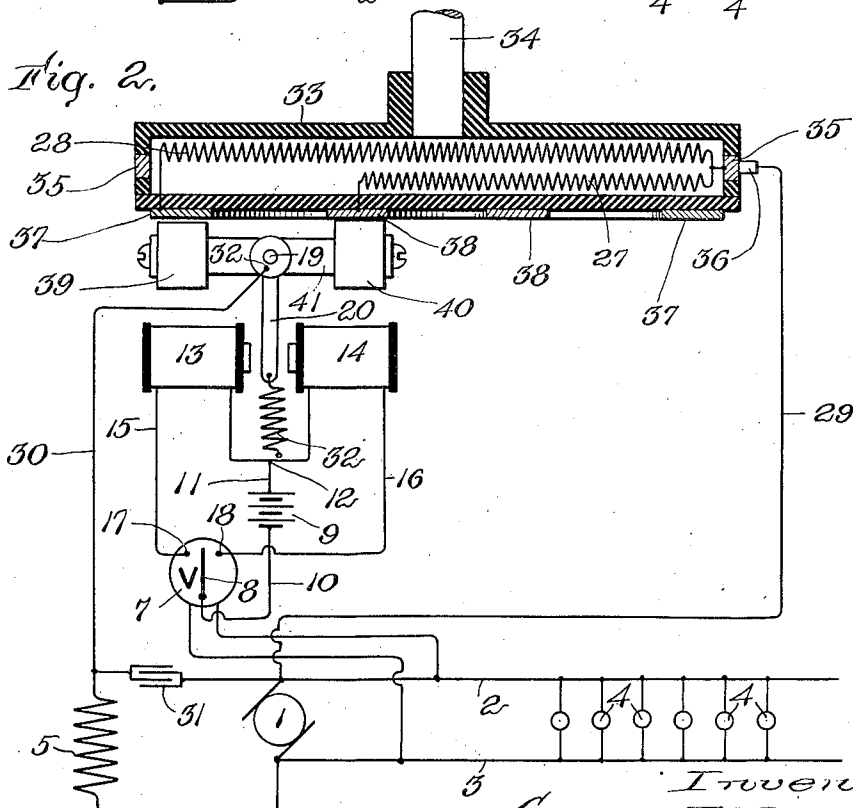
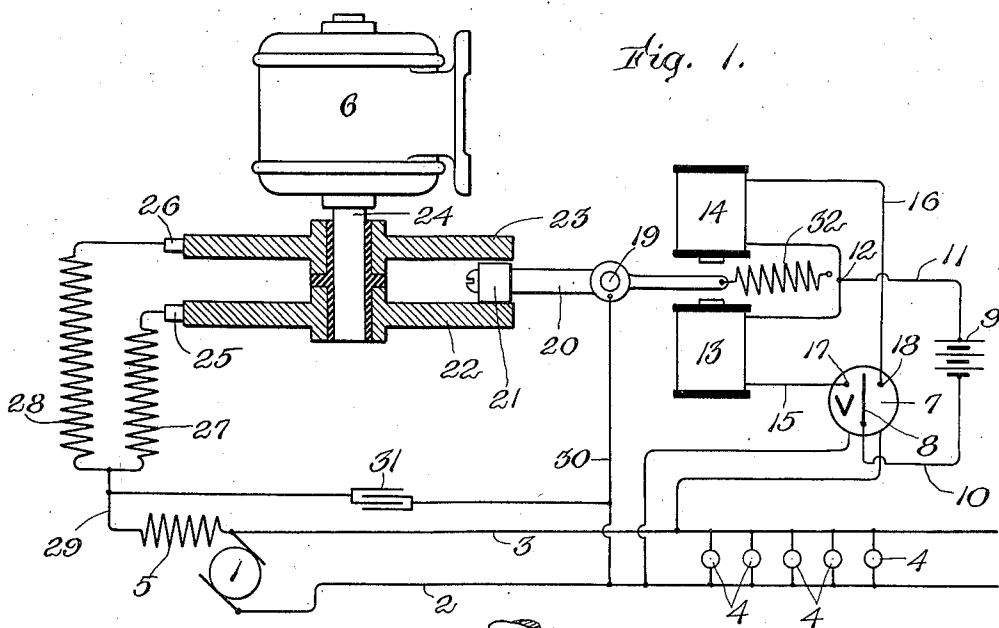


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 AUTOMATIC VOLTAGE REGULATOR.
 APPLICATION FILED SEPT. 30, 1910.

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AUTOMATIC VOLTAGE-REGULATOR.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, GEORGE A. BURNHAM, a citizen of the United States, residing at Cliftondale, 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 continuously moving and preferably rotating contact or pair of contacts, cooperating with a reciprocating contact or pair of contacts, having relative frictional engagement, preferably of a positive rubbing nature when the reciprocating contact engages the rotating contact. 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 largely diagrammatic and partly sectional of a preferred embodiment of the invention; and Fig. 2 is a similar view of a modified construction.

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 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 provided with a brush 21 arranged to cooperate alternately with a member or mechanism, comprising rotary contacts 22, 23 fast on an insulated driving shaft 24, driven by any suitable power as by a motor 6. Brushes 25, 26 connect from the rotary contacts 22, 23 respectively with resistances 27, 28 connected by a wire 29 in series with the field 5 of the generator 1, said circuit being completed from the opposite side of the generator by a wire 30 to the contact lever 20. A condenser 31 is shown as connected across from the wire 29 to the wire 30. A springs 32 tends to hold the contact arm 20 always in normal position against the rotary contact 22. In Fig. 2, instead of the two wheel-like contacts 22, 23, I provide a hollow or box-like rotary member 33 on a motor-driven shaft 34 the same as before, and containing the two resistances 27, 28 connected to a peripheral ring 35 engaged by a brush 36 of the wire 29. At their opposite ends said resistances connect respectively to face rings 37, 38 engaged by contacts 39, 40 on a rock bar or transverse head 41 of the contact lever 20, the remainder of the mechanism being the same as already described in connection with Fig. 1.

While the construction and operation thus far described are preferable, the point of paramount importance is that the contact shall have relative rubbing movement and action at the moment of break, and preferably at the moment of both make and break. This renders it practically impossible for any bugging or freezing to take place. At the moment the vibrating contact tends to leave the rotating disk an arc is formed which tends to melt the separating surfaces. If one of the surfaces is stationary so that the separating movement is straight-out, away from the other in a direction substan-

tially at right angles to their mutually engaging surfaces, and the only power with which to pull the metal apart is the very slight power of the relay or electromagnet 5 coupled with the very slight movement of the vibrating member, there will be a strong liability of their sticking or fusing together, whereas by combining with this straight-out movement a simultaneous lateral or shearing 10 movement substantially in the direction of the plane of their engaging surfaces, *i. e.*, by combining with the straight-out movement of the vibrating member the rotary movement of the rotary member, this tendency of the parts to fuse together is prevented. The same benefit, but in less degree, arises from having the combined outward and shearing movement, *i. e.*, the rubbing action, take place on the contact making 20 movement when the circuit is closed. Furthermore, by maintaining the rubbing action while the contacts are together, their engaging surfaces are kept in the best condition.

In operation, the continuously driven rotary contacts 22, 23 (Fig. 1), 37, 38 (Fig. 2) operate to bring continuously a new make-and-break surface in operative position to be engaged with the reciprocating contact or contacts 21, Fig. 1, or 39, 40, Fig. 2, so that 30 the apparatus continues to operate uniformly, continuously and without liability to stick or freeze. Inasmuch as the motor driven contacts are continuously moving and are intermittently engaged by the reciprocating contacts, it necessarily results that there is a continually recurrent rubbing action between the reciprocating contacts and the rotary contacts. This rubbing action is preferably supplemented by having the reciprocating contacts capable of yielding or 40 turning on their axes, the principal object, however, being to provide the foregoing rubbing action and continuously changing contacting surface, irrespective of the speed of the make and break action, so that all tendency to bug or freeze is eliminated. Whenever there is a variation in potential in the main circuit 2, 3, there results a corresponding movement in the voltmeter 7, causing the 50 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 the before mentioned sliding or rubbing engagement with the continuously rotating contacts of the make-and-break device. This cuts in one of the resistances and cuts out the other, correspondingly changing the value of the field 60 flux. The provision of the two resistances 27, 28 of different value in connection with the means described for cutting out one and cutting in the other, or vice versa, results in a further advantage. The value of 65 said resistances is either too high or too low

to give normal voltage at the generator. By introducing the resistance 27, 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. 70

Having described my invention, what I claim as new and desire to secure by Letters Patent is, 75

1. In a voltage regulator, two contact members, means for imparting a relative make-and-break movement thereto, and means for moving one of said members at a relatively high speed whereby a relative 80 transverse shearing movement is imparted at the instant of separation.

2. In a voltage regulator, two contact members, means for imparting relative make-and-break movement thereto, and 85 means for moving one of said members at a relatively high speed at the instant of making and breaking the contact, whereby a transverse movement is imparted as the contact is made and broken. 90

3. In a voltage regulator, two contact members mounted for make-and-break movement, means for imparting relative intermittent movement thereto to make and break the circuit, and means for moving one 95 of said members at the instant of separation in a direction transverse of said former movement whereby a transverse shearing movement is imparted at the instant of separation, in addition to said intermittent 100 make-and-break movement.

4. In a voltage regulator, two contact members mounted for make-and-break movement, means for imparting relative intermittent movement thereto to make and 105 break the circuit, and means for driving one of said members in a direction angular relative to said former movement as the contact is made and broken, whereby a transverse shearing movement is imparted as the contacts come together and separate. 110

5. In a voltage regulator, two contact members mounted for make-and-break movement, means for imparting intermittent movement thereto to make and break 115 the circuit, and means for driving one of said members at a constant relatively high speed whereby a transverse shearing movement is imparted at the instant of contact separation. 120

6. In a voltage regulator, two contact members, means for imparting relative make-and-break movement thereto, and means for imparting a separate relatively high speed movement to one of said members 125 in a direction at right angles to said make-and-break movement, whereby a transverse shearing action is effected at the instant of contact separation.

7. In an apparatus of the kind described 130

a generator for supplying a main circuit, its field and field circuit, and automatic make-and-break means for varying the value of the field flux, including a resistance and two intermittingly engaging contact members adapted to make an intermittent rubbing contact, said two contact members both having movement, at the moment of break, in the direction of planes angularly disposed to each other, whereby there is a combined relative separation and shearing action at said moment of break.

8. In an apparatus of the kind described, a generator, its field and field circuit, and automatic make-and-break means for varying the value of the field flux, including a resistance and two intermittingly engaging contact members adapted to make an intermittent rubbing contact, one contact member being continuously movable.

9. An apparatus of the kind described, comprising a generator, its field and field circuit, a main circuit containing translating devices, two intermittingly engaging contact members adapted to make a continuously rubbing contact and having relative make-and-break movement, means to move one of said contact members to bring a new contact surface into contact-breaking position for each circuit opening operation, means responsive to variations of voltage in said main circuit for intermittingly operating said contacts to close the circuit at varying intervals, and means responsive to the make-and-break action of said two contacts, including said field, for bringing about a desired voltage in said main circuit.

10. An apparatus of the kind described, including a generator, its field and field circuit, a main circuit, at least two cooperating contact members adapted to make an intermittent rubbing contact at each make-and-break action, means for moving one of said contact members to bring a new surface into position to cooperate with the other contact member, mechanism for moving said other contact member, including electromagnetic means responsive to variations of voltage in said main circuit, said two contacts being adapted to have their new surface engagement for each circuit opening operation independent of the voltage influence, and means responsive to the make-and-break action of said two contacts, including said field, for bringing about a desired voltage in the main circuit.

11. An apparatus of the kind described, including a generator, its field and field circuit, a main circuit, at least two cooperating contact members adapted to make a rubbing contact, mechanism for moving one of said contact members into contact with the other, including electro-magnetic means responsive to variations of voltage in said main circuit, means independent of said mechanism

for moving said other contact member for bringing a new contacting surface into position for each engagement of said first mentioned contact member and providing a relative rubbing movement and action at the movement of break, and means responsive to the make-and-break action of said two members, including said field, for maintaining a desired voltage in the main circuit.

12. An apparatus of the kind described, including a generator, its field and field circuit, a main circuit, two resistances different in value, operatively and independently related to the field, each to have a variable effect thereon, one of said resistances containing a greater amount of resistance then required for normal voltage in said main circuit, and the other of said resistances containing a less amount of resistance then required for normal voltage in said main circuit, and automatic means responsive to variations of voltage in the main circuit for varying the value of the field current by said resistances alternately, including make-and-break means adapted to make a rubbing contact at each operation for continuously cutting said respective two resistances alternately in and alternately out.

13. An apparatus of the kind described, comprising a generator and its circuit and field, combined with two resistances different in value operatively related to the field, and automatic means for varying the value of the field flux by said resistances alternately, said means cutting in one resistance and cutting out the other and vice versa continuously, said automatic means including two cooperating contact mechanisms operable in said field circuit in response to variations of voltage in said main circuit, one mechanism movable toward and from the other and adapted to make a rubbing contact, and said other being movable continuously to bring a new contact surface into make-and-break position for each make-and-break operation.

14. An apparatus of the kind described, including a field and its circuit, two resistances different in value operatively related to the field, and continuously operating means for continuously varying the value of the field flux by said resistances alternately in response to variations of voltage in said circuit, said continuously operating means including make-and-break members adapted to make a rubbing contact.

15. An automatic voltage regulator, comprising a generator, its field, and field circuit, a main circuit operated by said generator, a continuously movable contact member, a cooperating variable vibrating contact member, electromagnetic means to operate said variable vibrating contact member in response to variations in voltage in said

main circuit, and means influenced by the make-and-break action of said two contact members, including said field, for maintaining the desired voltage in said main circuit.

5 16. 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 alternately movable between said portions
10 from one to the other to render said resistances alternately effective.

17. An automatic voltage regulator, comprising a pivoted contact member, electro-
15 magnetic means for rocking said member on

its pivot, and cooperating contact mechanism having separated contact portions to cooperate with separate contact surfaces 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.

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

GEORGE A. BURNHAM.

Witnesses:

GEO. H. MAXWELL,

WM. J. PIKE.