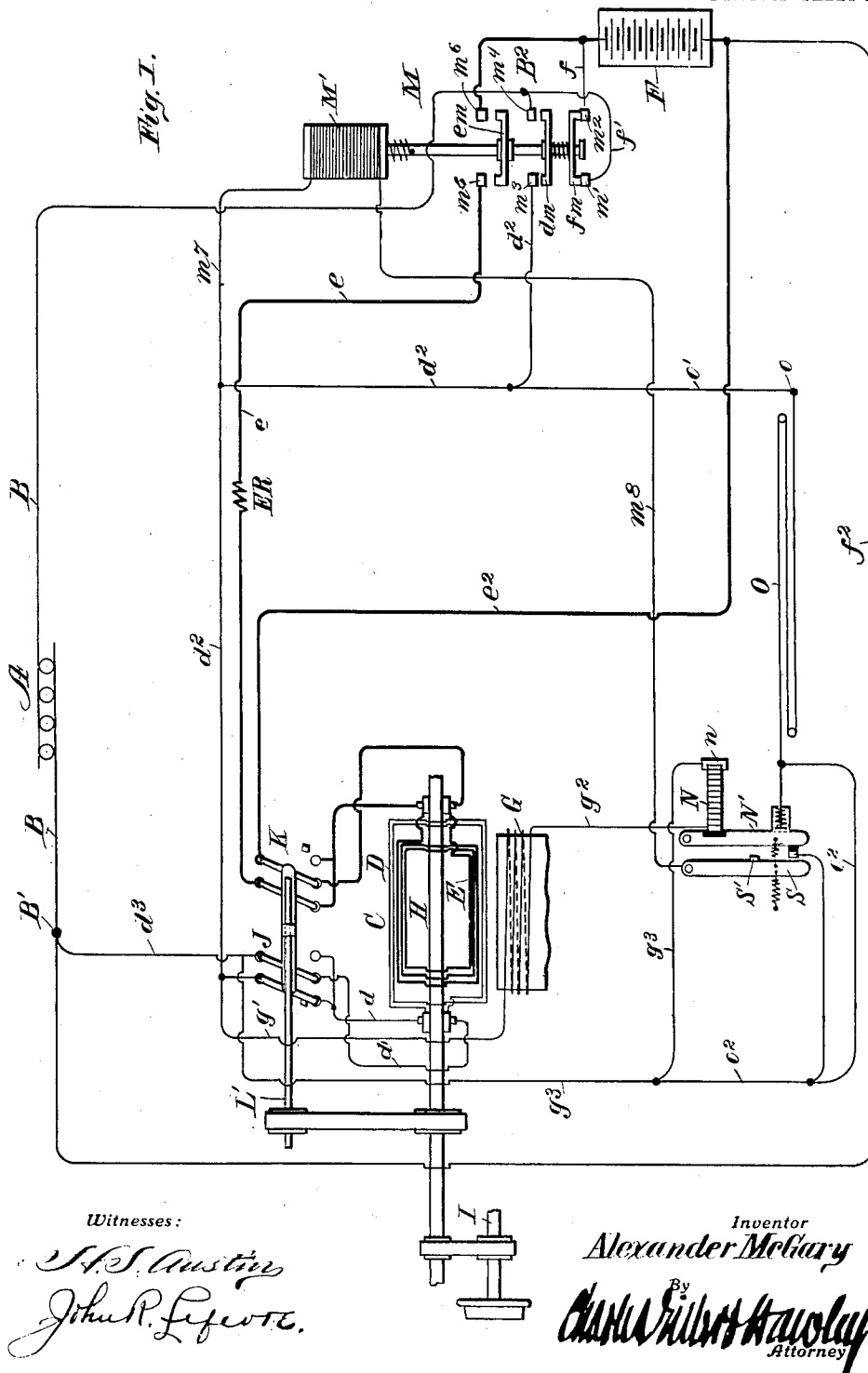


906,056.

2 SHEETS—SHEET 1.



UNITED STATES PATENT OFFICE.

ALEXANDER McGARY, OF LA GRANGE, ILLINOIS, ASSIGNOR OF ONE-FIFTH TO CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS.

AXLE LIGHTING SYSTEM.

No. 906,056.

Specification of Letters Patent.

Patented Dec. 8, 1908.

Application filed October 22, 1906. Serial No. 339,997.

To all whom it may concern:

Be it known that I, ALEXANDER McGARY, a citizen of the United States, and a resident of La Grange, Cook county, Illinois, have invented a certain new, useful, and Improved Axle Lighting System, of which the following is a specification.

My invention relates to the lighting of railroad trains by electricity and has particular reference to improvements in electric lighting systems of that class known as axle lighting-systems and characterized by circuits containing a storage battery and by a generator for alternate use, the generator being driven from the car axle, and at times operating to energize said battery.

The practice hitherto generally followed in devising and operating these systems has involved the use of current and voltage regulators, and the maintenance of a constant current upon the lamp or working circuit of the system. My investigations and experiments show that such systems are needlessly complicated and that the complication is chiefly attributable to the efforts made to regulate the current output and keep the same constant.

In my invention I proceed upon the basis of the known fact that the lamps or other translating devices belonging to such a system will themselves determine the current consumption, and in contra-distinction to the known systems my novel system is characterized by the maintenance of a constant voltage upon the lamp or working circuit of the system, without regard to the varying current flow.

The object of my invention may be briefly stated as being the provision of an electric lighting system which shall include a dynamo to be driven from a car axle, and a storage battery carried by the car, together with means that shall adapt the same to supply electric current, adequate to the varying demands of the lamp circuit, at a constant voltage.

Another object of my invention is to provide an electric system of the class mentioned which, when in operation, shall automatically charge the storage battery in a manner most favorable to longevity.

A further object of the invention is to simplify the construction and circuits of electric lighting systems for railroad cars

with a view to reducing the initial and the maintenance costs connected therewith.

Other objects of my invention will appear hereinafter.

My invention consists generally in the hereinafter described system of electric generation and distribution, comprising a lamp circuit, a duplex generator, a storage battery, and an automatic switch or circuit closer, adapted to connect the battery alone to the lamp circuit when the generator is at rest or running slowly, and also adapted to disconnect the battery from the lamp circuit and connect one of the windings of the generator to the circuit and the other winding to the battery, the battery being cut out of the lamp circuit after the generator is connected to the circuit and before the generator is connected to the battery.

My invention also consists in an electric system which is further characterized by novel automatic voltage regulating apparatus, the same comprising a variable compression resistance in the circuit of the field windings of said generator, and a compression device for said resistance, operated by a shunt from the lamp-armature circuit; and further, my invention consists in an electric system characterized by a generator adapted to be driven at different times in reverse directions and in an automatic pole-changer operated from the generator shaft or other part, whose rotation is governed by the direction of travel of the car, and adapted to maintain a constant polarity in the system regardless of the direction of rotation of the generator.

My invention further consists in various details of construction, in circuits and in circuit relations; all as hereinafter described and particularly pointed out in the claims.

My invention will be more readily understood by reference to the accompanying drawings which form a part of this specification, and in which

Figure I is a diagrammatic view of an electric system embodying my invention, the switches thereof being shown in the positions assumed when the storage battery is alone furnishing current to the lamp circuit, the generators being assumed to be at rest or with their armatures in slow rotation; Fig. II is an enlarged detail view of the resistance varying means and the circuit closer em-

ployed in my system; Fig. III is an enlarged view of the automatic switch or circuit closer; Fig. IV is an enlarged view of the pole changer.

5 From the drawings it will be seen that my system comprises three principal circuits aside from the lamp, that is, three circuits which at different times include or are connected with the lamp circuit, either directly
10 or indirectly. The three principal, or main, circuits alluded to, I designate as battery circuit, lamp armature circuit, and the battery armature circuit. The battery circuit is to supply current to the lamp circuit, while the
15 armature is at rest or running at a speed too low to maintain sufficient voltage on the system. The lamp armature circuit is to supply current to the lamps from the armature, after the latter has "picked up" sufficiently
20 to supply current at proper voltage; and the battery armature circuit for the recharging of the battery while it is cut out of the lamp circuit, and the lamp armature circuit is supplying the current to the lamps direct.

25 As shown in the drawings, A represents a group of electric lamps and B the lamp circuit, whereof B' and B² are terminals.

C, is a duplex generator having a single armature provided with two windings or sets of
30 coils, D and E. These are wound upon a single core and hence rotate together. The armature winding, D, as hereinafter explained, supplies energy to the lamp circuit, and the winding, E, which contains a greater
35 number of the turns than the winding, D, supplies energy to a storage battery, F, at a greater voltage than that on the lamp circuit.

G represents the field windings of the duplex generator wound upon a single set of
40 poles.

The armature shaft H is driven from the car axle, I, by a belt or other suitable mechanism. As the armature is driven from the car axle, it is obvious that each change in the
45 direction of movement of the car will cause a reversal in the rotative direction of the armature. Such change makes it necessary to employ means which shall operate to maintain a constant polarity upon the lamp circuit, and the battery circuit of the system. With this end in view, I employ pole
50 changers J and K, represented in Fig. I of the drawings. The office of the pole-changer J is to reverse the connections of the lamp circuit armature when the rotation of the armature is reversed, and thereby to maintain the polarity of the lamp circuit and of the field windings of the generators which are connected to said lamp circuit. The office of
55 the pole-changer K is to reverse similarly the connections of the battery circuit armature. For convenience, and to avoid multiplicity of parts, I construct the apparatus so that both pole-changers may be operated by a single
60 device. The pole-changers are of the simple

two-armed, five pole type. The four arms are connected by a cross bar JK, which carries a block K', and a screw L upon a shaft L' is threaded through said block. It will be
70 observed that by turning the shaft L' the pole changers are shifted. The shaft L' should turn only during the first few revolutions of the armature, after the direction of rotation has been changed. That is, the
75 screw shaft should only turn until the contacts are changed, and should then remain inoperative until the direction of rotation of the armature is again reversed. Accordingly, I provide a friction pulley upon the shaft L, and connect it by belt to the armature
80 shaft H. Assuming that the armature has been running in one direction, as soon as it is reversed the shaft L is turned until the pole-changer is shifted. Stops, *jb*, limit the movement of the pole-changer and arrest the
85 shaft L from further rotation, the friction pulley permitting this stoppage without injury to the device.

The lamp armature circuit is traced from the armature windings, D, through the line
90 *d* or *d'*, to the pole-changer, J. From the pole-changer it is traced through the lines *d*² to the terminal B² of the battery circuit, through the interposed switch or circuit
95 closer M; through the lamp circuit B to the terminal B', and thence through the line *d*³ to the pole-changer, returning to the armature through one of the lines *d*, *d'*. I speak of the current going to and from the pole-changer through one of two lines. The reason
100 for this is obvious, as which line is the positive and which the return wire, depends solely upon the direction of the rotation of the armature, and it will also be seen from the foregoing description that the automatic
105 pole-changer, maintains a constant polarity upon the lamp circuit regardless of the direction of rotation of the armature.

The field winding G is connected across the lamp armature circuit, and at points between
110 the pole-changer and the lamp circuit, so as to maintain the field at a constant polarity. The current is traced from the line *d*² through *g'* to the field winding G. Thence it is traced through the line *g*², to a variable resistance
115 N, and then through line *g*³ to the line *d*³.

I will now describe the variable resistance and the manner in which it is operated.

The resistance N comprises a carbon pile held between suitable terminals to which the
120 lines *g*²—*g*³ are connected. One of these terminals, *n*, is stationary, whereas the other is movable and is engaged by a compression lever N'. It is obvious that the resistance of the pile N will be varied according to
125 the degree of compression exerted thereon through the lever N', and that the greater the pressure, the less the resistance; and conversely, the less the pressure the greater the resistance. To operate the lever N' to vary
130

the compression of the pile N, and hence to vary the resistance, I rely upon the well known facts that the temperature of a conductor varies with the square of the current flowing therethrough, and that a body expands in direct proportion to its temperature. I attach one end of a wire of great tensile strength and high resistance to the lever N' and the other end to a stationary member, and connect this wire across the lamp-armature circuit. O represents the expansible wire, known hereinafter as the "hot wire", and o, the stationary connection point. The tension of the wire O when cold, is sufficient to compress the resistance N to give it its minimum resistance. The hot wire is connected to the lamp armature circuit through wires o', o², and o³. To prevent rupturing the device, should too great a strain be placed thereon by the cooling of the wire O, and for other reasons which will appear hereinafter, I make a yielding connection P between the wire O and lever N'. It will be seen, from the foregoing that as the lamp armature circuit "picks up", a current of increasing voltage will pass through the "hot wire" O; and that as the voltage increases the wire becomes more and more heated, with a consequent proportional expansion of the wire. This obviously lessens the pressure on the pile J and thereby increases the resistance of the field circuit. In this manner I regulate the out-put of the main generator and maintain a constant voltage upon the system.

The battery circuit, as before stated, is in service when the armature is at rest, or running at too low a speed to supply sufficient voltage to the lamp circuit. It is traced from the storage battery, F, through the line f to the circuit closer M, and through said circuit closer and a line f' to the terminal B² of the lamp circuit, and from the terminal B', to the battery through a line f².

The automatic circuit closer M comprises primarily three plates or bridges insulated from each other and actuated at the proper time by a solenoid which is connected across the armature lamp circuit. These bridges serve as circuit closers for the three principal circuits before mentioned, one being located in each said circuit. When at rest, that is, when unacted upon by the armature lamp circuit, it operates to close the battery circuit; and when the solenoid is energized it operates to cut the battery out of the lamp circuit and place it in the circuit of the armature winding E, and also to place the armature winding D in the lamp circuit. In other words, the circuit closer M serves to replace the battery by the dynamo. The means and manner in which this is accomplished will now be described.

M' represents the solenoid having a core, M². To the core is attached a rod, m, which

is preferably of insulating material, and upon this rod are located the closers proper or bridges. As before stated, I provide a bridge for each of the three principal circuits; thus the bridge, fm, serves to close the battery circuit; a bridge, dm, the lamp armature circuit, and a bridge, em, the battery armature circuit. The bridge, fm, is adapted to engage the contacts, m', m²; the contact, m', being connected to the lamp terminal, B², through the line f', and the contact m², being connected to the battery by the line f. As illustrated in the drawings, the battery circuit is closed, and the battery is supplying the current to the lamps, while the dynamo is at rest. When the circuit closer is in the position shown in the drawings, current will flow from the battery F, through the line f, contacts m², fm, m', and thence through line f' to the lamp circuit B, returning through the line f². At such times the lamps will be supplied from the battery, F, and from there only. When the rod, m, is drawn up by the solenoid the bridges dm and em engage respectively contacts m³, m⁴, m⁵, and m⁶. These last two represent the duplex armature windings, D and E respectively, and the circuits established when the circuit closer is raised are easily traced, they having been mapped out hereinbefore. To avoid a momentary flicker of the lights, when the battery is cut off and the dynamo thrown in, it is necessary to close the lamp armature circuit before breaking the battery circuit. It is also obviously necessary to break the battery circuit before closing the battery-armature circuit. To this end the bridges fm and dm are slidably mounted on the rod m, while the bridge em is rigid therewith. The bridges fm and dm are held apart by a spring M³, and stops dm' and fm' limit their movement apart. These stops, dm', fm' are a slightly greater distance apart than the pairs of contacts m', m², and m³, m⁴. Consequently, one circuit represented by these bridges is always closed before the other is broken. When the circuit closer is down, as illustrated in Fig. III, the bridge fm seats against the contacts m', m²; and the stop dm' holds the bridge dm out of engagement with the contacts m³, m⁴. As the rod m is drawn upwardly, the spring M³ seats the bridge dm on the contacts m³, m⁴, and also maintains the engagement of the bridge fm with the contacts m', m². With further upward movement of the rod m, the stop fm' raises the bridge fm, thereby breaking the battery circuit and a slight additional movement closes the battery armature circuit by seating the bridge em on the contacts m⁵, m⁶.

The hot wire O, besides being used to vary the resistance of the field G to maintain a constant voltage on the system, is also used to automatically close the circuit through the solenoid M'. The lever N' carries a con-

tact R, which is insulated therefrom and is adapted to engage a lever S; these parts constituting a circuit closer for the circuit of the solenoid, M'. S' is a limiting stop for the lever S, and the contact, R, only engages the lever S when and after the hot wire, O, has been expanded by a flow of current therethrough. The solenoid M' is connected with the lamp armature circuit by a line m^7 , and its opposite terminal is connected with the lever S, through a line m^8 . As the solenoid circuit is bridged across the terminals of the armature, D, the solenoid M' may be energized irrespective of the closing of the main circuit through the contacts m^3 , m^4 . The solenoid is therefore always in readiness to operate the circuit closer M, and the various parts of the device are so constructed as to raise the circuit closer against the tension of the spring M⁴ whenever the armature has attained sufficient speed to supply a current of sufficient voltage for the lamps. This operation of the solenoid, however, does not take place immediately upon the starting of the generator or at an indeterminate time, for the reason that the circuit is not closed through the solenoid M, until the flow of current from the armature D has caused sufficient expansion of the hot wire O to permit the contact R to engage the switch lever S. As previously stated the expansible or hot wire is the means employed for controlling or determining the action of the circuit closer, and said wire is so proportioned that its sufficient expansion will occur only when the armature D has reached the minimum speed that will enable it to supply current the requisite voltage. The construction of this portion of the device as a whole is shown in details in Fig. II, wherein it will be seen that a spring NS, connects the levers N' and S, tending to draw them together, and another and weaker spring, S², tends to draw the lever S away from the stop S'. The lever N' presses upon the carbon pile N and carries a spring case P. Within the case P is a rod p , and plunger p' . The rod works freely through an opening in the end of the casing P, and is attached to the free end of the hot wire O. A spring p^2 , between the plunger p' and the end of the casing P, tends to draw the lever N' away from the lever S; that is, the plunger is fixed except as moved by the expansion and contraction of the hot wire; and the spring, acting from the stationary plunger p' , forces the lever N' away from the lever S and against the carbon disk N.

Obviously, as the hot wire is in circuit connection with the lamp armature D, said wire will receive current from the time that the armature begins its rotation, and as the speed of the armature increases its greater output will increase the temperature of the hot wire with accompanying expansion. As the hot wire expands the spring will take up the ex-

pansion or slack of wire until an adjustable nut p^4 upon the rod P seats itself on the end of the casing P; the spring meantime maintaining pressure on the compression resistance. The nut p^4 is so positioned that it will engage the lever casing P, when the voltage upon the hot wire, due to the full energization of the main field and the more rapid rotation of the armature, has closely approached the number of volts required upon the lamp circuit, and a slight increase on the hot wire circuit (thereafter operating to further expand the wire O) will cause the release of the lever N', and permit the contact R to close upon the lever S. This action closes the circuit containing the solenoid M' and the operation of the circuit closer follows immediately, the effect being to cut out the battery and place the main armature D in the lamp circuit. At the same time, the armature E is connected with the battery and will begin to recharge the same.

The operation of the automatic switch with relation to the armature E is as follows: One of the terminals of the armature windings is connected to the contacts k' and k^3 of the pole changer K, and the other terminal is connected to the contact k^2 . From the pole changer the current is traced through the line e to the contacts m^5 , em , and m^6 , of the circuit closer M and thence to the battery F, returning through the line e^2 . When the solenoid M' is energized the battery is cut out of the lamp circuit and connected with the armature winding E to be recharged therefrom.

For the purpose of tapering the battery charge I introduce resistance ER in the line e . The effective resistance varies with the current flow. Consequently, when the potential of the battery is low it will be charged at a high rate by a current of relatively low voltage, and as the capacity of the battery is approximated, the voltage of the charging current will be increased, thereby insuring the completeness of the charge and protecting the battery from injury. The special merit of this portion of my apparatus is that its operation and regulation are wholly automatic.

Reverting to the controller; it has been seen that the spring exerts its maximum pressure upon the resistance N when the wire O is cold and it will be evident that as the hot wire expands and thus lessens the spring pressure, the effective resistance of the mass N will be increased, and this will result in weakening the field of the generator and reduce the output of the lamp armature. In this measure the temperature of the hot wire will be reduced and the same will tend to reduce the resistance N and cause the restoration of the armature output. This operation so far as it concerns the reduction of the output of the main generator does not begin to have

practical effect until the lamp armature has been placed in the lamp circuit.

It will now be understood that the further movement of the lever N' , which occurs after the switch $N'S$ closes, is slight, but is sufficient to vary the resistance N to such an extent as to vary the strength of the field G in response to slight variations in the length of the wire O , and thus compensate for changes in the speed of the generator armature and in the load upon the lamp circuit. The result is a substantially constant voltage upon the lamp circuit, which constant voltage is maintained irrespective of the current consumption and irrespective of variations of car speed, so long as the generator speed does not fall below the minimum. When a drop in speed does occur, the hot wire, which is in direct connection with the lamp circuit, will at once respond and its contraction will result in opening the automatic switch circuit, whereupon the storage battery will be instantly restored to the lamp circuit and will remain therein until the generator speed again rises to the point at which the controller and switch operate to close again the circuits of the lamp and charging armatures. In practice suitable circuit breakers are provided in the various circuits for the purpose of cutting off the lamps when desired and to prevent battery leakage, when the system is at rest, but such switches and the manner of their use being well known, it has been deemed unnecessary to either show or describe them.

The operation of my invention is as follows: When the car that is equipped with my system is at rest, and also after the car has been started, but before the generator speed has reached the required minimum, the battery is in circuit with the lamps, the bridge fm of the automatic circuit closer serving to close the circuit through the lamps and battery. The armature being rotated, the hot wire which is in closed circuit with the armature winding D , will be heated. Meantime the armature winding E remains idle as its circuit is open at the contacts m^5 and m^6 . As the speed of the armature increases, the energization of the main field increases and the pressure increment upon the circuit of the hot wire O , will cause further expansion thereof. This condition will continue until the hot wire has been sufficiently expanded to permit the closing of the switch $N'S$, which closes the circuit of the automatic circuit-closer M . Incidentally the effective resistance of the pile N is increased and consequently the main field is weakened. It should be noted that this weakening of the main field takes place only when the current from the generator has acquired sufficient voltage properly to supply the lamps; and that the weakening of the field is in proportion to the increase of voltage thereafter.

In this manner the voltage on the entire system is kept constant, for the hot wire O responds to every change of potential upon the lamp armature and in so doing causes the described variations in the strength of the main field of the generator, which latter accurately compensates for every change of speed in the armature shaft. When the solenoid M' is energized, by the closing of the switch $N'S$, the rod m carrying the bridges fm , dm , and em , is shifted, first closing the lamp armature circuit, then breaking the battery circuit, and lastly, closing the battery armature circuit, all as hereinbefore described in detail. The lamp circuit is now supplied with energy from the armature winding C , and the current flow in the battery will be reversed, the same being charged with current from the armature winding, E , the resistance ER in that circuit operating in the advantageous manner hereinbefore set forth.

The operation of the automatic pole changer J, K has been fully described in connection with the detailed description of its structure, therefore it is sufficient to repeat here that with every reversal of the direction of rotation of the generator, the pole-changer is shifted, thereby maintaining a constant polarity on the entire system.

As various modifications of my invention will suggest themselves to one skilled in the art, I do not confine my invention to the specific constructions herein shown and described.

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

1. An electric system, comprising a working circuit, in combination with a storage battery, a direct current generator having a variably driven duplex armature one part of which is devoted to said working circuit, and the other to said battery, means for maintaining the output of said generator at a constant voltage when running at or above a certain speed, and means automatically operative, when the armature attains sufficient voltage, to connect the respective parts of said armature successively to the lamp circuit and to the battery, and disconnect the battery from the lamp circuit intermediate said successive steps; and conversely, operating to disconnect the same from and connect the battery with said working circuit, when the voltage of said armature output falls below a certain predetermined voltage, substantially as described.

2. In an electric system, a storage battery and a working circuit suitably connected, in combination with a variably driven, constant voltage generator comprising two direct current armatures within a single field and means automatically operative, when the armature attains sufficient voltage, to con-

nect the respective parts of said armature successively to the lamp circuit and to the battery, and to disconnect the battery from the lamp circuit intermediate said successive steps, and conversely, operating to disconnect the same from and connect the battery with said working circuit, when the voltage of said armature output falls below a certain predetermined voltage, substantially as described.

3. In a system of electric generation and distribution, a working circuit, in combination with a storage battery, a generator having a duplex armature and means automatically operating to connect one of the windings of said armature to said working circuit, to disconnect said battery from said working circuit after said connection has been made, and to connect the other of said armature windings to said battery after said battery has been disconnected from said working circuit, and means for varying the strength of the field to maintain a constant voltage on the system, substantially as and for the purpose described.

4. In an electric system of the class described a working circuit, and a storage battery suitably connected thereto, in combination with a variably driven generator having a duplex armature, means for automatically disconnecting said battery from said working circuit and connecting one of the windings of said generator to said circuit and the other to said battery, a pole changer interposed between said generator and said battery and means mechanically connecting said pole changer with a moving part of said generator to operate said pole changer to maintain a constant polarity on said system, substantially as described.

5. In an electric system, a generator provided with a duplex armature, in combination with a storage battery for connection with one of said armatures, a lamp circuit for connection with the other armature, means connecting said lamp circuit with the field windings of said generator, current varying resistance provided in the circuit of said field windings, means automatically operative for connecting said lamp circuit with its armature and with said battery at different times, and pole changers for maintaining the polarity of said lamp circuit and said battery circuit, and thereby maintaining the polarity of the field of said generator, substantially as described.

6. In an electric system, a generator provided with a duplex armature, in combination with a storage battery for connection with one of said armatures, a lamp circuit for connection with the other armature, means connecting said lamp circuit with the field windings of said generator, current varying resistance provided in the circuit of said field windings, means automatically op-

erative for connecting said lamp circuit with its armature and with said battery at different times, and pole changers actuated by the rotation of said duplex armature for maintaining the polarity of said lamp circuit and said battery circuit and thereby maintaining the polarity of the field of said generator, substantially as described.

7. In an electric system, a generator provided with a duplex armature, in combination with a storage battery for connection with one of said armatures, a lamp circuit for connection with the other armature, means connecting said lamp circuit with the field windings of said generator, current varying resistance provided in the circuit of said field windings, means automatically operative for connecting said lamp circuit with its armature and with said battery at different times, and actuated from the lamp circuit armature, and pole changers actuated by the rotation of said duplex armature for maintaining the polarity of said lamp circuit and said battery circuit and thereby maintaining the polarity of the field of said generator, substantially as described.

8. In an electric system of the class described, a working circuit, and a variably driven generator suitably connected thereto, in combination with a pole changer interposed between said generator and said working circuit, and operated by the rotation of said armature, said pole changer comprising a two arm switch, a yoke connecting said arms, a lug on said yoke, a shaft screw threaded through said lug, and means connecting said shaft with the shaft of said generator, substantially as and for the purpose designated.

9. In a system of electric generation and distribution, a working circuit, in combination with a storage battery, a generator and means automatically operating to connect the armature of said generator to said working circuit and to disconnect said battery from said working circuit after said circuit has been closed, substantially as described.

10. In a system of electric generation and distribution, a working circuit, in combination with a storage battery, a generator, means automatically operating to connect the armature of said generator to said working circuit and to disconnect said battery from said working circuit after said circuit has been made, and means for varying the strength of the field to maintain a constant voltage on the system, substantially as described.

11. In a system of electric generation and distribution, a working circuit, in combination with a storage battery, a generator, and means automatically operating to connect the armature of said generator to said working circuit and to disconnect said battery from said working circuit after the first said

circuit has been closed, said means comprising a solenoid connected with said armature circuit, a core having a suitable extension, and a pair of circuit closers on said extension and having relative movement thereon, substantially as described.

12. In a system of electric generation and distribution, a working circuit, in combination with a storage battery, a generator, and means automatically operating to connect the armature of said generator to said working circuit and to disconnect said battery from said working circuit after said circuit has been made, said means comprising a support, contacts arranged upon said support in pairs, a reciprocating member, circuit closers upon said member and having relative movement thereon, and a solenoid connected with said armature circuit for actuating said reciprocating member, substantially as described.

13. In a system of electric generation and distribution, a working circuit, in combination with a storage battery, a generator, and means automatically operating to connect the armature of said generator to said working circuit and to disconnect said battery from said working circuit after said circuit has been closed, said means comprising a support, contacts arranged upon said support in pairs, a reciprocating member, circuit closers slidably mounted upon said member and spring pressed apart, stops for limiting the movement of said circuit closers, said stops being at a greater distance apart than said pairs of contacts, and a solenoid for actuating said reciprocating member, substantially as described.

14. In a system of electric generation and distribution, a working circuit, in combination with a storage battery, a generator, and means automatically operating to connect the armature of said generator to said working circuit and to disconnect said battery from said working circuit after the aforemen-

tioned circuit has been closed, said means comprising a support, contacts arranged upon said support in pairs, a reciprocating member, circuit closers slidably mounted upon said member and spring pressed apart, stops for limiting the movement of said circuit closers upon said members, said stops being at a greater distance apart than the distance between said pairs of contacts, a spring operating to move said member in one direction to connect the battery with the working circuit, and a solenoid connected with the armature circuit for actuating said member to disconnect the battery from the working circuit and connect the armature therewith, substantially as described.

15. In a system of electric generation and distribution, a working circuit, in combination with a storage battery, a generator having a duplex armature, and means automatically operating when the armature attains sufficient voltage to connect the respective parts of said armature successively to the lamp circuit and to the battery and to disconnect the battery from the lamp circuit in intermediate said successive steps, said means comprising a support, contacts arranged upon said support in pairs, a reciprocating member, a pair of circuit closers slidably mounted upon said member and spring pressed apart, stops for limiting the movement of said circuit closers, said stops being at a greater distance apart than the respective pairs of contacts, a third circuit closer rigidly secured to said member, and a solenoid for actuating said member, substantially as described.

In testimony whereof, I have hereunto set my hand this 17th day of October, 1906, in the presence of two subscribing witnesses.

ALEXANDER MCGARY.

Witnesses:

WILLIAM BERGMANN,
WILLIAM H. READER.