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STORAGE BATTERY SYSTEM.

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Fig. 1.

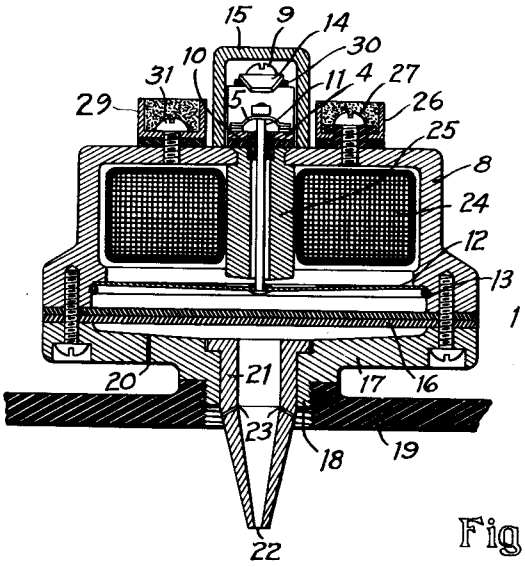


Fig. 2.

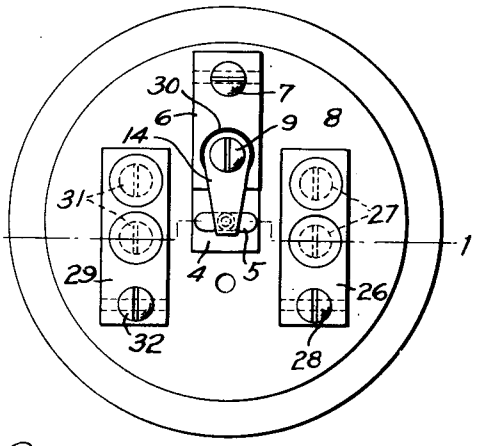
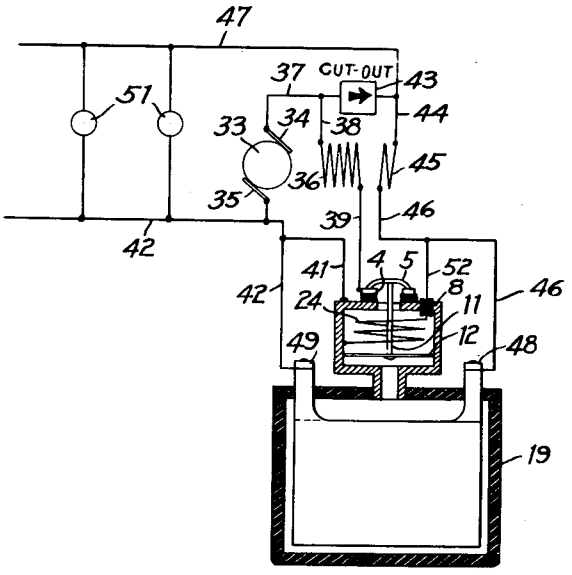


Fig. 3.



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UNITED STATES PATENT OFFICE.

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STORAGE-BATTERY SYSTEM.

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To all whom it may concern:

Be it known that I, EDWARD A. HALBLEIB, a citizen of the United States, and resident of Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Storage-Battery Systems, of which the following is a specification.

This invention relates to electric systems of the type in which a load-circuit, carrying electric lights or other devices, is fed with current from a generator and a storage-battery.

The object of the invention, broadly stated, is to produce a system of this type in which a substantially constant voltage is maintained in the load-circuit, and in which the battery is charged and discharged automatically in the manner best adapted to preserve it against deterioration and to conduce to economical and efficient operation.

More particularly, the present invention is designed for use where the generator is driven at varying speed, as is the case where it is employed in connection with a railway-train or an automobile and is actuated by connection with an axle or shaft of the vehicle or its propelling motor.

To the foregoing end I employ an arrangement in which the charging of the battery is controlled by the conjoint action and coöperation of pneumatic, electromagnetic and mechanical devices, the pneumatic devices being actuated by gas generated in the battery, the electromagnetic devices being controlled by the electromotive force of the battery, and the mechanical means being adapted to impose a critical resistance to the operation of the pneumatic and magnetic devices, so as to preserve oscillatory action.

The invention consists in the coöperative arrangement or combination of these means, together with certain novel details of construction which may be employed therein, as described in the following description of the preferred embodiment of the invention.

In the drawings: Figure 1 is a vertical median section, on the line 1—1 in Fig. 2, of a battery-charging controller embodying the present invention; Fig. 2 is a plan-view of the device of Fig. 1, with a portion of the casing removed; and Fig. 3 is a diagram illustrating the electrical connections of the complete system embodying the present invention.

The specific construction of the illustrated controller will be first described, and then the system as a whole. As shown in Figs. 1 and 2, the controller comprises a circuit-breaker having a fixed contact-device 4 and a movable contact-device 5. The fixed contact 4 is a portion, of reduced thickness, at the end of a metal block 6. This block is provided with a binding-screw 7 to secure the end of a wire by which it is connected with the proper circuit. The block 6 is secured upon the upper surface of a casing 8 by means of a screw 9.

The movable contact 5 is carried upon the upper end of a stem 11 which slides vertically through an insulating bushing 10 seated in a perforation in the fixed contact 4. The lower end of the stem 11 is fixed at the center of a diaphragm 12 which is made of thin sheet-iron. This diaphragm is seated against a shoulder in the casing 8, and is maintained in place by means of a snap-ring 13.

The diaphragm is formed with a slight bulge, as shown in Fig. 1, and, in the normal position of the parts this bulge is in downwardly-convex position, so as normally to retain the contacts in engagement, as illustrated. When the diaphragm is subjected to upward pressure in the manner hereinafter described this pressure is firmly resisted by the diaphragm, owing to its downwardly-convex form, until the pressure becomes sufficient to overcome what may be described as the critical resistance of the diaphragm, whereupon the diaphragm yields suddenly and buckles, that is to say, it moves upwardly to a position in which it is upwardly convex, in the manner familiar in the case of the bottom of an oil-can. By this upward movement of the diaphragm the contacts are disengaged, and to limit this upward movement a stop is provided in the form of a sheet-metal arm 14, fixed on top of the block 6 by means of the screw 9. The stop is insulated from the block by means of an insulating washer 30, and it is adjusted by being bent up or down. The circuit-breaker is inclosed by a removable cover 15, which is shown in place in Fig. 1, but is removed in Fig. 2.

Beneath the iron diaphragm 12 is a diaphragm 16 which is made of sheet-rubber, or other flexible and incorrodible material, and this diaphragm is inclosed, below, by the

removable bottom 17 of the casing. The bottom 17 has a threaded downward projection 18 which is adapted to be screwed into the filling-opening of the casing 19 of a storage-battery, thereby making a gas-tight connection therewith. Seated in the projection 18 is a tapering sleeve 21 which is provided with a small opening 22 at its lower extremity and with small lateral openings 23. The sleeve 21 is adapted to permit gas from the battery-casing to flow freely into the space beneath the diaphragm 16, while at the same time preventing liquid from splashing upwardly into the diaphragm-chamber.

Above the iron diaphragm 12 is a solenoid 24 which is mounted upon a core 25 surrounding the stem 11. The core 25 and the casing 8 are both made of soft iron, so that, with the iron diaphragm 12, they constitute a magnetic circuit having only a slight air-gap between the diaphragm and the lower end of the core. Consequently, when the solenoid is energized by electric current a powerful attraction is exerted between the core and the diaphragm, tending to raise the diaphragm and operate the circuit-breaker.

The device just described is adapted to control the charging of the storage-battery under widely-varying conditions of load. The solenoid 24 is connected across the terminals of the storage-battery, so that there is a constant flow of current through it from the battery. The resistance of the solenoid is so high, however, that this flow of current is not sufficient to substantially reduce the economy of operation of the battery, while it nevertheless tends to increase the life of the battery as it provides for a constant slight flow of current under all conditions, which experience has demonstrated to be beneficial to a storage-battery of ordinary type.

The controller operates as follows: Considering the battery to be partly discharged, the voltage in the battery is somewhat less than at full charge, and the flow of current through the solenoid, and the pull of the magnet upon the iron diaphragm, are correspondingly reduced. At this time the circuit-breaker is closed, and charging-current flows through the battery. This condition of the apparatus continues until the battery has become fully charged. At this time the flow of current through the solenoid has increased to a maximum, but the magnet alone is not sufficiently powerful to buckle the diaphragm and operate the circuit-breaker. As soon, however, as the battery has become fully charged the further flow of charging current causes gasing in the battery, and the gas so produced accumulates in the battery-casing and in the space below the rubber diaphragm 16, and the pressure of the gas causes this diaphragm to bend upwardly and press against the iron diaphragm 12. Eventually this gas-pressure, reinforcing the action of the magnet, becomes sufficient to overcome the resistance of the iron diaphragm, and when the critical point is reached the diaphragm yields suddenly and the circuit-breaker operates to discontinue the charging operation. The battery immediately begins to discharge, and at the same time the pressure of gas begins to diminish. I have found in practice that this diminution in gas-pressure may occur even though no provision is made for the escape of the gas, this action being due probably to the reabsorption of the gas in the electrolyte. In some cases it may be preferable, however, to provide a minute vent or leak, such as the vent 20 shown in Fig. 1, through which the gas may gradually escape. In any case, however, the diminution in gas-pressure and in the flow of current in the solenoid, which result from the discharge of the battery, does not immediately cause the diaphragm to move downwardly again and close the circuit-breaker, for the reason, before stated, that the force required to maintain the diaphragm in raised position is substantially less than the critical resistance of the diaphragm to buckling. Accordingly, the battery discharges to a substantial extent before the controller operates to renew the charging of the battery. This mode of operation is of great practical value since it prevents a constant opening and closing of the circuit-breaker such as would result in the rapid destruction of the electric contacts and in constant gasing in the battery.

The operations just described are those which occur when the battery is operating constantly against a substantial load and is being repeatedly charged and discharged. The operation of the controller is such, however, as to provide for various other circumstances. If, for example, the load be removed from the battery at the time when the battery is fully charged, it is obvious that in the course of time the gas will escape and the gas-pressure against the diaphragm 16 will be removed. As the battery remains fully charged, however, it is undesirable to renew the charging operation. Under these circumstances, however, the electromagnet continues to maintain the diaphragm in raised position, thus holding the circuit-breaker open. On the other hand, after the battery has been charged, an unusually heavy load may be thrown upon it, the discharge of the battery being more rapid than the fall in the gas-pressure. Under these circumstances the electromotive force of the battery is temporarily reduced far below the normal point, and the flow of current in the solenoid accordingly diminishes to such an extent that the iron diaphragm falls against the opposition of the remaining gas-pres-

sure and thus the flow of current from the generator is at once resumed, and excessive discharge of the battery is prevented.

In addition to the functions just described the controller also operates very effectively to prevent unduly rapid charging of the battery, such as may occur in a system where the generator is liable to run at high speed and is not protected with effective governing devices. In such a case, if the voltage of the charging-current be very excessive, the enhanced flow of current through the solenoid of the controller will operate at once to buckle the diaphragm and open the circuit. If the charging-current be not sufficient to act in this manner it may still be sufficient to cause gasing in a battery, and in this case the gas-pressure will assist the solenoid in operating the circuit-breaker.

The stem 11, the iron diaphragm 12 and the casing 8 constitute conductors by which the movable contact 5 is connected in the proper circuit, and a metal block 29 mounted upon the casing 8, is electrically connected therewith by screws 31 and is provided with a binding-screw 32 by which a wire may be attached. One end of the solenoid 24 is also grounded on the casing, while the other end of the solenoid is connected with a metal block 26 which is mounted upon, but insulated from, the casing, being secured in place by screws 27 insulated from the block, as shown in Fig. 1. The block 26 is provided with a binding-screw 28.

The electrical connections of the system as a whole are illustrated diagrammatically in Fig. 3. The armature 33 of the generator is provided with the ordinary brushes 34 and 35, and with a shunt field-winding 36. The current flows from the brush 34 through wires 37 and 38 to the field-winding 36, thence through a wire 39 to the fixed contact 4 of the controller, thence through the movable contact 5, the stem 11, the diaphragm 12 and the casing 8, and, from the casing, through wires 41 and 42 to the brush 35 and back to the armature. The current for charging the storage-battery flows from the wire 37 through a return-current cut-out 43. This is a device by which current is permitted to flow in one direction, but is prevented from returning in the opposite direction. As such devices are well known to those skilled in the art, its construction is not particularly illustrated. From the cut-out the current flows, through a wire 44, to a field-winding 45 consisting of a few turns arranged in opposite direction to the winding 36. This field-winding 45 constitutes an opposition-winding, and its function is to limit the flow of charging-current to the battery by reducing the strength of the generator-field when the flow tends to become excessive. From the field-winding 45 current flows through a wire 46 to one terminal 48 of the storage-battery. From the other terminal, 49, of the battery the current returns to the generator through the wire 42. As shown in the diagram, the wire 42 constitutes a portion of the load-circuit, through which current is conducted to electric lamps 51 or other devices energized through said circuit. The other main wire, 47, of the load-circuit is connected with the wire 44. The current for the solenoid 24 flows from the wire 46 through a wire 52 to the solenoid, and returns through the casing 8 and the wire 41 to the generator. The solenoid may thus be fed either by current from the generator, or by current from the battery, according to the electromotive forces in these two devices at any given time.

The above-described arrangement is such that when the armature of the generator is rotating at speed sufficient to produce an electromotive force greater than that of the storage-battery, current flows through the return-current cut-out and the opposition field-winding, to and through the battery, and thus the battery is charged. When the charging of the battery has been completed, however, the controller operates as before described, and the flow of current through the field-winding 36 of the generator is interrupted. The battery then immediately begins to discharge through the load-circuit. At this time current is prevented from flowing from the battery through the shunt field-winding of the generator, by means of the cut-out 43. The generator is not wholly inactive, however, since the current from the battery to the wire 47 flows through the field-winding 45 in such a direction as to energize the field and cause the generator to produce a certain amount of current, and the consumption of battery-current is thereby reduced. At the same time the reaction of the winding prevents excessive discharge of the battery in case of an accidental short-circuit or overload in the load-circuit.

As soon as the battery has become discharged sufficiently to cause the controller to move its circuit-breaker to closed-circuit position again, as above described, the circuit is again closed through the field-winding 36, and the generator again operates to recharge the battery. During the recharging operation the current for the load-circuit is derived from the generator. At this time the voltage in the load-circuit depends upon the speed of the generator, and in order that a constant voltage may be maintained it is desirable to make some provision for governing the action of the generator automatically. As devices for this purpose are well known, and constitute no part of the present invention, they are not illustrated in this connection. It may be noted, however, that the opposition-winding 45 and the solenoid 24 constitute, to some extent, a governing-

device for the generator, since current flows constantly through these windings when the generator is charging the battery, so that the action of the opposition-winding varies somewhat with the electromotive force of the generator.

While my improved controller is particularly adapted for use in connection with the complete system illustrated in Fig. 3 and above described, it will be apparent that it is adapted for use in various other ways to control the charging of a storage-battery. In general, my invention is not limited to the details of construction and operation of the embodiment thereof hereinbefore described and illustrated in the accompanying drawings, but may be embodied in various forms, within the nature of the invention as it is defined in the following claims.

I claim:—

1. A battery-charging controller comprising a casing adapted to be connected gas-tight with a storage-battery, a circuit-breaker, a diaphragm in said casing connected with the circuit-breaker and adapted to be moved by the pressure of gas generated in the battery, and electromagnetic means also controlling the movement of said diaphragm and adapted to be connected in circuit with the storage-battery.

2. A battery-charging controller comprising a casing adapted to be connected gas-tight with a storage-battery, a circuit-breaker, and means for actuating the circuit-breaker including a diaphragm, in said casing, connected with the circuit-breaker and subjected to the pressure of gas generated in the battery, the diaphragm being normally convex in form so as to have a buckling action and oppose a critical resistance to movement of the diaphragm and the circuit-breaker.

3. A battery-charging controller comprising a casing adapted to be connected gas-tight with a storage-battery, a circuit-breaker, and means for actuating the circuit-breaker including a metal diaphragm, in said casing, connected with the circuit-breaker and normally convex in form, so as to have a buckling action and oppose a critical resistance to movement of the diaphragm, and a flexible acid-proof diaphragm in said casing subjected directly to the pressure of gas from the battery and adapted to engage the metal diaphragm and transmit said pressure thereto, while protecting it from direct contact with fluids from the battery.

4. A battery-charging controller comprising a casing adapted to be connected gas-tight with a storage-battery, a circuit-breaker, an iron diaphragm in said casing connected with the circuit-breaker and adapted to have a buckling action so as to oppose a critical resistance to movement of the diaphragm and the circuit-breaker, an electromagnet acting directly upon the iron diaphragm and adapted to be connected in circuit with the storage-battery, and means in said casing subjected to the pressure of gas from the battery and adapted to move the iron diaphragm while protecting it from direct contact with fluids from the battery.

5. A battery-charging controller comprising a circuit-breaker, pneumatic means adapted to be operated by gas-pressure from the battery and tending to produce a movement of the circuit-breaker to interrupt the charging operation, electromagnetic means adapted to be energized constantly by current from the battery and tending also to produce said movement of the circuit-breaker, and means for opposing a critical mechanical resistance to said movement.

6. A battery-charging controller comprising means for interrupting the charging operation, and a diaphragm, for actuating said means, adapted to be subjected to gas-pressure from the battery, said diaphragm being slightly convex in form so as to have a buckling action and oppose a critical mechanical resistance to movement by the gas-pressure.

7. A battery-charging controller comprising means for interrupting the charging operation, a diaphragm, for actuating said means, adapted to be subjected to gas-pressure from the battery, and electromagnetic means adapted to be energized by current from the battery and tending to move the diaphragm in the same direction as said gas-pressure, said diaphragm being slightly convex in form so as to have a buckling action and oppose a critical mechanical resistance to movement by said gas-pressure and electromagnetic means.

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