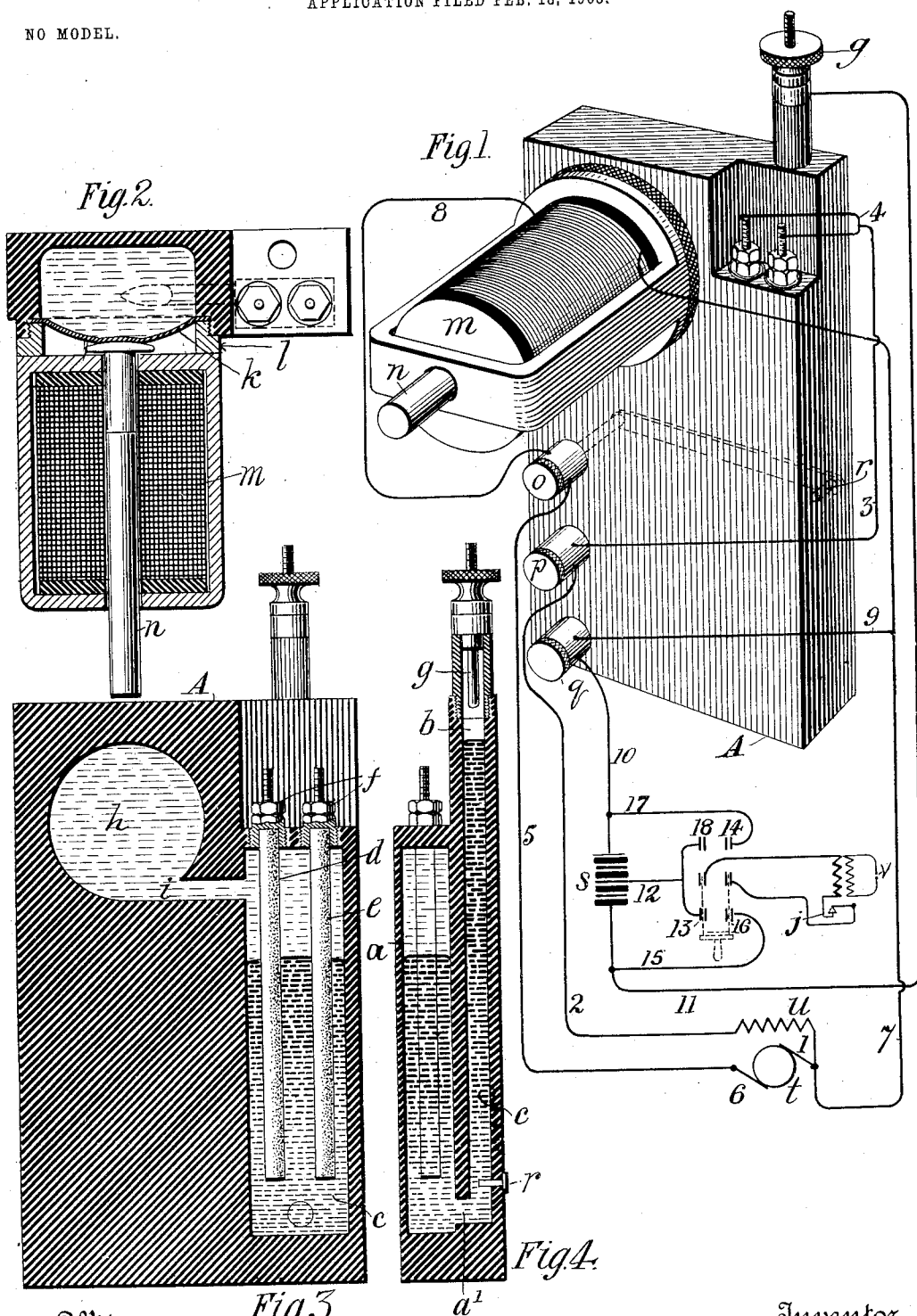


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A. LE BLANC.
VOLTAGE REGULATOR.
APPLICATION FILED FEB. 18, 1903.

NO MODEL.



Witnesses
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VOLTAGE-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 744,771, dated November 24, 1903.

Application filed February 18, 1903. Serial No. 143,909. (No model.)

To all whom it may concern:

Be it known that I, ALEXIS LE BLANC, a citizen of the United States, residing at the city of New York, in the borough of Manhattan and State of New York, have invented certain new and useful Improvements in Voltage-Regulators, of which the following is a full, clear, and exact description.

This invention is a voltage-regulator and circuit-controlling device adapted for use in storage-battery-charging systems wherein the charging-dynamo is driven at a variable speed.

The object of the invention is to provide a simple device which will effectively and automatically maintain the voltage of the charging dynamo substantially constant during the charging operation and which will automatically cut out the battery in case the voltage drops to an abnormally low point and will again cut in the battery when the normal charging voltage is regained.

My invention is especially adapted for automobile and marine purposes where the storage battery is used to supply current for the igniting-spark of an internal-combustion motor; but the invention is not limited to such use, as it is obvious that it will be available as a voltage-regulator in other situations—such, for instance, as in railway-car lighting, where the battery is charged from a dynamo driven from an axle of the train.

My invention also includes a switching device by means of which the polarity of the current in the primary of the induction-coil can be reversed at will to equalize the effect of the current on the trembler-contacts and whereby only half of the battery is in use at a time, so that a reserve force is always at hand when occasion arises.

My invention comprehends the use of a resistance in the field-magnet circuit of the charging-dynamo and an electromagnetic device whose strength varies with the voltage of the main circuit, arranged to vary the amount of resistance in the field-circuit, to thereby compensate for changes in the main-circuit voltage.

The details of the invention will be more fully brought out in connection with the accompanying drawings, in which—

Figure 1 is a perspective view of the improved voltage-regulator and the circuits and apparatus operating in connection therewith. Fig. 2 is a horizontal section through the upper part of the voltage-regulator, including the electromagnet. Fig. 3 is a vertical section of the regulator through the resistance-chamber, and Fig. 4 is a vertical section taken at right angles to Fig. 2 and through the resistance and cut-out chambers.

A indicates a block of hard rubber, glass, or other suitable insulating material. This block contains two vertical chambers *a* and *b*, communicating with each other near the bottom by a passage *a'*. I prefer to call the chamber *a* the "resistance-chamber" and the chamber *b* the "cut-out chamber." These chambers contain a quantity of mercury, (indicated by *c*), which is free to flow from one to the other through the passage referred to. The resistance-chamber contains two carbon or graphite pencils *d* and *e*, respectively, arranged vertically therein, being supported by suitable metallic heads *f*, having binding-screws for wires and projecting into the mercury and nearly to the bottom of the chamber, as shown. In the upper end of the cut-out chamber I provide a metallic terminal *g*, suitably supported in a metallic head, also provided with a binding-screw. The block A also contains a cylindrical chamber *h*, which communicates with the upper end of the resistance-chamber through the passage *i*. I call this chamber the "water-chamber," since it is filled with water, the quantity being such as to also fill the space above the mercury in the resistance-chamber. The front side of the water-chamber is closed by a flexible diaphragm *k*, fitted water-tight thereto by means of a clamping-ring *l*.

m is an electromagnet of the solenoid type, mounted concentrically in front of the diaphragm and having a movable core or plunger *n* resting at one end, which is of non-magnetic material, against the center of the diaphragm and projecting outside of the magnet at its opposite end.

For the purpose of making the necessary wire connections the block carries three binding-posts *o*, *p*, and *q*, respectively, the post *o* being electrically connected with the body of

mercury by a metallic plate *r*, having a pin which reaches into the body of mercury, as shown in Fig. 4.

The armature of the charging-dynamo is indicated by *t*, its field-magnet coils by *u*, and the storage battery by *s*.

The circuits will be traced in connection with the description of the operation, which follows. The weight of the column of mercury in the cut-out chamber is sufficient when the apparatus is not working to force the diaphragm *k* outward, the pressure being communicated through the mercury and water, the charging-circuit being thereby interrupted between the terminal *g* and the surface of the mercury, as will hereinafter appear. In this condition also the level of the mercury in the resistance-chamber is at the highest point. When the dynamo is driven, the strength of its field-magnet *u* and of the magnet *m* increases with the speed, and the voltage of the armature-circuit likewise builds up. The field-magnet circuit may be traced as follows: from dynamo-brush 1 through field-magnet coil *u*, wire 2, binding-post *p*, wire 3, resistance-pencils *d* and *e*, through the mercury to pin and plate *r*, binding-post *o*, and wire 5 to brush 6 of the dynamo. Thus the field-coil is in circuit with the resistance-pencils *d* and *e*, and at starting the greatest possible portion of such resistance is short-circuited by the mercury. It will be seen that the electromagnet *m* is in parallel with the field-coil *u*, as follows: from brush 1 by wire 7 to the magnet-coil, wire 8 to post *o*, and wire 5 to brush 6. As the voltage of the dynamo rises magnet *m* becomes strengthened and gradually forces the diaphragm *k* inward, displacing the water behind it and lowering the level of the mercury in the resistance-chamber, while raising its level in the cut-out chamber until finally when the voltage becomes sufficient to charge the battery the surface of the mercury in the cut-out chamber connects with the terminal *g* in the upper end thereof and completes the battery-charging circuit, as follows: from brush 1 by wire 7 and wire 9, binding-post *g*, wire 10, battery *s*, wire 11, terminal *g*, the body of mercury, plate *r*, post *o*, and wire 5 to brush 6. Further increases of speed of the dynamo result in giving greater strength to the magnet *m*, which forces the diaphragm farther inward and correspondingly lowers the level of the mercury in the resistance-chamber, which short-circuits less of the length of the pencils, and consequently increases the resistance in the field-magnet circuit, which lowers the voltage of the dynamo notwithstanding its increase in speed. Reversely, a decrease of speed weakens magnet *m* and allows the mercury to rise in the resistance-chamber, decreasing the resistance in the field-magnet circuit and lowering the voltage. The tendency of the apparatus therefore is to maintain a substantially constant voltage after the battery has been cut into the charging-circuit. If the

speed should drop abnormally, the weight of the mercury in the cut-out chamber overcomes the magnet *m* and the charging-circuit is broken at the terminal *g*, thus preventing the battery from reversing the dynamo.

In the distribution of the current I have arranged the circuits so that either the dynamo or the battery can supply the translating device or devices, so that if the battery is fully charged the translating devices take current direct from the dynamo, and if not fully charged the consumed current flows from the battery and the dynamo current charges the battery. The translating device is here represented as a pair of sparking terminals *v* in the secondary circuit of an induction-coil *I*. The primary circuit of this coil includes the usual vibrator or trembler *j* and terminates at the pivotal points of a double-poleswitch. (Shown in dotted lines.) The battery is tapped in the middle, the branch 12, leading therefrom, connecting with the contacts 13 and 18. Wire 15 leads from one outside terminal of the battery to contact 16, and wire 17 leads from the other outside terminal of the battery to contact 14. With the switch in the position shown the primary of the induction-coil receives current from one-half of the battery only through the wires 12 and 15. This circuit can be maintained as long as desired—say during the outward trip of the automobile. Then the switch can be thrown to the opposite position to engage with contacts 14 and 18, whereupon current will flow to the primary from the other half of the battery through wires 12 and 17, and in this position it will be seen also that the direction of current through the primary coil is reversed. This circuit can be maintained as long as desired—say during the return trip of the automobile. The reversal of the switch changes the direction of the current in the primary coil and across the contacts of the trembler, and thus produces an equal effect upon the trembler-contacts.

It will be obvious that the design of the block and of the parts attached to and mounted upon it may be altered without departing from the spirit of my invention. I may prefer to use a wooden or even a metallic block and incase therein glass tubes or vessels for the mercury and water. Glass, being a secure holder of mercury, may be preferable to any other material. It is also obvious that the nature of the resistance material used for the pencils *d* and *e* is a subject for selection. I may also use other material than water for the liquid behind the diaphragm and may even use a gas or other fluid.

For automobile purposes the device will be very small and can be secured to the side of a battery-box, where it will occupy very little space and require but little attention.

Having described my invention, I claim—

1. In a voltage-regulator for dynamos, the combination of a body of conducting liquid,

a resistance-conductor projecting into said liquid and included in a circuit of the dynamo, a body of non-conducting fluid above the surface of the body of conducting liquid and
5 an electromagnetic device adapted to exert pressure upon the surface of the conducting liquid through the non-conducting fluid, substantially as described.

2. A voltage-regulator for dynamos, consisting of two chambers, one containing mercury and the other containing water, the latter connecting with the upper end of the mercury-chamber, a resistance-conductor projecting into the mercury-chamber and adapted
15 to be more or less covered by the mercury, a diaphragm forming one wall of the water-chamber and an electromagnet whose armature controls said diaphragm, substantially as described.

20 3. In a voltage-regulator for dynamos, the combination of a suitable casing containing two vertical chambers communicating with each other at their lower ends and containing a body of mercury, a circuit-terminal in one
25 chamber with which the surface of the mercury

is adapted to connect and disconnect, a body of liquid supported upon the surface of the mercury in the other chamber and an electromagnet adapted to exert pressure upon said liquid for the purpose of connecting and disconnecting the mercury with said terminal,
30 substantially as described.

4. A voltage-regulator for dynamos, consisting of a suitable casing provided with two communicating chambers, a body of mercury
35 contained in said chambers, a circuit-terminal above the surface of the mercury in one chamber, a resistance-conductor in the other chamber projecting into the mercury therein, an electromagnetic device adapted to alter
40 the level of the mercury in the chambers, said resistance-conductor being in circuit with the dynamo and a translating device in circuit with said terminal, substantially as described.

In witness whereof I subscribe my signature in presence of two witnesses.

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Witnesses:

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