(No Model.) 2 Sheets—Sheet 1.

A. DE KHOTINSKY.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 263,870. Patented Sept. 5, 1882.

Fig. 2.

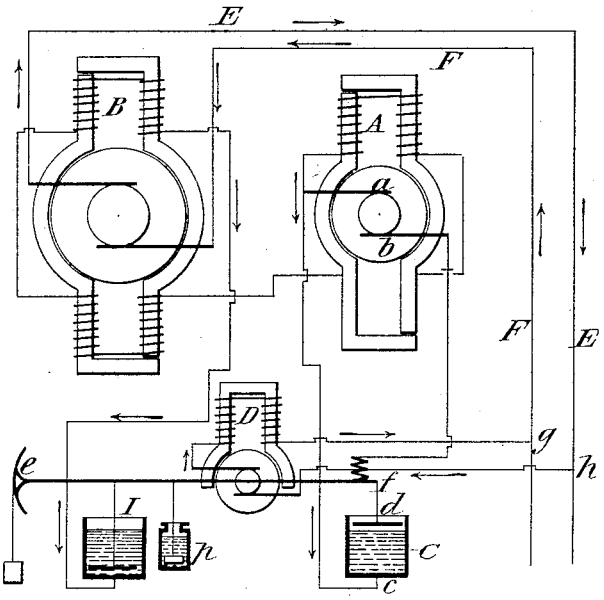


Fig. 1.

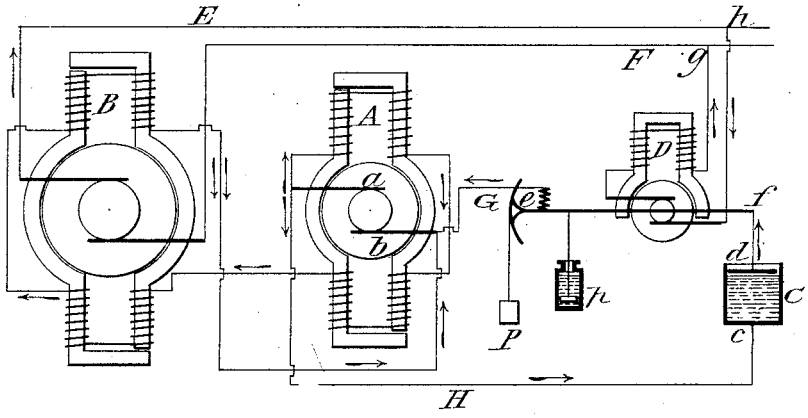
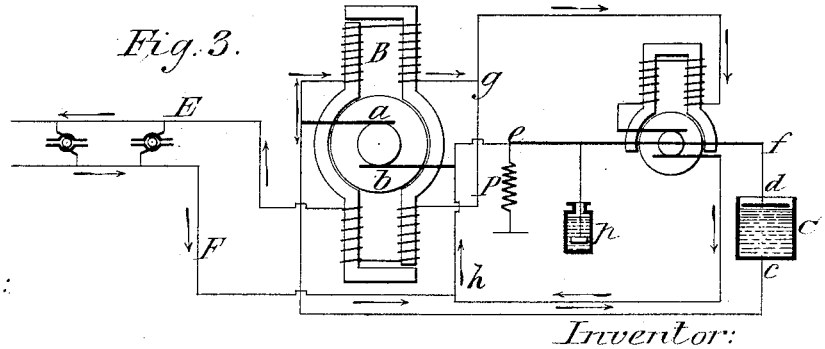


Fig. 3.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 4.

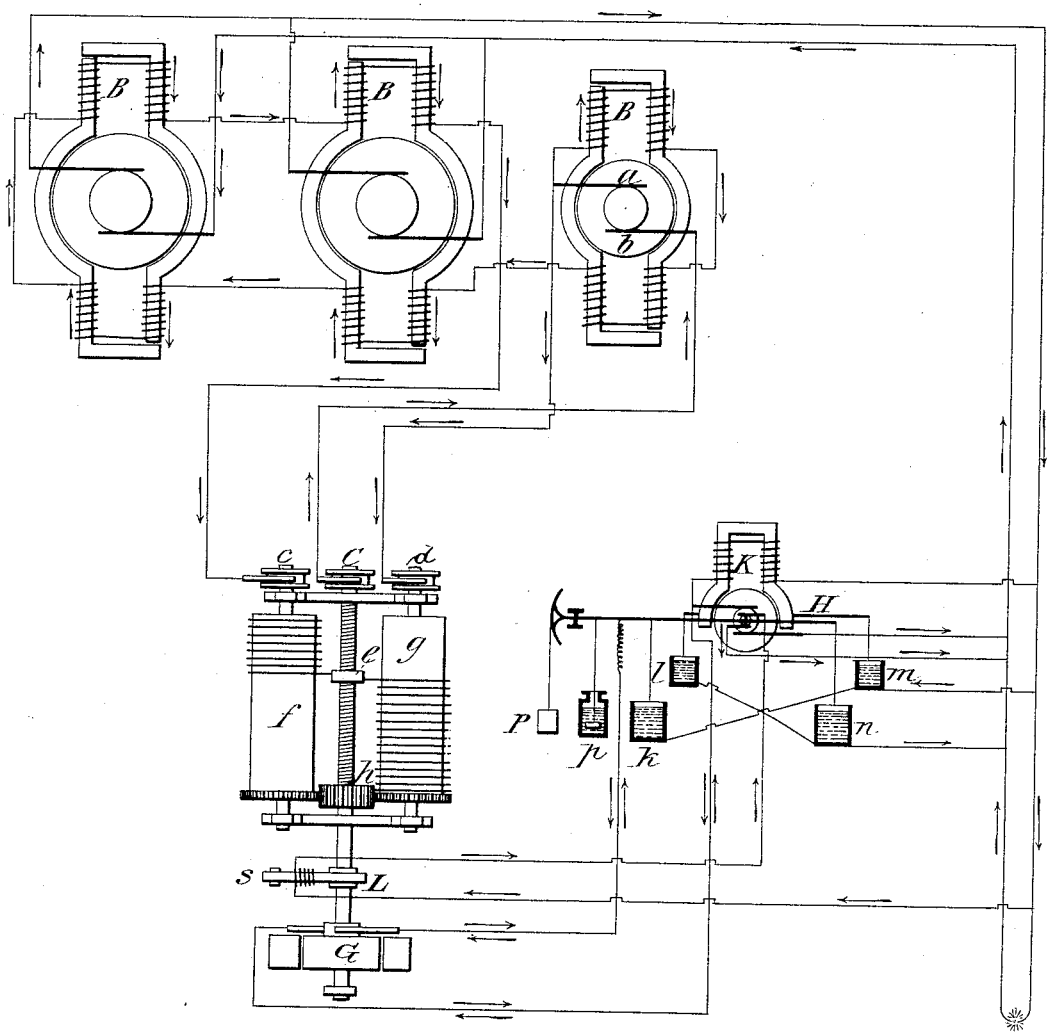


Fig. 5.

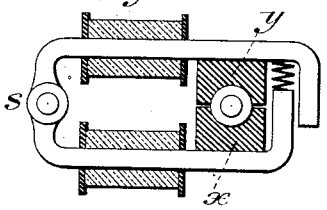
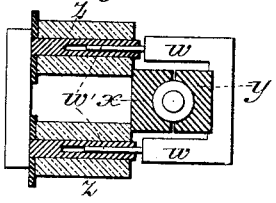


Fig. 6



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UNITED STATES PATENT OFFICE.

ACHILLE DE KHOTINSKY, OF ST. PETERSBURG, RUSSIA.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 263,870, dated September 5, 1882.

Application filed May 1, 1882. (No model.) Patented in France January 10, 1882, No. 146,790; in Belgium January 11, 1882; in England January 17, 1882, No. 245; and in Spain February 7, 1882, No. 2,623.

To all whom it may concern:

Be it known that I, ACHILLE DE KHOTINSKY, of St. Petersburg, Russia, have invented Improvements in Apparatus for Regulating Electric Currents; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the annexed sheet of drawings, making a part of the same.

In the application of the energy of electric currents for lighting purposes either by incandescence or by a voltaic arc, or for the transmission of power or the like, it is necessary not only to regulate such energy, but also to economize the motive force which is to be spent in its production.

This invention has for its object to provide an automatic current-regulator which is based on the following principles: first, to establish by means of a conductor with variable resistances a derivation in the circuit of the current operating upon the bobbin of a dynamo-electric machine (either an exciting or a generating machine) before its entrance into the coils of the inducing electro-magnets, and so provide means for varying the electro-motive force of the principal current; secondly, to establish a derivation with variable resistance in the circuit of the current operating upon the bobbin before its entrance into the coils of the electro-magnets, and at the same time to place in the circuit of the current which excites the electro-magnets of the inductor another resistance, whereby variations in the intensity of the principal current can be obtained.

In Figures 1, 2, 3 of the accompanying drawings I have represented diagrams illustrating the arrangement of my improved regulator, in which the variable resistance is a liquid column.

Diagram 1 represents the arrangement of the apparatus, the magnetic field being produced by an exciting-machine. A is an exciting-machine. B is a generating-machine. The current of the exciting-machine A leaves the brush *a*, and passes through the coils of the field-magnet of the said machine and of the generating-machine. It re-enters the machine through the other brush, *b*. From the brushes *a* and *b* two conductors lead, one of which is connected with the conducting-plate *c*, placed at the bottom of a vessel, C, and the other ends at a small conducting-rod, *d*. The rod *d* is fixed to the arm or lever *e f*, which is in its turn fixed upon the axis of the armature of an electric motor, D. The collectors of the motor D are connected with the conductors E and F of the principal circuit, so that the useful current tends to make the bobbin of the motor D turn in the manner of the hand of a watch. For instance, supposing that an equilibrium has been obtained by opposing to the motive couple a spring with a regulating-screw or a weight, P, so long as the intensity of the current remains the same the arm or lever does not change its position; but as soon as the electric pressure between the two points *g* and *h* changes (reverses, for instance) by reason of the diminution in the number of lights or of motors the end *f* of the arm *e f* descends like the hand of a watch, the rod *d* touching the liquid (acidulated water) in the vessel C. The conductors G and H are then connected, thus establishing a derivation in the circuit of the exciting-machine. The current which goes through the derivation depends on the difference between the resistance of the conductors coiled round the electro-magnets of the exciting-machine and of the generating-machine on the one hand and that of the vessels C on the other hand. This last resistance depends on the height of the liquid in the vessel, the surfaces of the conductors *c* and *d* remaining constant. It will be readily understood that the derivation of the principal current in the regulator D causes its bobbin to move until the resistance of the vessel C (the conductors *c* and *d*) re-establishes equilibrium. The contrary will take place when the intensity of the current shall have diminished.

In order to give to the working of the regulator more regularity and sensitiveness, which is necessary in certain cases, I may arrange on the arm *e* of the arm *e f* another rheostat, I, as is shown in the diagram Fig. 2, and I place it in the general circuit of excitation. The diminution of resistance of the rheostat C thus brings about simultaneously the increase of resistance in I, and consequently in the whole exciting-circuit. The angle of inclination of the arm or lever *e f* can thus be considerably diminished without diminishing the effect ob-

tained, for the difference of the resistance increases more rapidly.

The diagram shown by Fig. 3 represents the arrangement of the regulator applied to a dynamo-electric machine working without an exciting-machine.

The letters refer to the same parts in Figs. 2 and 3 as in Fig. 1.

To the arm *e f* is fixed a glycerine-pump, whose piston has an aperture that can be made to vary at will. The pump serves to ease the movements of the arm.

Instead of the regulator with hydraulic resistance which I have just described, it may be preferable in certain cases to use as a resistance wires or strips of platinum or German silver or other metal. The principle of the regulator will always remain the same, and the arrangement represented in Fig. 1, for instance, may be employed. In this figure, A is the exciting-machine. B B are the generating-machines. The useful current passes along the conductors E F. The current of the exciter leaves the brush *a*, passes around the inductors of the exciting-machine, then along the wire coiled upon the magnets of the generators B B. It enters by means of the contact-plate *c* into the half *f* of the rheostat C, and traversing the resisting-conductor which surrounds it, returning to the exciter A by way of the conductor *e b*. The derivation of the current goes from the brush *a* toward the other half of the rheostat C, passes through the resisting-conductor coiled round the insulating-cylinder *g*, and enters the coil of the exciter A by way of the conductor *e b*.

The rheostat C is composed of two cylinders, *f g*, of similar diameter, and made of some insulating material. These two cylinders receive their motion by means of a pinion, *h*, which communicates to them a rotation in the same direction, so that the resisting-conductor uncoiling from one cylinder coils around the other. One terminal of the resisting-conductor is connected with the axis of the cylinder *f*, the other with the axis of the cylinder *g*. In the part of the resisting-conductor which is free, and between the two cylinders, is arranged a sliding contact-plate, *e*, connected with the brush *b* of the exciter. This contact-plate divides, so to say, into two parts the resistance-conductor. One of its parts is in the circuit of the exciting-current, and consequently increases its resistance. The other is in the derived circuit, and there plays the same part, but in the contrary direction. The different lengths which may be given to the resisting-conductor on both sides of the sliding contact-plate *e* are of essential importance. The regulation rests upon the fact that by diminishing the length of the wire coiled upon one cylinder I increase by the same length the portion arranged upon the other cylinder. If, for instance, all the resistance of the cylinder *g* is transferred to the cylinder *f*, the current produced by the coil of the exciter A, induced by the residual magnetism, will be derived in the direction *a d e b*, which presents least resistance as compared with the exciting-circuit *a c e b*. It is clear that at this moment there will be hardly any current in the principal circuit, E F. On the contrary, if it be the cylinder *g*, which carries all the resistance, the effect obtained will be the reverse—that is to say, a complete excitation of the electro-magnets of the generator will be produced, and consequently the maximum of intensity in the useful circuit obtained. The intermediate positions will produce intermediate effects.

In order that the apparatus may automatically regulate the principal current, the axis of the pinion *h* is connected with an electric motor, G, whose rotary direction may change with the direction of the current. This double operation is effected by means of an inverting commutator, H, which in its turn is set in motion by an electric motor, K, similar to that represented in Figs. 1, 2, 3. It is to the shaft of this motor that the inverting commutator H is fixed.

In order that under the influence of inertia the coil of the resisting motor (rheostat) G should not go beyond the position of equilibrium, the inverter H closes by means of a contact-spring the circuit of a brake, L. This brake L is composed of two halves of a horse-shoe electro-magnet fixed one upon the other by means of a hinge, *s*, as shown in Fig. 5. In the interior the two branches of this magnet carry blocks *x y*, which press against the shaft of the motor when the current traverses the electro-magnet, and which consequently moderate the motion of the latter.

Instead of the arrangement shown in Fig. 5, that represented in Fig. 6 may be employed, in which *x* and *y* are the blocks of the brake, *z* the electro-magnet, and *w* an armature of soft iron, guided by two rods, *w'*.

I may, if desirable, operate upon the brake-blocks by means of a solenoid or any other magnetic device acting upon them either directly or by means of suitable proper transmitting devices.

It is obvious that the use of this improved regulator economizes the expenditure of motive power. Each time that the useful current diminishes the magnetic change of the exciter and generator also becomes less.

The forms, dimensions, and detailed arrangements of the parts of this regulator, as also the nature of the resistances which are therein used, may vary without in any way changing the nature of my invention.

I claim—

1. The combination, with a dynamo-electric generator, of a regulating apparatus consisting of an electric motor, D, connected with the principal circuit, a lever, *e f*, fixed on the armature-shaft of said motor, and a counterbalancing weight or spring, P, said lever carrying a conducting-rod, *d*, and a rheostat or vessel containing a liquid and closing a resisting shunt-circuit, substantially as and for the purpose set forth.

2. In combination with an exciting-machine, A, a dynamo-electric generator, B, a regulator consisting of an auxiliary electric motor, D, connected with the principal circuit and actuating a lever, *e f*, fixed on the armature-axle of said motor, said lever being drawn by a spring or weight, P, which counterbalances the motive action of the motor, and carrying at its opposite end a small conducting-rod, *d*, which closes a shunt-circuit, G H, the resistance of which varies in proportion with the height of the liquid in a vessel, C, substantially as and for the purposes set forth.

3. In combination with an exciting-machine, A, and a dynamo-electric generator, B, a regulating apparatus consisting of an electric motor, D, connected with the principal circuit, and carrying on its armature-shaft a lever, *e f*, drawn by a spring or weight, P, counterbalancing the motive action of said motor, said lever adapted to operate in connection with two vessels or rheostats containing liquid, and placed on both sides of the fulcrum of the lever in such a manner that the vessel C, which closes the circuit of the exciting-machine, causes simultaneously the resistance of the general field-circuit of the generator to be increased by means of the liquid of the vessel I, substantially as above described in reference to Fig. 2 of the annexed drawings, and for the purpose specified.

4. The combination, with a dynamo-electric generator, of a regulating apparatus consisting of an electric motor, D, a lever, *e f*, fixed on the armature-shaft of said motor, and a counterbalancing spring or weight, P, a glycerine-pump, *p*, and a rheostat or vessel, C, containing a liquid and closing a resisting shunt-circuit, all acting substantially as above described in reference to Fig. 3, and for the purposes set forth.

ACHILLE DE KHOTINSKY.

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