(No Model.) 2 Sheets—Sheet 1.

H. S. MAXIM.

SPEED REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 255,310. Patented Mar. 21, 1882.

FIG. 1.

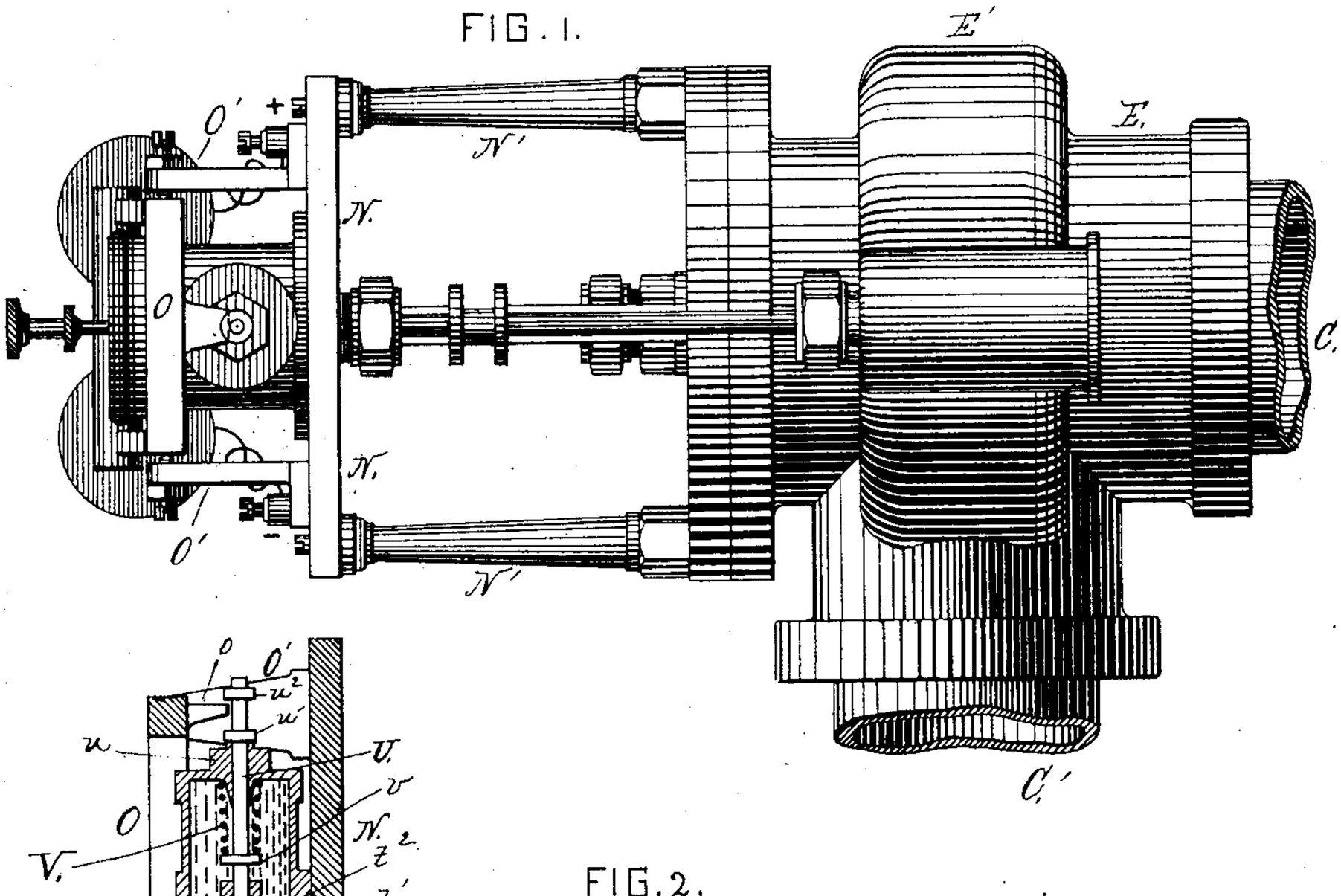
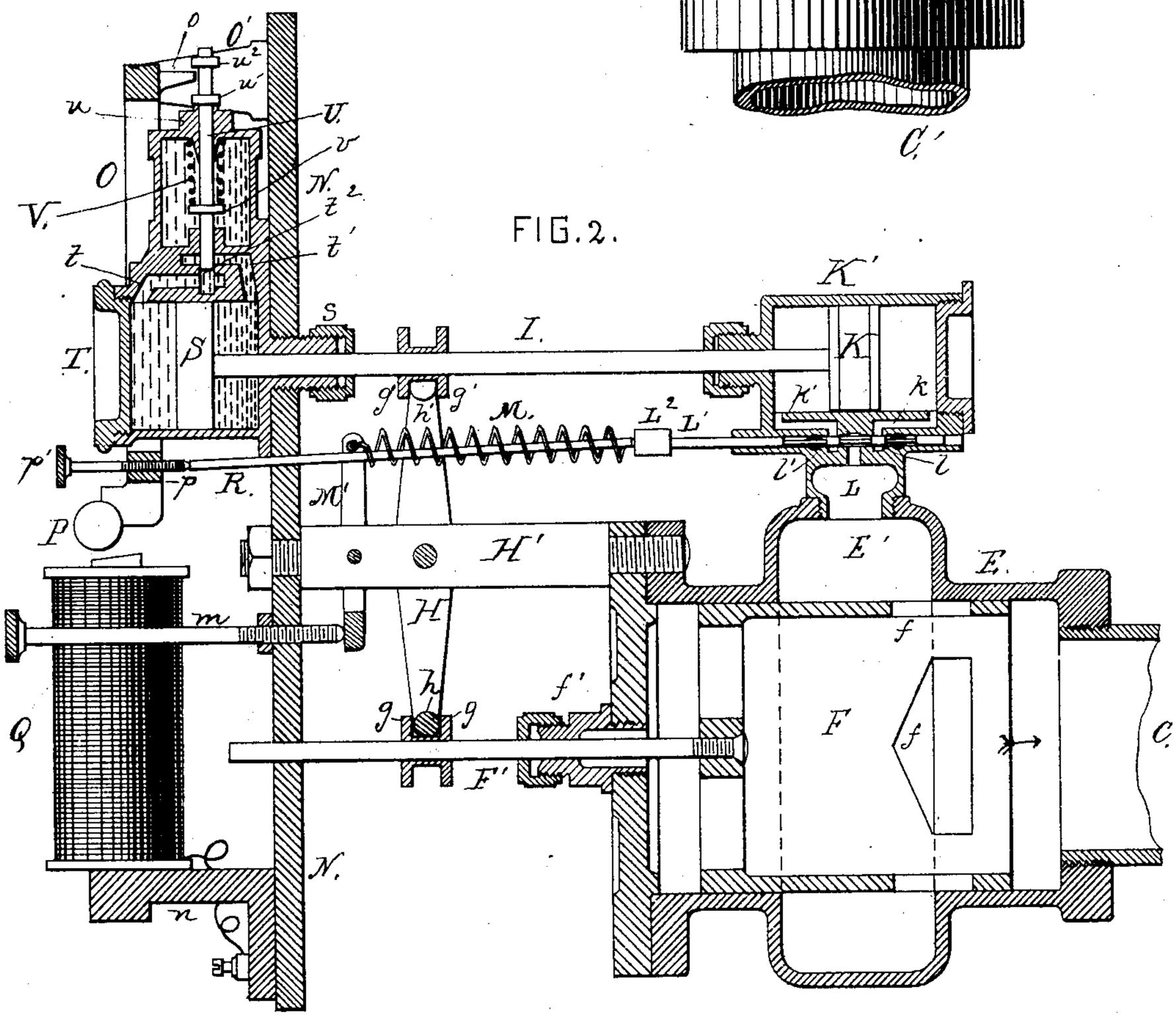


FIG. 2.



ATTEST:
Clayton Sherland
S. M. Madden

INVENTOR:
Hiram S. Maxim
per Parker W. Page
atty.

(No Model.) 2 Sheets—Sheet 2.

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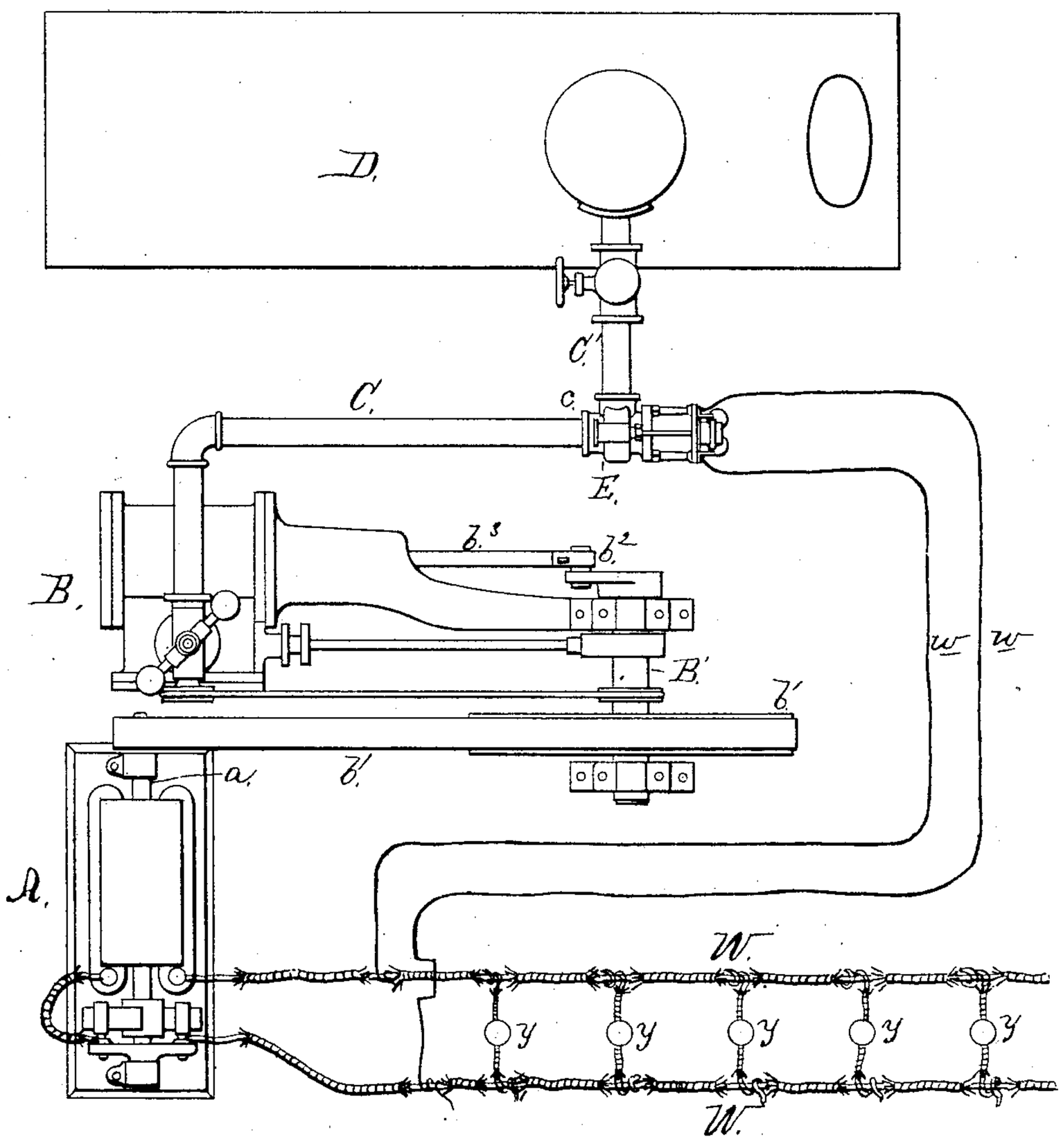
FIG: 3.



ATTEST:

Clayton Sweetland

S. M. Madden

INVENTOR:

Hiram S. Maxim

by Parker W. Page

atty.

UNITED STATES PATENT OFFICE.

HIRAM S. MAXIM, OF BROOKLYN, ASSIGNOR TO THE UNITED STATES ELECTRIC LIGHTING COMPANY, OF NEW YORK, N. Y.

SPEED-REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 255,310, dated March 21, 1882.

Application filed July 20, 1881. (No model.)

To all whom it may concern:

Be it known that I, HIRAM S. MAXIM, of the city of Brooklyn, county of Kings, and State of New York, have invented certain new and useful Improvements in Regulators for Dynamo-Electro Machines, of which the following, taken in connection with the accompanying drawings, is a specification.

The object of this invention is to automatically regulate the speed of the steam-engine employed to drive one or more dynamo-electro machines, so that the same shall at all times produce a current sufficient in amount for accomplishing the work required thereof in an external circuit. For instance, suppose the dynamo-electric machine is used to generate a current for maintaining electric lights arranged in multiple arc in any given circuit. If all the lamps in the circuit are brought into operation, then the dynamo-electro machine will be required to be run, say, at its maximum speed in order to produce a current of sufficient amount to supply all said lamps, and its driving-engine will consequently be required to be run at a high speed also; but if a portion of the lamps are switched out of circuit, then, the supply of current being in excess of that actually needed, the dynamo-machine will not be required to work at its full capacity. As a saving of power, and to maintain the intensity of the light uniform, it is therefore necessary to reduce the speed of the engine in proportion to the work required of it, and the object of this my invention is to bring about these reductions or acceleration of speed. This I accomplish by the devices illustrated in the accompanying drawings, in which—

Figure 1 is a top view of my invention. Fig. 2 is a section on line *x x*, Fig. 1; and Fig. 3 is a diagram illustrating the connections between the dynamo-machine and its driving-engine and between the latter and its boiler, showing the location of my invention as applied to use.

Referring to Fig. 3, the letter A indicates a dynamo-electric machine, the belt-pulley on the armature-shaft *a* of which is connected by a belt, *b*, with a belt-wheel, *b'*, on a shaft, D', driven by crank-connection, as shown at b^2, with the piston b^3 of the steam-engine B.

C and C' indicate the steam-pipe leading from the boiler D to the valve-chest of a steam-engine, said steam-pipe forming an angle at *c*, where the part C' connects as an induction-pipe. Inside of this valve-chamber E, which has an annular enlargement, E', is arranged a hollow slide valve, F, which fits closely the main portion of the chamber, and is surrounded by said annular enlargement. The valve F is provided with steam-ports *f* to said annular enlargement, that are opened more or less, according to the position of valve F in its chamber. When the valve moves to the left the ports are opened, and when it is moved to the right they are closed by being carried into that portion of the valve-chamber which closely surrounds the valve. Steam passes through the portion of the steam-pipe C' through the annular enlargement, and thence through the ports *f* to the interior of the valve F, and through its open end in the direction of the arrow to that portion C of the steam-pipe which leads to the valve-chest of the steam-engine; so it will be seen that the position of the ports *f* with relation to the annular enlargement governs the quantity of steam which flows to the steam-chest, and consequently controls the speed of the engine. The automatic devices for controlling the position of these ports are as follows:

The valve F has a stem, F', which extends through a stuffing-box, *f'*, in the head of its valve-chamber, and outside of said chamber this stem is provided with two projections, *g g*, between which fits loosely a stud, *h*, projecting laterally from the lower end of an oscillating lever, H, which is pivoted at its middle to an arm, H', extending horizontally from the upper side of the head of the valve-chamber.

From the upper end of the arm H a stud, *h'*, projects laterally and fits loosely between the projections *g'* on a piston-rod, I. At one end this piston-rod I carries a piston, K, which plays in a cylinder, K', mounted upon the top of an annular enlargement, E', of the valve-chamber E, and provided with the steam-passages *k* and *k'* in its lower wall, arranged for alternate connection by means of valves *l* and *l'* with a steam-passage, L, leading into said annular enlargement.

The valves *l* and *l'* are connected to a common valve-stem, L', having a head, L^2, to which is connected one end of a spiral spring, M, the

other end of which is connected to one arm of a lever, M′, pivoted to the arm H′, and having bearing upon its other arm an adjusting-screw, *m*, which passes through a vertical plate, N, supported by the pillars N′ and the arm H′, projecting from the head of the valve-chamber E, said screw being adjusted normally to give such tension to the spring M that it will draw the valve-stem L′ outward or to the left.

The letter O indicates a pendent frame, pivoted at its upper end between posts O′, projecting from the plate N, and carrying at its lower end a cylindrical armature, P, arranged adjacent to the oblique faces of the poles of an electro-magnet, Q, supported in a vertical position by a bracket, *n*, projecting from said plate N.

Through a cross-bar, *p*, of the frame O is arranged an adjusting-screw, *p′*, the conical tip of which enters a correspondingly-shaped socket in the end of a rod, R, the other end of which bears upon the head L^2 of the valve-stem L′, so that when the armature P is attracted by the cores of the magnet Q the rod R will be caused to force said valve-stem inward; but when said armature is not attracted the spring M will draw said valve-stem outward to place the valves *l* and *l′* in their normal positions—that is, so that the valve *l* will close the steam-passage *k*, and the valve *l′* will open the passage *k′*, so that it will admit steam to the left of the piston K, in which position the piston-rod I will be carried to the right, the projections *g′* causing the lever H to act upon the projections *g* of the valve-stem F′, drawing the valve F to the left. When, however, the armature P is attracted by the magnet the positions of the valves *l* and *l′* will be reversed and steam admitted to the right of piston K, causing the valve F to be driven to the right and nearly closing the ports *f*, so that but little steam will pass to the valve-chest, and the speed of the engine will be correspondingly slow.

In order to give steadiness of motion to the piston K, the end of the piston-rod I opposite said piston passes through a stuffing-box, *s*, arranged through the plate N, and is provided with another piston, S, which plays in a dash-pot, T, projecting horizontally from the plate N, and provided in its upper wall with the connected passages *t* and *t′*, through which a liquid in the dash-pot may pass from one side of the piston to the other.

The letter U indicates a vertical rod, the lower end of which projects into the opening t^2 between the two sides of the dash-pot, through which the liquid is forced by the movement of the piston. The extent to which the said rod closes the passage t^2 is regulated by the nut *u′*, and it is maintained in the position to which it is adjusted by the spiral spring V. By this means the rapidity with which the piston S works is regulated. The upper portion of rod U passes through a suitable guide, *u*, above which it is provided with the screw-nuts *u′* and u^2, under the latter of which projects a finger, *o*, from the armature-frame O. The finger *o* is arranged to come in contact with the stop u^2 when the armature is fully depressed, so that the rod U is raised only when the magnet is cut out of circuit. In this case it is essential that the engine should be immediately stopped, and this is effected by the sudden movement of the piston-rod I and piston S, which encounters comparatively little resistance when the passage t^2 is fully opened, as it would be by the full movement of the armature-frame and the consequent withdrawal of rod U by the finger *o*.

The magnet Q is arranged in a derived circuit, shown by the wires *w* and *w*, connected respectively to the wires W and W, which are the terminals of the main line connected with the dynamo-electric machine A, as shown in the diagram Fig. 3, and forming the electric-light circuit, in which are arranged the lamps *y*, in an ordinary manner, in multiple arc.

The operation of the invention as now described is as follows: The valve F being in its normal position to the left, the throttle-valve is opened and steam passes from the boiler through the portion of the steam-pipe C′ to the valve-chamber E, through the annular enlargement E′, ports *f*, and valve F to the portion of the steam-pipe C which leads direct to the valve-chest, starting the engine gradually under a full head of steam, which drives the dynamo-machine at a speed sufficiently high to fully charge the main line W and maintain all the lights in the circuit. Should all the lights be in circuit at the time, the only effect on armature P would be to slightly depress it, so that it closes both of the passages *k* and *k′*, and in this position it will remain until some of the lights are cut out of circuit. In this event more current is diverted through the high-resistance coils of the magnet Q, the armature P is further depressed, valve *l* is opened and *l′* closed, upon which the piston-rod I is driven to the left, stem F carried to the right, and the ports *f* partly closed. With the partial closing of the steam-ports *f* the speed of the engine is reduced, so that the magnet Q again loses its attractive force. Steam is consequently admitted again through passage *k′*, which operates to accelerate the speed of the engine, and so (theoretically at least) there will be an oscillatory action of the valve mechanism, which lasts until an equilibrium is established and both passages *k k′* again closed. This point is soon reached, owing to the slow movement of the piston-rod I, so that in practice it may be said that the piston K assumes a different position for every change in the number of lamps in circuit or for every variation in the amount of current generated by the machine, and that this position will always be such that the speed of the engine will be just sufficient to cause the dynamo-machine to generate exactly the amount of current that the line requires.

I have described and shown the above de-

vice in connection with a system of incandescent lamps arranged in multiple arc to the external circuit of the generator. In this case the regulator-magnet Q must also be included in a branched or derived circuit. When, however, the system involves a number of arc lights or other devices run in series, the magnet Q must be of low resistance and included in the direct circuit from the machine, the purpose in this latter case being to maintain the volume of current at all times constant, whatever may be the number of lamps or other devices in the circuit.

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

1. The combination, in a regulator adapted to regulate the speed of a steam-engine used for driving a dynamo-electric machine, of a steam-pipe, C, a valve for controlling the admission of steam, a stem for said valve, and mechanism, substantially as described, for shifting the same, an electro-magnet included in the circuit from the dynamo-electric machine driven or in a closed branch thereof, and an armature connected with and controlling the shifting mechanism, whereby the flow of steam to the engine is regulated according to the varying attraction of the said magnet, as set forth.

2. The electric regulator consisting of the valve-chamber E, arranged for interposition in a steam-pipe and provided with the annular enlargement E′, the hollow open valve F, arranged within said chamber and provided with the ports *f* and stem F′, the cylinder K′, connected with said annular enlargement by steam-passages controlled by suitable valves arranged to admit steam alternately to opposite end of said cylinder, the piston K, playing in said cylinder and provided with piston-rod I, the oscillating lever H, loosely connected with said piston-rod and the valve-stem F′, and an electro-magnet and connections, as described, for controlling the positions of the valves governing the flow of steam from said annular enlargement E′ to said cylinder K′.

3. The combination, with the valve-chamber E, having the annular enlargement E′, and the valve F, provided with the ports *f* and stem F′, of the cylinder K′, connected with said annular enlargement by steam-passages controlled by valves for admitting steam alternately to opposite end of said cylinder, the piston K, having the piston-rod I, the oscillating lever H, connected to said piston-rod and stem of valve F, the electro-magnet, the pivoted armature-frame carrying armature P, the valve-stem L′, the rod R, arranged between said armature-frame and said valve-stem, and the spring M, arranged substantially as described.

4. The combination, with piston-rod I, arranged for operation substantially as described, of the piston S of the dash-pot T, in which said piston plays, and means, as described, for regulating the flow of a liquid in said dash-pot from one side of the piston to the other, substantially as described.

5. The combination, with piston-rod I, arranged for operation substantially as described, of the piston S, the dash-pot T, in which said piston plays, an adjustable rod, U, for regulating the flow of a liquid in said dash-pot from one side to the other, and an electro-magnet and armature connected with the said rod U, and having a projection adapted to raise the same and permit a free passage to the liquid in the dash-pot when the armature has been depressed to its lowest point, substantially as and for the purpose set forth.

In testimony whereof I have hereunto set my hand this 15th day of July, 1881.

HIRAM S. MAXIM.

Witnesses:
PARKER W. PAGE,
CLAYTON KNEELAND.