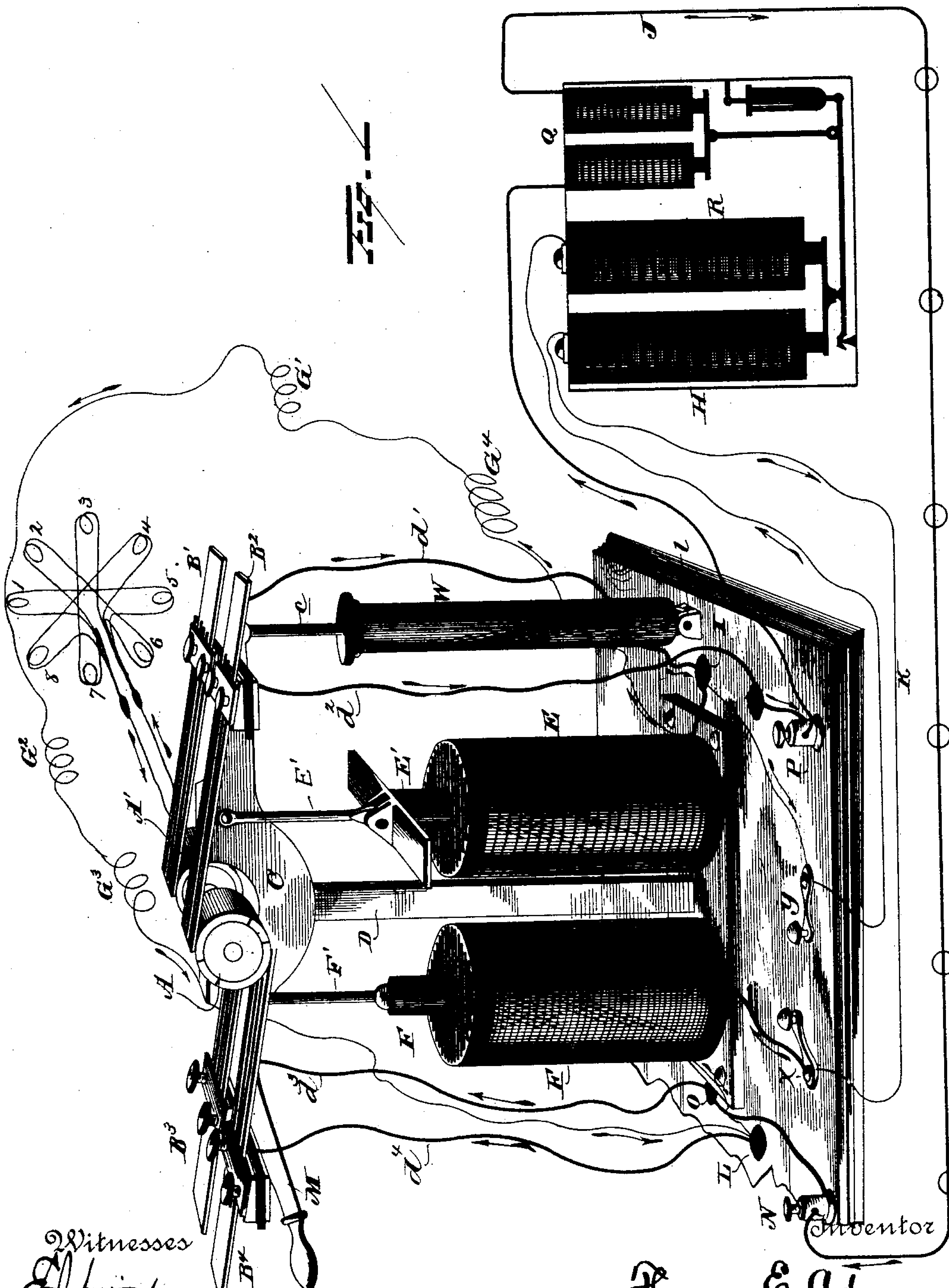
(No Model.)

3 Sheets—Sheet 1.

T. E. ADAMS.

AUTOMATIC BRUSH SHIFTER FOR DYNAMO ELECTRIC MACHINES.

No. 457,330. Patented Aug. 4, 1891.



Witnesses
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(No Model.) 3 Sheets—Sheet 2.

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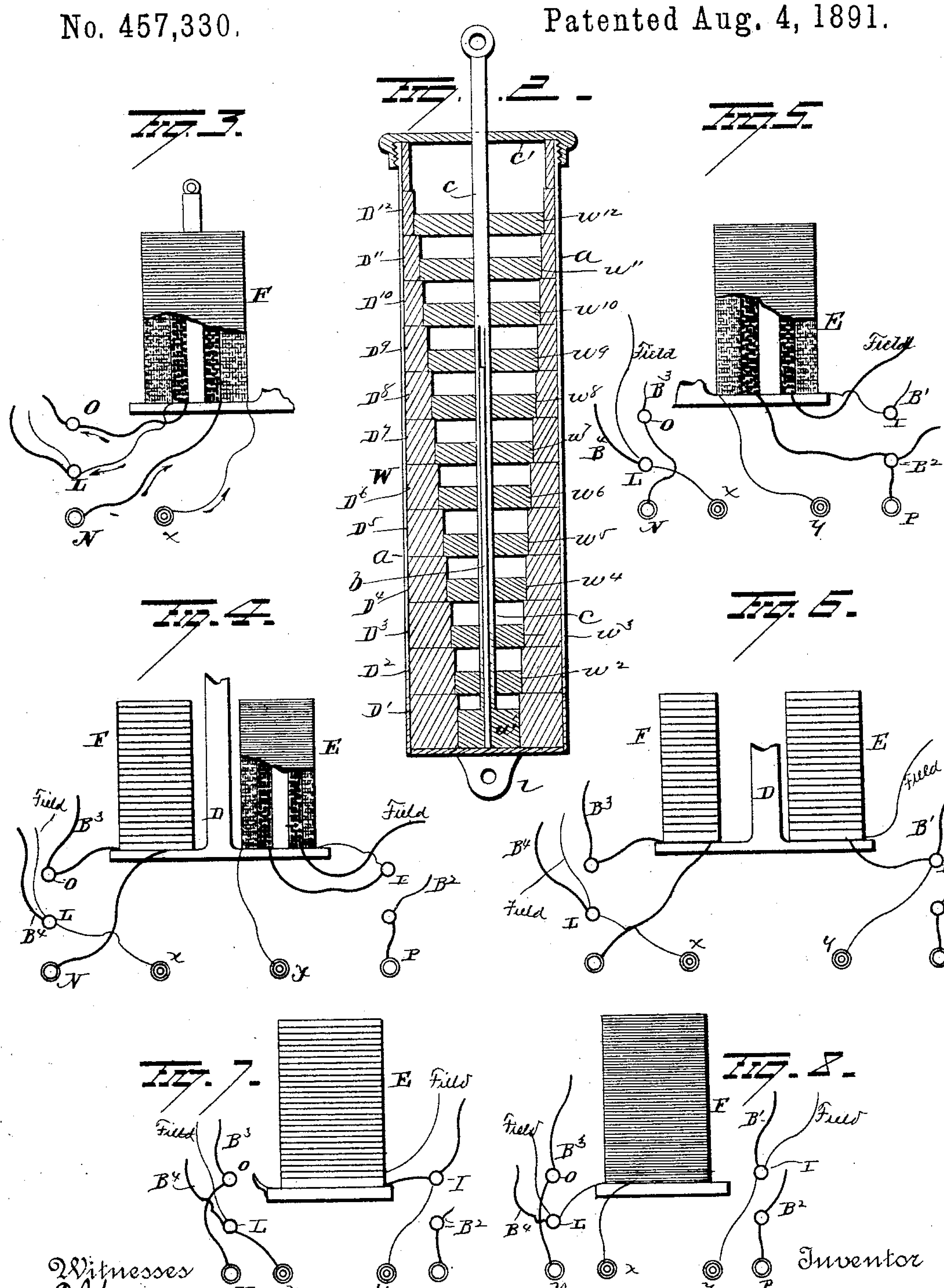

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3 Sheets—Sheet 3.

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Fig. 9.

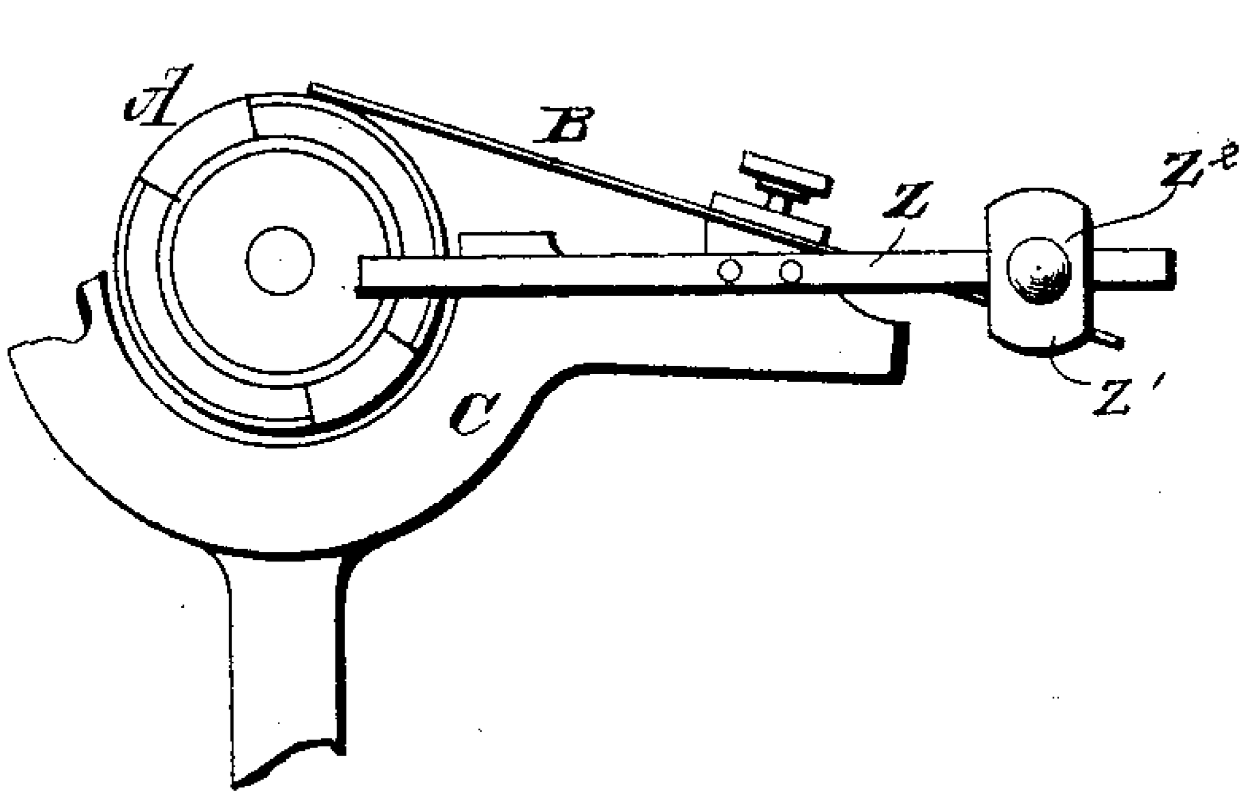


Fig. 10.

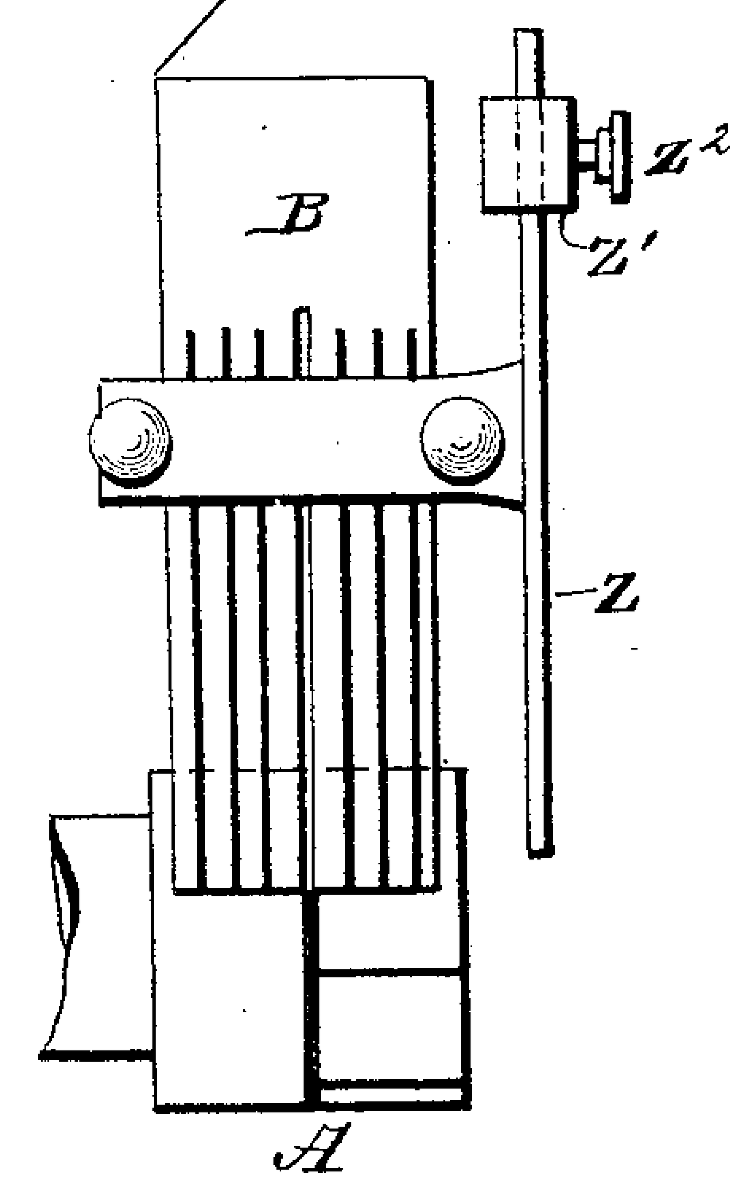
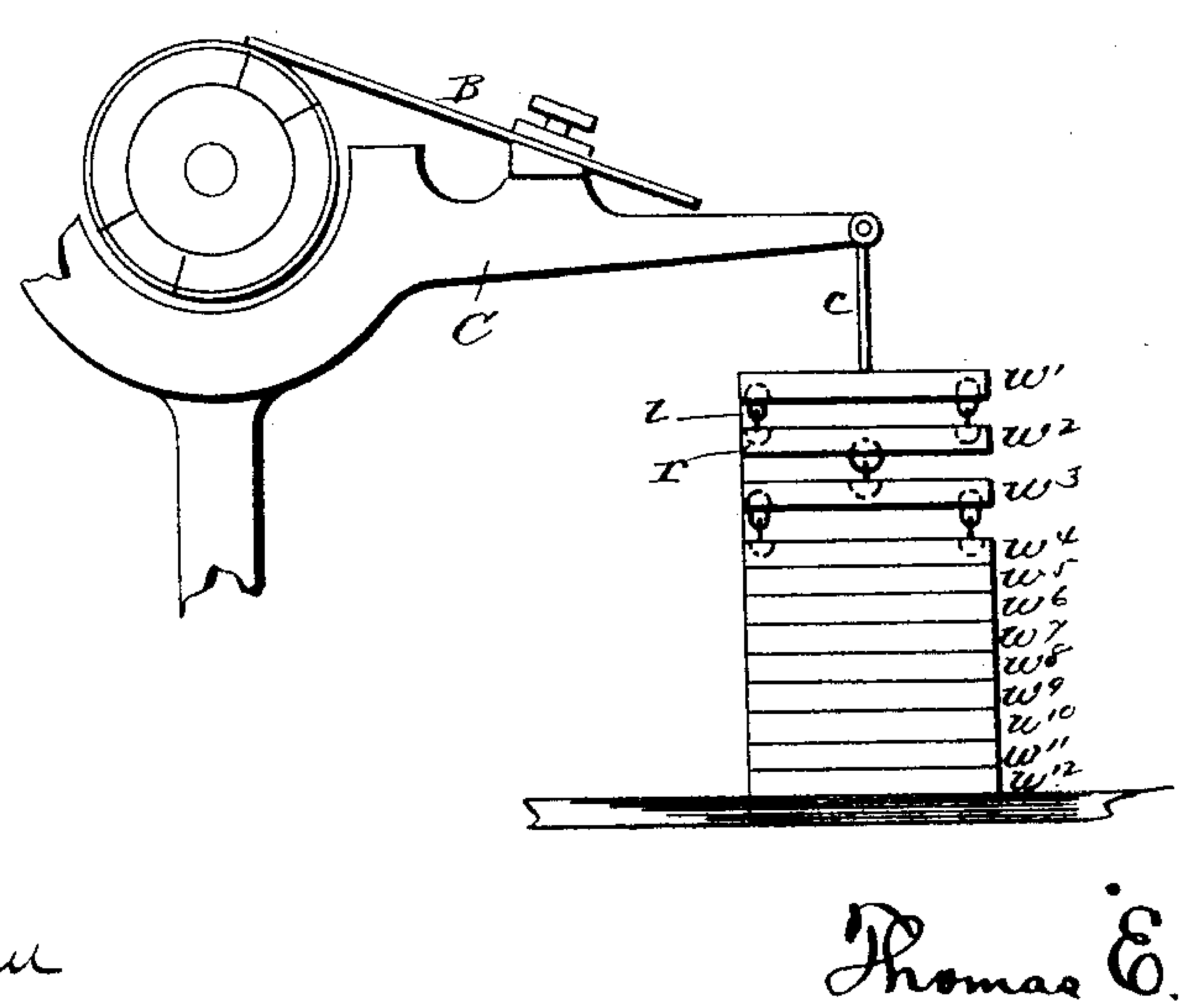


Fig. 11.



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UNITED STATES PATENT OFFICE.

THOMAS E. ADAMS, OF CLEVELAND, OHIO, ASSIGNOR TO THE BRUSH ELECTRIC COMPANY.

AUTOMATIC BRUSH-SHIFTER FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 457,330, dated August 4, 1891.

Application filed September 16, 1887. Serial No. 249,860. (No model.)

To all whom it may concern:

Be it known that I, THOMAS E. ADAMS, of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Automatic Brush-Shifters for Dynamo-Electric Generators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention has reference to automatic brush-shifters designed for use more particularly in connection with the "Brush constant-current dynamos" and other dynamos of this type. The Brush constant-current dynamo and its current-regulator are both well known to and understood by those skilled in the art, and for the purpose of this application it is only necessary to mention that its regulation—*i. e.*, its constancy of current under various changes of external resistance—depends on the resistance of the regulating branch in multiple arc with the field-exciting coil. The well-known "Brush regulator for constant current" varies this branch resistance in inverse proportion to the variations of the external resistance. It follows, therefore, that as the latter varies so does the regulator vary the intensity of the magnetic field acting on the armature, thereby increasing or reducing the electro-motive force and keeping the ratio $\frac{E}{R}$ constant, and thereby also the current itself. This device fulfils its purpose very well indeed, its only drawback being the disturbing and changing of the proper proportion between the mutually-reacting intensities of the magnetic force due to the field-magnets and of that due to the armature itself, which is kept constant, and as a certain ratio between these two forces coincides with a certain position of the resultant poles on the armature-ring it becomes self-evident that a variation of only one of these two forces must also cause a variation of the position of the resultant pole and with it of the diameter of commutation. If, then, the brushes are not simultaneously adjusted with the changes in the magnetic force of the field-magnets, caused by the current-regulator, a considerable amount of sparking at the commutator is unavoidable. The more the diameter of commutation is displaced from its predetermined position—as, say, the maximum external resistance—the more excessive and mischievous will be the sparking. At the same time practical observations on Brush constant-current dynamos have shown that for a given diameter of commutation the brushes may be moved to and fro on the commutator for a considerable distance without materially affecting the current strength, and it will therefore be practicable to let the brushes follow the varying movements of the diameter of commutation, thereby suppressing the deleterious sparking without affecting the current strength or interfering with the proper action of the current-regulator. Heretofore the brushes have been moved by hand for the specified purpose; but my present invention covers the automatic moving of the brushes in conformity with the varying movements of the diameter of commutation for the purpose of suppressing excessive sparking at the commutator. All the automatic brush-shifting devices known to me have the purpose of regulating the current strength thereby, while the automatic moving of the brushes in my invention has nothing whatever to do with the regulation of current strength, but aims exclusively at the suppression of sparking, it having no effect on the current regulation. The distinction between my invention and other automatic brush-shifters is thus made perfectly plain.

To carry out my invention I employ electro-magnets or solenoids or weights, or a combination of the same, and to further explain it I have illustrated in the accompanying drawings, which form a part of this specification, several forms of the automatic brush-shifter as applied to constant-current field-shunt-regulated Brush dynamos, or to other similar dynamos.

In the drawings, Figure 1 represents a perspective view of my collecting-brush shifter, with the armature, the field-magnet coils, and the circuit connections represented diagrammatically. Fig. 2 is a longitudinal section of a graduated check-weight used in connection with my brush-shifter. Figs. 3, 4, 5, 6, 7, and 8 illustrate various modifications of the principal part of my improvement; Figs. 9 and 10, an end elevation and plan, respectively, of the commutator and balancing-weight; and Fig. 11, an elevation of a modified form of graduated check-weight.

Referring now more particularly to Fig. 1 the general arrangement of a Brush dynamo is there represented diagrammatically by the armature-coils 1 2 3 7 8 and by the field-magnet coils G' G^2 G^3 G^4. The terminals of the armature-coils are connected, as usual, with the commutator-segments on the commutator-disks A A′, and the collecting-brushes B' B^2 B^3 B^4, bearing upon the commutators, are adjustably mounted upon a carrier C, which is pivotally connected with a standard D, and which is provided with a handle M, by means of which the shifting of the brushes may be effected manually, if so desired. Two electro-magnets or solenoids E and F are located one on each side of the pivot of the brush-carrier, and their armatures or cores are connected by links E′ F′, respectively, with the brush-carrier, one on each side of the fulcrum of the same, so that if either solenoid becomes active it will swing the brush-carrier in the direction of its pull, making the brushes assume different positions upon the commutators.

H represents an ordinary current-regulator employed for the regulation of Brush dynamos. It is composed in the main of a variable resistance R, included in the regulating-shunt or governing-circuit K, a governing magnet or solenoid Q in the external circuit J, and a dash-pot. The operation, as well as the construction, of this regulator is well understood by those skilled in the art, and need not here be particularly described.

The circuit connections are as follows: Brushes B' B^2 B^3 B^4 are connected by flexible conductors d' d^2 d^3 d^4 with posts or plates I, P, O, and L, respectively. Post I also forms one terminal of solenoid E, the other terminal of which is connected with the field-magnet coils, and there is also an electric connection from post I to the switch-post y, which in turn is connected with the variable resistance R, the other terminal of the resistance being formed by the switch-point x. Post P, which may be an ordinary binding-post, is connected with the governing-magnet Q, which, as has been stated above, is in the external circuit J, terminating in a binding-post N, from which a connection is made to post O. Post L constitutes the other terminal of the field-circuit and one terminal of solenoid F, the other terminal of which is connected with switch-point x. Solenoid E is of coarse wire, and is adapted to carry the normal current of the field-magnets, with which it is connected in series, as will be seen by tracing the connections above described. Solenoid F is wound with fine wire capable of carrying the maximum current in the governing-shunt of the dynamo, of which shunt it forms a part.

The circuits of the apparatus can now be easily traced as follows: The current from the armature which reaches commutator-disk A′ is carried by brush B′ and flexible connection d' to post I. Here the current divides, the main branch passing through solenoid E and the field-magnets to post L and the governing branch to switch-point y through the governing-circuit K, resistance R of the regulator H to switch-point x, and through solenoid F to post L, where the field and governing branches unite. The current then passes by flexible connection d^4 to collecting-brush B^4, commutator-disk A, and through the other coils of the armature to collecting-brush B^2 and by flexible connection d^2 to binding-post P. From P the current passes through the external circuit, including governing-magnet Q, to binding-post N, which connects with post O, and from where the circuit is completed by flexible connections d^3, collecting-brush B^3, commutator A′, and armature back to collecting-brush B′. It will be observed that the more current passes through the shunt-resistance the smaller will be the magnetic force of the field-magnets and the greater will be the displacement of the diameter of commutation in the direction of the rotation of the armature, and vice versa. When the dynamo is started, the resistance of the shunt is at its maximum, and very little current being diverted from the field-magnets and solenoid E, the latter will be sufficiently energized to swing the brush-carrier to its own side of the pivot, and the lead of the brushes will approximately coincide with the then diameter of commutation, thus preventing flashing or current-breaking. As the current increases in strength, solenoid F will be energized to a greater extent and the collecting-brushes will continue to move in a direction opposed to the rotation of the armature. This movement will be gradual as the increase of current strength is also gradual. If the current becomes too strong, the regulator acts to reduce the strength of the field-magnet coils, and since the solenoid E is in series with the field-coils its magnetic strength is also weakened, while by the greater amount of diverted current in the shunt solenoid F is strengthened until it overpowers solenoid E, when the brushes are shifted in the opposite direction, as required by the new position of the resultant magnetic pole. This action is also gradual, since the regulator H acts slowly and gradually, owing to the dash-pot which is used in connection therewith. If the current is of normal strength, the portion of it diverted into the shunt will energize solenoid F sufficiently to just balance solenoid E, and this balance will be maintained so long as the current maintains its normal strength. It will now be understood that any variation from the normal strength of the current in the main line will disturb the equilibrium of forces residing in the two solenoids, and any difference between those two forces will consequently move the brushes in the sense and to the extent of such difference. Electro-magnets may take the place of solenoids when desirable. In some forms it is impracticable to permit the solenoids to act unchecked upon the brush-carrier, for in that case, while the sparking would be reduced to a minimum the fluctuations of current in the external circuit would be too great for practical purposes, and for this reason it is necessary to make provision for checking the action of the solenoids; and this I accomplish by means of a graduated check-weight W, two forms of which I have shown in Figs. 2 and 11, respectively.

In Fig. 2 the graduated check-weight W consists of a sleeve or tube a, having a series of rings D' D^2 D^{11} D^{12} placed vertically above each other within the tube, the inner diameter of each successive ring being greater than that of the preceding one, whereby a series of ledges is formed, upon which the weights w^2 w^3 w^4 w^{11} w^{12} loosely rest. These weights are centrally perforated, and through them passes a sleeve or tube c loosely, while a weight w', also centrally perforated, is fixed to the lower end of said tube and rests upon the bottom of tube a. A guide-pin b is fixed centrally at the bottom of sleeve a and passes through the central perforation of weight w' and into tube c. A perforated cap c' is screwed upon the sleeve a and serves as an additional guide to the tube c in its upward and downward movements. It will now be understood that if tube c is raised it will carry weight w' with it until the latter comes in contact and lifts weight w^2 from the ledge upon which it rests. A continued upward movement of tube c will lift successively weights w^3, w^4, w^{11}, and w^{12}. If from this elevated position tube c is allowed to descend, it will drop successively the weights w^{12} w^{11} w^3 w^2 until weight w' again comes to rest upon the bottom of tube a. By reference to Fig. 1 it will be seen that the check-weight arrangement is pivoted by a lug l, projecting from the bottom of tube a, to the base-plate of the apparatus, and that tube c is pivotally connected to one end of the brush-carrier. Thus as the brush-carrier is rocked by the action of the solenoids E F weight w' is actuated in the manner of a piston of a pump, and its weight is increased step by step as it ascends and is decreased step by step as it descends, the increasing and decreasing weight being graduated to correspond to and to counterbalance the increasing and decreasing pull upon the commutator-brushes.

Another form of graduated check-weight is shown in Fig. 11. It consists of a series of graduated weights w' w^2 w^{12} freely piled upon each other, but connected by links $l\,l$ of graduated length, which when the weights come into contact are received in recesses $r\,r$, formed in the faces of the weights, as indicated in dotted lines. The masses of the weights are graduated in the same manner as the corresponding weights shown in Fig. 2, and the lengths of the links are graduated like the distances from each other of the weights shown in Fig. 2. The uppermost weight w' is pivotally connected with the brush-carrier, as shown. The operation of this form of graduated check-weight is very much like that shown in Fig. 2; but it is deemed unnecessary to dwell upon the details of construction, since this check-weight will be made the subject of a separate application.

It is well known that the collecting-brushes bear with considerable force upon the commutators, and the brush-carrier being delicately pivoted there will be a tendency in the commutator to carry the brushes forward by frictional hold upon the same in the direction of rotation. To overcome this tendency I make use of a weight movable to or from the center of the carrier, the arrangement of which is clearly shown in Figs. 9 and 10. The bar Z is fast upon the brush-carrier C, and extends upon a line, or nearly so, radial to the commutator. It is secured at its middle with its two halves extending freely toward and from the center of the commutator, respectively. A sliding weight Z′ can be placed upon either side of the bar and moved from and toward the center of the commutator to compensate a greater or less frictional pull upon the brushes, which depends upon the greater or smaller pressure upon the commutator with which the brush is set. The sliding weight is held in its adjusted position by a set-screw Z^2.

In place of two solenoids E F and their circuit connections numerous other arrangements involving the same principle or similar principles of action may be employed. Some of these forms I will now describe.

In Fig. 3 the solenoid F is modified by making it of two distinct spools, one of coarse wire included in the external circuit between the binding-post N and post O, and the other of fine wire connected in circuit in the same manner as solenoid F, in Fig. 1. The two coils are wound in the same direction, so that the currents passing through the same will coact, the coarse-wire coil exerting a constant pull upon the core. The objection to this form is the liability of the insulation to burn out, owing to the great difference of potential between the coarse and fine wires.

Fig. 4 is another modified form, in which spool F is composed wholly of coarse wire in the external circuit, between the posts N and O, while solenoid E is composed of a coarse and fine wire spool wound in opposition to produce differential action, the coarse wire in this case being connected in the circuit in the same manner as solenoid E in Fig. 1, while the fine-wire coil is in the governing branch, the same as solenoid F in Fig. 1. In this case solenoid F exerts a constant pull upon the brushes sufficient to move the same, when enough current traverses the fine wire on solenoid E to neutralize the pull of the coarse wire.

In the modification shown in Fig. 5 solenoid F is altogether omitted, while solenoid E is constructed with a coarse and fine wire coil, the course wire being in series with the field-magnet and the fine wire being in the shunt, and the current in the same flowing in opposite direction to that in the coarse wire. In this construction the forward movement of the brushes is effected frictionally, which, however, can only take place when the backward pull of the coarse wire is neutralized by the counteracting force of the current in the fine wire, and it will be understood that in this modified form, as well as in others, the check-weight arrangement must not be omitted.

In the arrangement shown in Fig. 6 the shunt-circuit is not used at all. Solenoid F is in the external circuit and exerts a constant forward pull against the opposing pull of solenoid E, which latter being in series with the field-magnets varies in strength with the same. These variations of strength of the field-magnet coils necessitate the moving of the brushes, which in this case should be accurately effected by the corresponding variations in solenoid E; but the greatly varying friction of the parts renders this form of apparatus somewhat objectionable in practice.

In the modification shown in Fig. 7 both solenoid F and the shunt-circuit are omitted. The forward movement of the brushes is effected by friction of the same upon the commutator, and the backward movement is effected by the pull of solenoid E, as in the other forms. The same objections which may be urged against the arrangement shown in Fig. 6 also apply to this form.

Another modification is shown in Fig. 8, where solenoid F is composed wholly of fine wire in the shunt-circuit and acts to move the brushes forward against the pull of the check-weights, which, when there is little or no current in spool F, overcomes the friction of the brushes and moves the brushes backward to the limit of their travel. The operation of this modification is as follows: When the current is started, the resistance of the shunt is at its maximum and but little current can pass through it while the brushes are, as we have seen, back at the limit of their travel, which position they also occupy when there is a full load on the dynamo. If now lamps are switched off or the speed of the dynamo is increased, the regulator will reduce the resistance of the shunt, more current will flow therein, and the strength of the solenoid F will be increased, which will enable it to pull down one end of carrier C and raise the opposite end, to which tube c of the check-weight device is attached. Weight w' will be lifted until it touches in turn weight w^2, and the brushes are thereby moved forward proportionate to the distance between w' and w^2. Thus it will be seen that the distance the brushes are shifted at each step depends upon the distance of one weight from the other, and the change of load in the dynamo which is necessary before the brushes move is directly dependent upon the mass of the weights. I am thus enabled to reduce the sparking to a practical minimum for different loads upon the dynamo by graduating the distances between the successive weights w' w^2, &c., and the masses of said weights. Should more load be thrown off, as by the switching off of other lamps, weight w^2 would be lifted until it came in contact with weight w^3, &c., until, when all the load is off, the brushes are at the limit of their forward movement. Increasing the load of the dynamo will of course reverse this operation.

It will be understood that the devices hereinbefore described may be modified to operate in connection with dynamos regulated by regulating the resistance of the field-magnet coils or with dynamos of the compound type. By a modification of a check-weight device the brushes can be automatically shifted on straight-shunt dynamos; but my present invention does not extend specifically to such modifications, since I propose to claim the same in a separate application.

Having now fully described my invention, I claim and desire to secure by Letters Patent—

1. The combination, in a dynamo-electric generator having a current-regulator in a shunt around the field-magnets, of a brush-carrier controlled by the differential action of the currents in the field-circuit and in the governing-shunt, with a graduated check-weight acting upon the brush-carrier for determining the extent of shift of the brushes for a given change of load, substantially as and for the purpose described.

2. The combination, in a dynamo-electric generator having a current-regulator in a shunt around the field-coils, of a pivoted brush-carrier controlled by the differential action of the currents in the field-circuit and in the governing-shunt, and a pivoted graduated check-weight device acting upon the carrier for determining the extent of shift of the brushes for a given change of load, substantially as described.

3. In an apparatus for controlling the length of spark at the commutators of such dynamo-electric generators, in which the strength of current is governed by a shunt of variable resistance around the field, the combination of a solenoid in the field-circuit adapted to carry the normal current through the field, and a solenoid in the governing branch adapted to carry the maximum current in the latter, with a pivoted brush-carrier controlled by the differential action of the solenoids, and a sliding weight for counteracting the frictional drag of the commutator upon the brushes, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

THOMAS E. ADAMS.

Witnesses:

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A. B. CALHOUN.