(No Model.) 3 Sheets—Sheet 1.

A. G. WATERHOUSE.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 294,169. Patented Feb. 26, 1884.

Fig. 1.

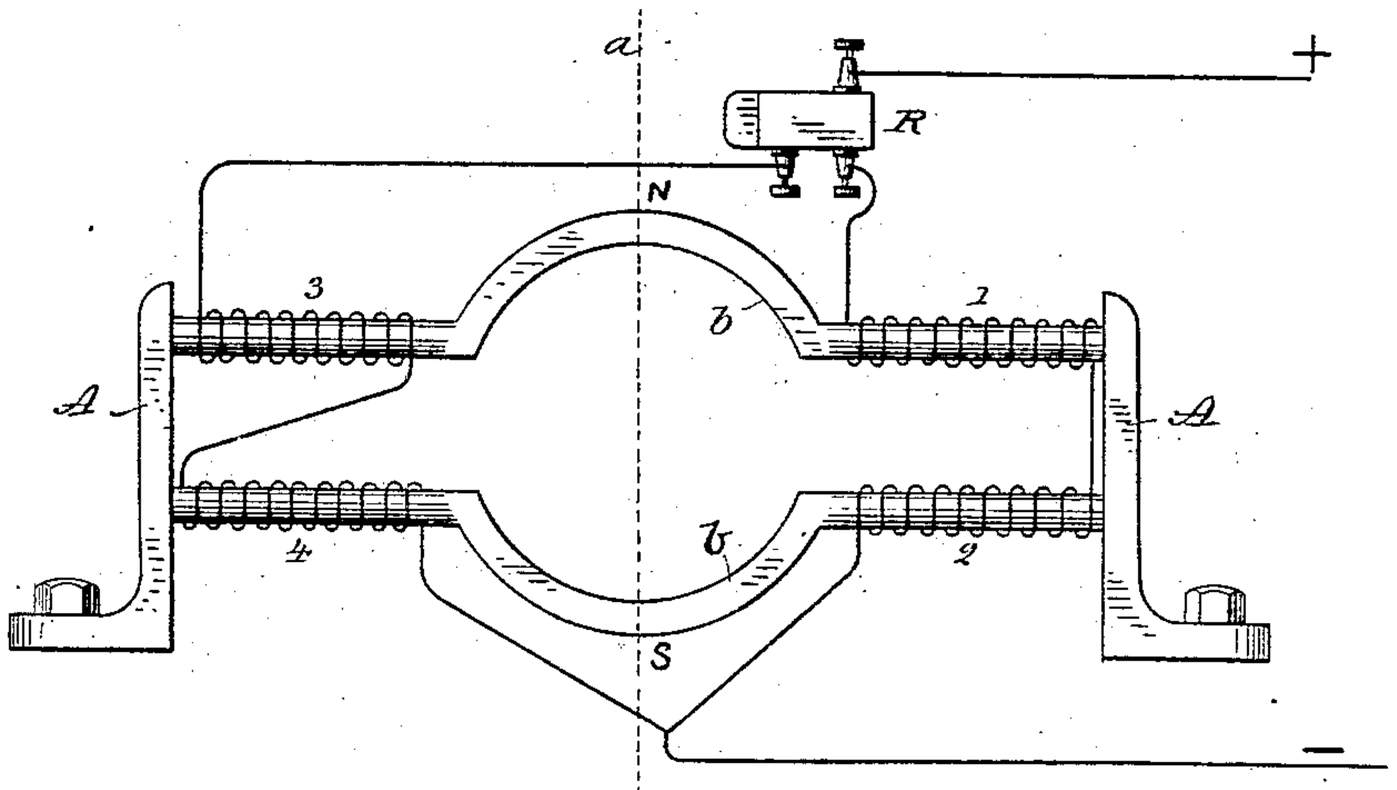


Fig. 2.

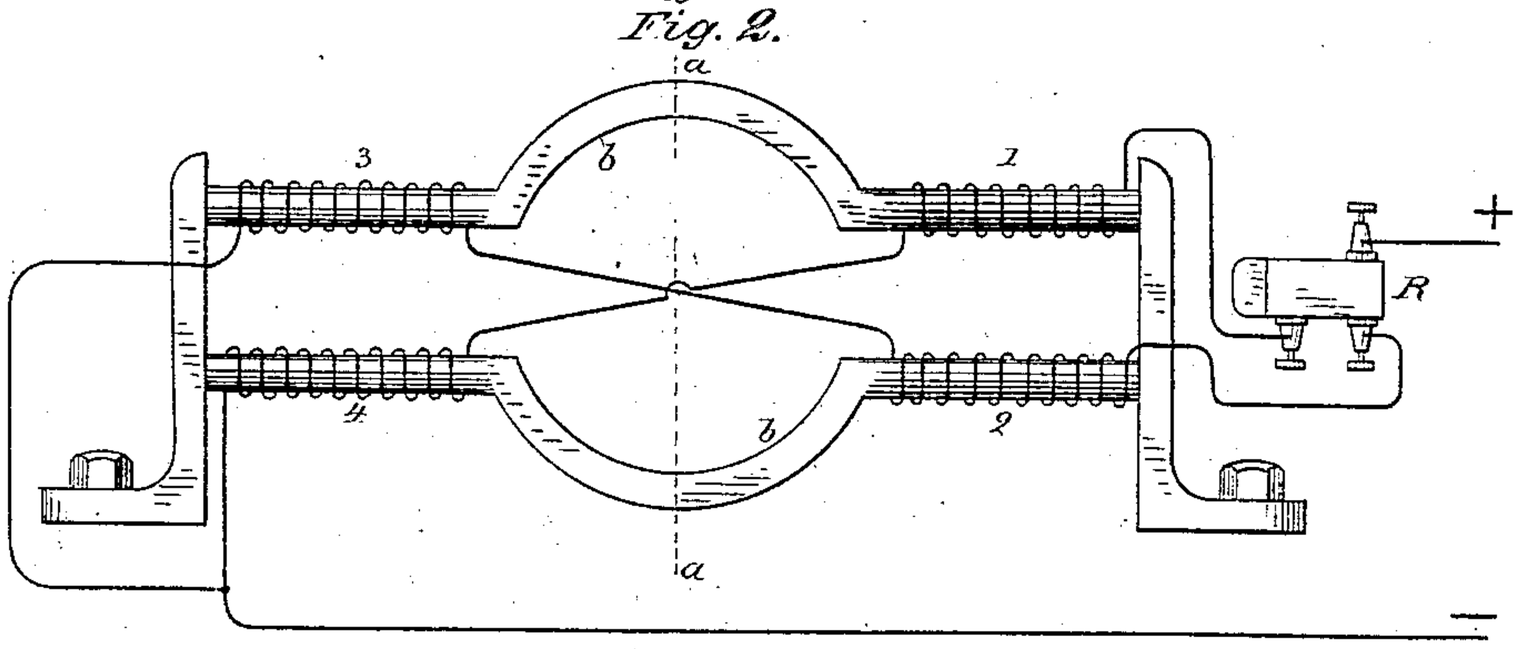
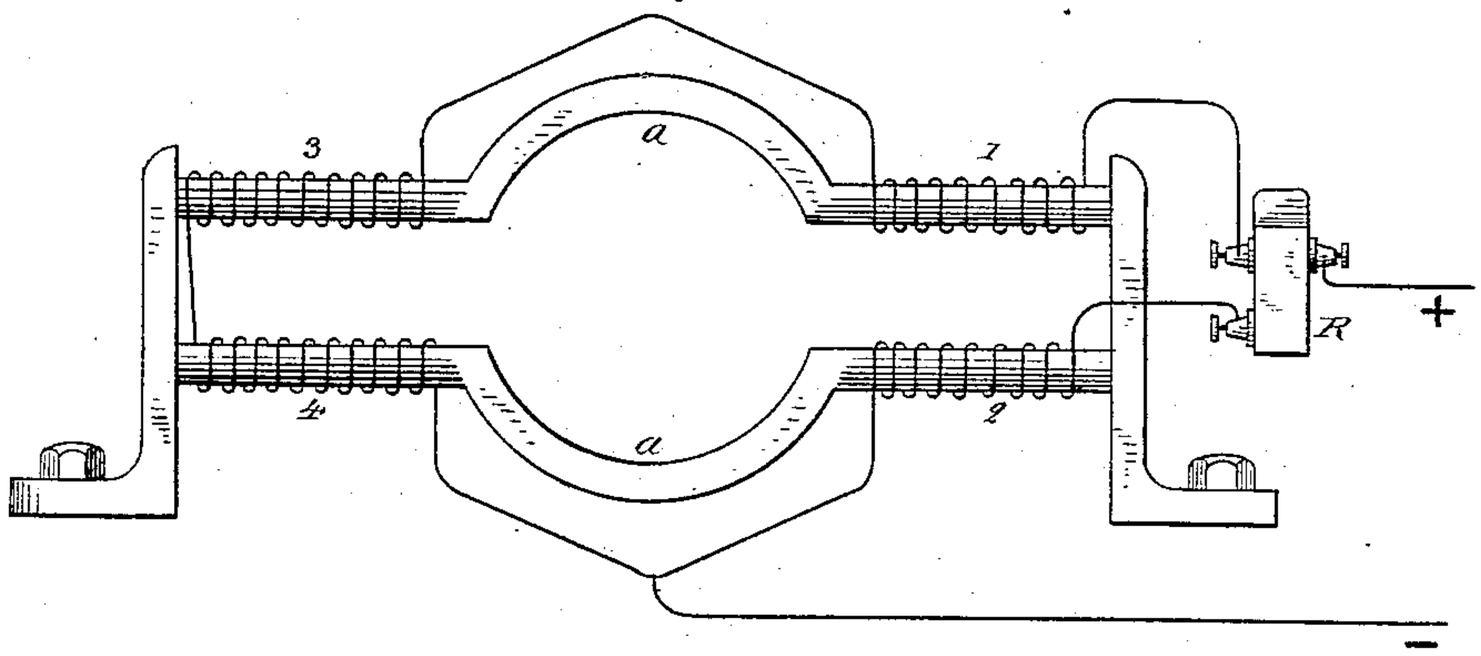


Fig. 3.



Witnesses:
Ernest Abshagen
Thos. Dorney

Inventor:
A. G. Waterhouse
By his Attorney: H. C. Turnbull

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 3 Sheets—Sheet 2.

A. G. WATERHOUSE.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 294,169. Patented Feb. 26, 1884.

Fig. 4.

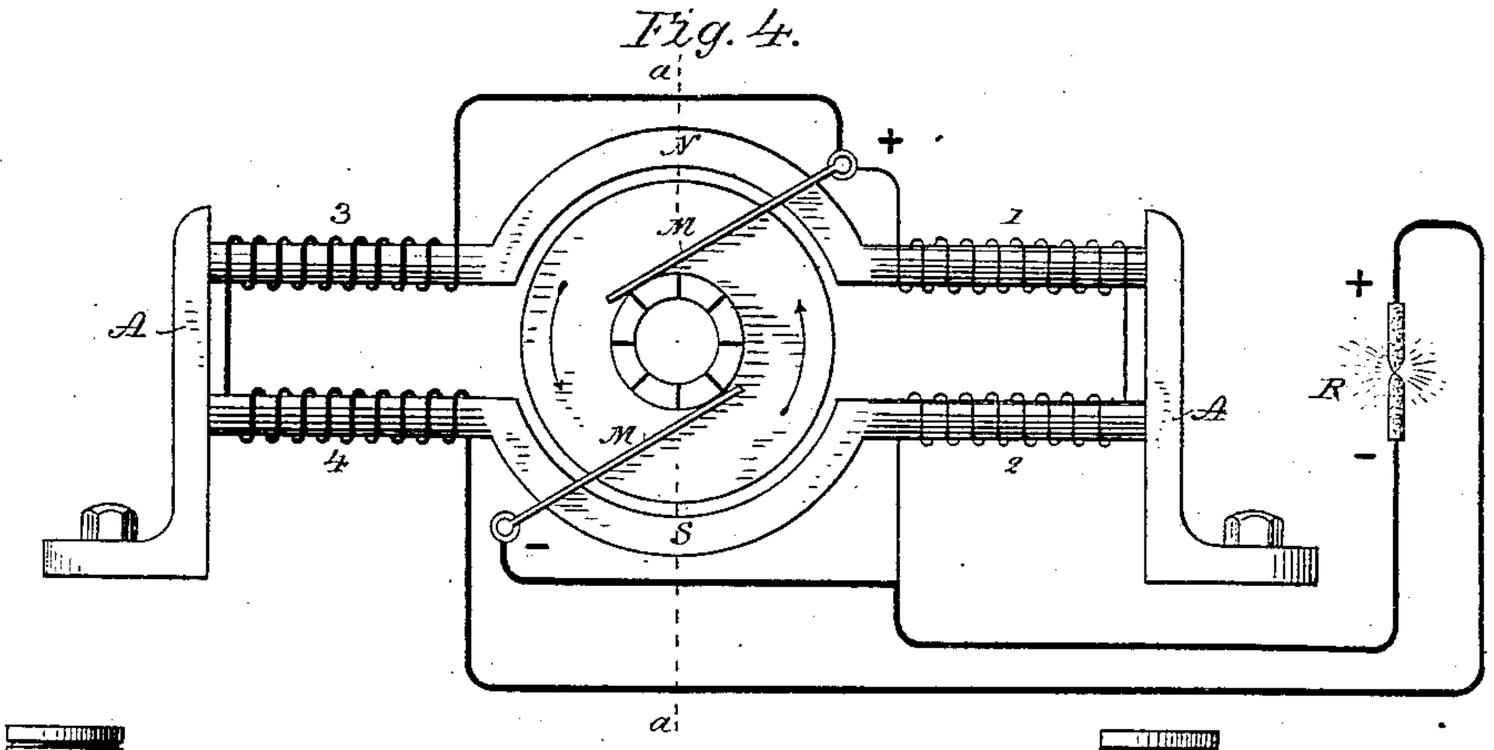


Fig. 5.

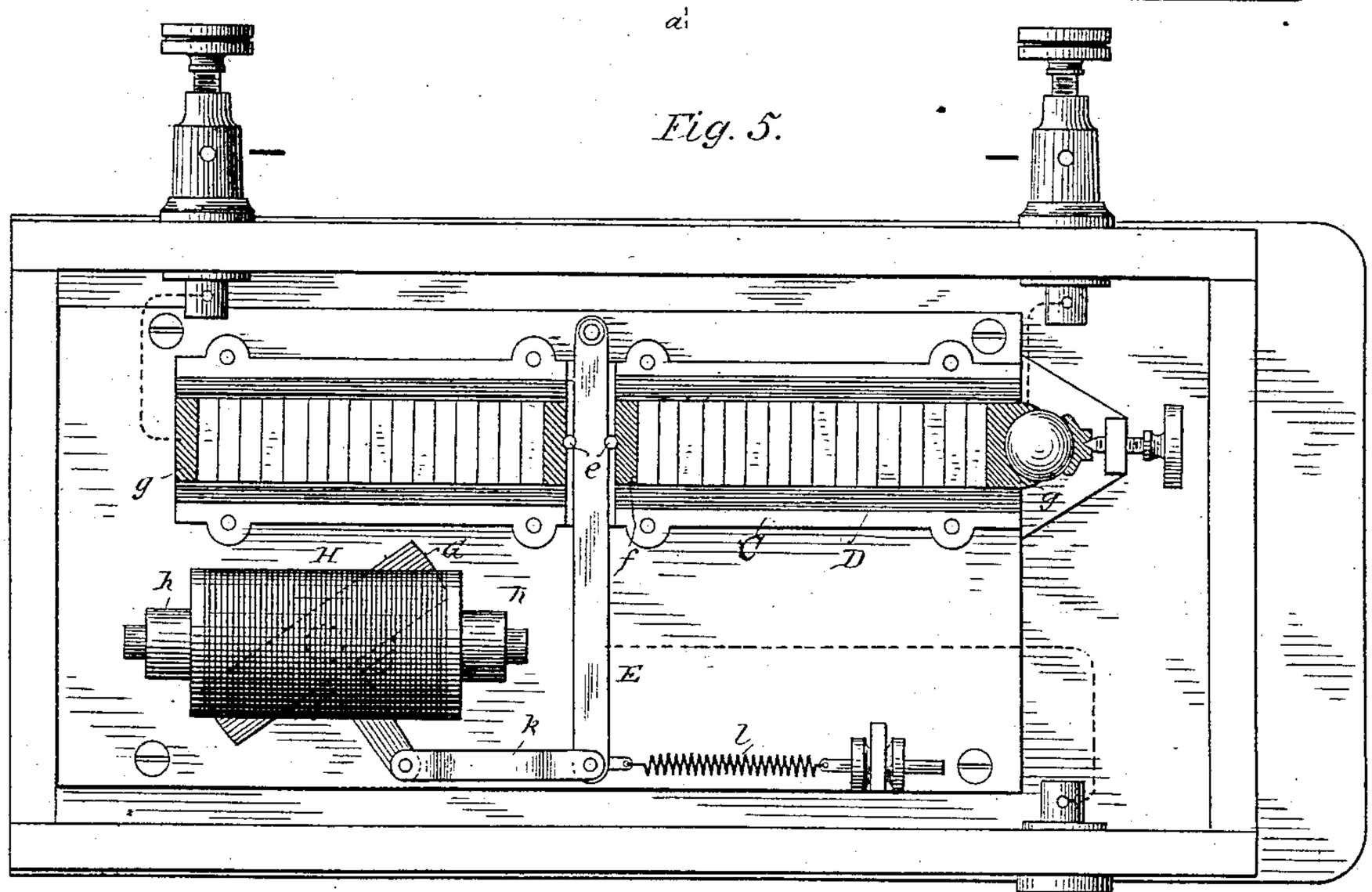
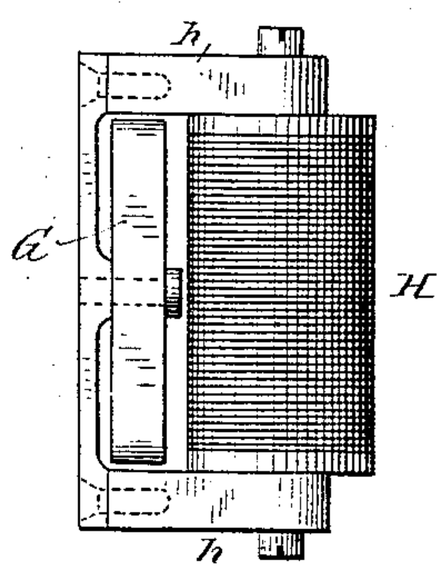


Fig. 6.



Witnesses:
Ernest Abshagen
Thos. Dorney

Inventor:
A. G. Waterhouse
By his Attorney: H. L. Townsend

(No Model.) 3 Sheets—Sheet 3.

A. G. WATERHOUSE.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 294,169. Patented Feb. 26, 1884.

Fig. 7.

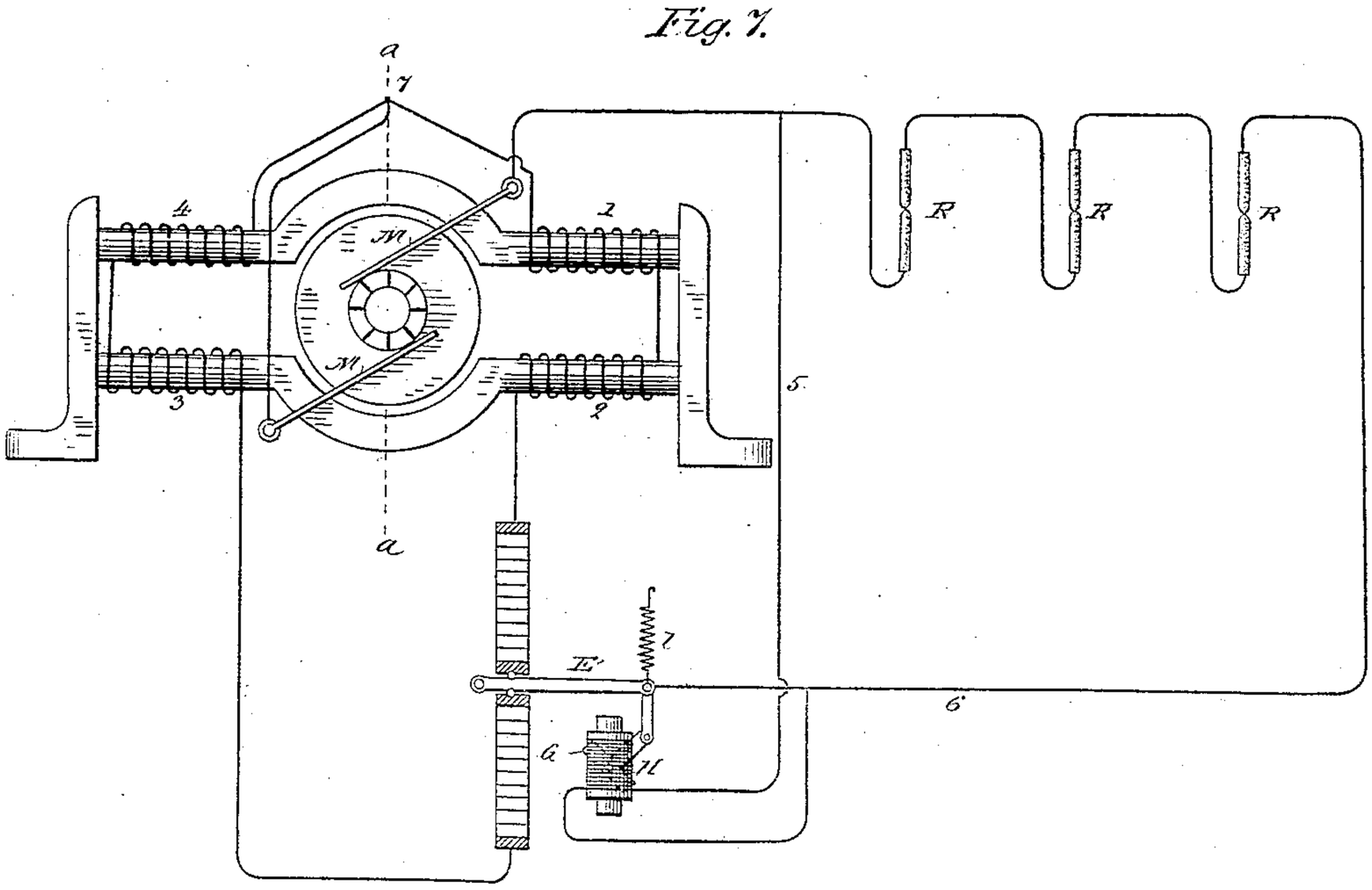
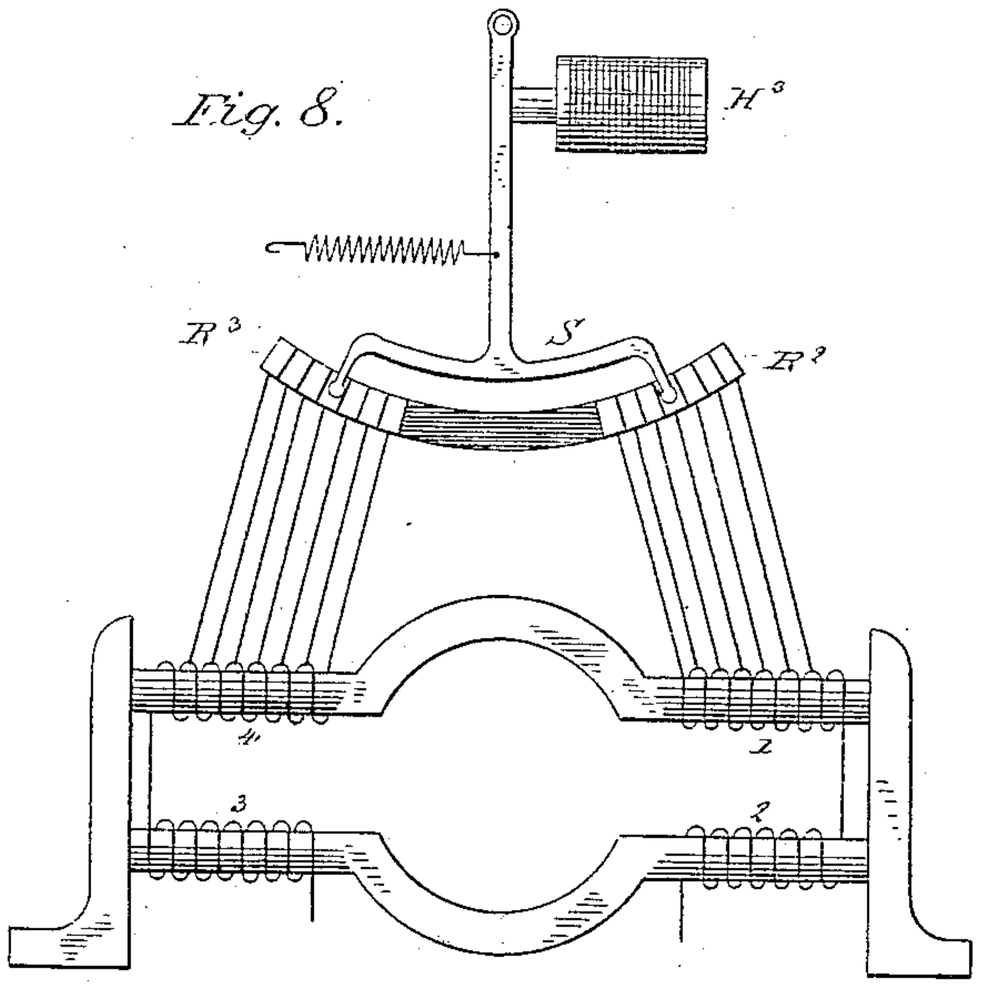


Fig. 8.



Witnesses:
Ernest Abshagen
Thos. Dorney

Inventor:
A. G. Waterhouse,
By his Attorney: H. B. Townsend

UNITED STATES PATENT OFFICE.

ADDISON G. WATERHOUSE, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE SCHUYLER ELECTRIC LIGHT COMPANY, OF SAME PLACE.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 294,169, dated February 26, 1884.

Application filed June 12, 1883. (No model.)

To all whom it may concern:

Be it known that I, ADDISON G. WATERHOUSE, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Regulators for Dynamo-Electric Machines, of which the following is a specification.

My invention relates to the regulation or adjustment of the currents of dynamo-electric machines to suit changes in the external resistance; and it consists in a novel combination of apparatus, whereby the polarity of the field-of-force pole-pieces may be shifted or distorted so as to vary the electro-motive force of the current generated by the armature.

In carrying out my invention, I propose to vary the distribution of the current magnetizing the field-of-force magnets, without, however, increasing or diminishing the total magnetizing-current in such a way as to cause a shifting or distorting of the consequent points in the field-magnet, or the points of greatest magnetization.

My invention is distinguished from other regulators, in that the total magnetizing-current flowing in the field-magnet coils of my machine is constant; but its distribution in the several coils is varied, so as to cause a shifting of the consequent points, whereas in other inventions the strength of the magnetism is varied by increasing or diminishing the magnetizing influences that work upon the field-magnet core to produce magnetism therein. The shifting or distortion of the magnetism, or of the consequent points, may be made to take place in such a way that the two consequent points of an ordinary field-magnet shall approach to or recede from one another; or the two points may be shifted together in the same direction, either forward or back, according to the necessities of the case.

Some of the various ways in which my invention may be carried into practice are shown in the accompanying drawings.

Figures 1, 2, and 3 show in skeleton the frame of a dynamo-electric machine, and illustrate the manner in which the field-magnet coils are subdivided to produce the desired effect. Fig. 4 illustrates a modified manner of carrying out the invention, in which the current-distributing apparatus is dispensed with, and the desired change in distribution of current in the field-magnet coils is effected automatically by the changed relation of the resistances in one set of coils in local or derived circuit, and the other set of coils in main circuit with the working-resistances, which occurs by reason of changes in the number of lamps or other apparatus in circuit. Fig. 5 is a side view, partially in section, of a form of a current regulator or distributer which governs the distribution of current in the field-magnet coils. Fig. 6 is an edge view of the regulator-magnet, Fig. 5. Fig. 7 is a diagram illustrating the arrangement and connection of the complete apparatus. Fig. 8 is a modified plan of varying the distribution of magnetizing-current in the field-coils.

Referring to Fig. 1, A indicates the frame or field-of-force magnet of an ordinary dynamo-electric machine, having the four coils 1, 2, 3, and 4 wound thereon in such manner as to produce the desired consequent poles or points in the field-of-force pole-pieces N S.

R indicates the current-distributer, to be presently described, through which the currents which pass through the several coils 1 2 3 4 are taken. As will be seen, coils 1 and 2 are in one branch and 3 4 in another branch. The regulator R serves to increase the flow in one branch simultaneously and equally with a decrease in the other, and vice versa. This distribution takes place without changing the total amount current flowing in the two branches. Let it be supposed that the consequent points, or the points of maximum polarity, are on the line *a a*, the current flowing in the two branches is equal, and the current generated by the armature is at its maximum. If, now, the current flowing in 3 4 be increased, and the current in 1 2 be simultaneously diminished by R, the consequent points will be shifted toward the points *b b*, and a diminution in the electro-motive force of the current generated will be effected thereby. If, now, the distribution be again changed, so as to tend toward an equality of flow in the two

branches, the consequent points will change back toward their normal point, or the point of greatest efficiency, where the current supplied by the armature is normal.

In Fig. 2 coils 1 and 4 are in one branch and coils 2 and 3 in the other; but the effect is, upon an increase of current in one branch and a simultaneous and equal decrease in the other, to shift the consequent points, or points of greatest magnetization, both in the same direction, but away from the line *a a*, either forward or backward, as the case may be. The result is to diminish the strength of the current supplied or generated by the armature.

In Fig. 3 coils 1, 3, and 4 are supposed to be in one branch and coil 2 in the other. The same effect of a distortion or shifting of the field magnetism would be produced in this case, but the arrangement would be somewhat less efficient than in the previous instances.

In the arrangement of Fig. 3 the resistance of coil 2 should be as nearly as possible the same as that of coils 1 3 4. This may be accomplished in any desired manner known in the art.

Having described the general principles of my invention, I will proceed to describe some of the special means that may be employed for carrying the same into effect.

Fig. 5 shows a current-distributing device arranged to be operated or controlled by an electro-magnet, whereby an automatic regulation may be effected; but it will of course be understood that the current-distributer might be worked by hand without departing from the invention.

Referring to Fig. 5, C indicates a brass or metal tube mounted on a suitable support, and D an interior tube or lining of slate, within which are contained two series of carbon disks or plates, as indicated, between which is supported a lever, E, carrying contact-pins *e*, bearing against terminal plates of the two series, and arranged, as shown, so that if it be moved in one direction it will compress the one series of plates, thus diminishing the resistance therein, while simultaneously the pressure upon the other series will be relieved, thus increasing the resistance in the latter series. One series of these plates is to be included in one of the field-magnet branches, and the other series in the other branch. The electrical connections are made through the lever E to the terminal plates *f f* of the two series of carbon resistances, thence through either one of the series of carbon plates to the terminal plates *g*, and thence by suitable electrical connections to the field-magnet coils.

H indicates an electro-magnet, whose core is provided with the rectangular polar extensions *h*, acting on an armature, G, to swing the same into line with them and parallel to the magnetic axis, said armature being connected by a suitable link, *k*, with the lever E, so as to act on said lever in opposition to a retracting-spring, *l*. When the attraction of the armature and the spring are balanced, the lever E will occupy a central position between the two carbon resistances, the resistances will be equal, and the flow of current through the two field-magnet branches will be the same. Electro-magnet H may be connected to the working-circuit in any suitable manner, so as be affected by changes of working-resistance. By preference it is placed in a derived circuit around the working-resistances. It might, however, be placed in direct circuit or arranged in other ways.

Fig. 7 shows the circuit connections of the magnet, the carbon resistances, and the field-magnet coils and armatures.

R R R indicate the working-resistances—such as electric lamps—and M M the ordinary commutator-brushes of the machine. Magnet H is included in a branch wire, 5, around the working-resistances. The general circuits are as follows: Starting from lower commutator-brush, M, the current divides at 7, one portion passing through coils 1 and 2, and one set of carbon plates, and the other through coils 4 and 3, and through the other set of carbon plates, to lever E, from which connection is made to the general circuit containing the lights R R and back to the other commutator-brush. When the whole number of lamps are in circuit, the amount of current diverted through magnet H is just sufficient to keep the magnetism at its normal, and of such strength as to hold the lever E in position where the resistance of the two portions of the current-distributer will be equal, and the flow of current in coils 1 2 will be equal to that in 3 4. The consequent points will then be upon the normal line *a a*, and the armature will generate its proper amount of current. If, now, the number of lamps be diminished, thus decreasing the resistance, less current will flow in magnet H, and the lever E will be acted upon by its retractor in such way as to decrease the flow of current in one field-magnet branch and simultaneously increase it in the other, so as to cause a shifting or distortion of the points of greatest magnetization. The effect of this will be, as before explained, to cut down the electro-motive force, to correspond with the diminution of external resistance. On the other hand, if the number of lamps be now increased to the original number, more current will flow in H, and the distribution of current in the two branches will return to its normal. When the field-coils are wound in two sets, arranged as in Fig. 2, the current-distributer is so arranged as to shift the consequent points backward, or in the direction reverse to the direction of revolution of the armature, when the number of lamps increases and the electro-motive force or current strength is to be diminished.

I do not limit myself to any particular method of distributing or varying the relation of

the currents flowing in the two branches; and I may, instead of varying the resistance in a field-magnet circuit, vary the number of magnetizing-coils in circuit by such an arrangement as is shown in Fig. 8. In this arrangement loop-connections are taken from the field-magnet coils to sets of insulated plates R^2 R^3, over which move a circuit-closing arm, S, actuated by the core of a magnet, H^3, or by any other suitable means. When the magnet H^3 and the retractor for S are balanced, the circuit-closer S occupies such a position that the number of magnetizing-helices in 1 will be the same as in 4, the circuit being taken, as indicated, to S, from which it branches to the coils 1 and 4 through the contact-plates R^2 R^3. If the arm S be moved to one side or the other, the number of coils or convolutions in one field-magnet bobbin will be increased, while, simultaneously, the number in the other will be decreased, and the same effects may be produced as when the flow of current in two coils the convolutions of which are all in circuit is varied by the adjustable resistance.

I have herein described the current-distributing device as arranged in direct circuit with the field-magnet coils; but it is obvious that it might be arranged to shunt or divert the current from such coils. I have also described the field-magnet coils as in circuit with the working-resistances; but they might obviously be arranged in derived circuit and the current distributed through them in the manner hereinbefore set forth.

To effect an automatic change in the relation of magnetizing effects in the various field-coils, any other means or any other controlling or operating devices might be used, provided they be properly arranged to respond to variation of resistance in the working-circuit. In Fig. 4 the distribution is effected automatically, without the use of resistances or additional appliances, by merely modifying the winding of the field-magnet coils of the machine. In this case one pair of coils on a field-magnet is arranged in a derived circuit around the working-resistances, and the other in a direct circuit with them. Thus coils 1 and 2 are in a derived circuit, and coils 3 and 4 in the working-circuit, as indicated. The effect of this is that when the working-resistance diminishes less current flows in coils 1 and 2 and more in coils 3 and 4, so that, all of said coils being arranged to produce magnetism in the ordinary way, the consequent points, or points of greatest magnetization, will be shifted or distorted. If the coils were divided, as in Fig. 2, and coils 1 and 4 were placed in the derived circuit, the effect would be, upon a diminution of working-resistance, to shift the consequent poles backward in a direction contrary to the direction of revolution of the armature, and the electro-motive force would be diminished correspondingly. If, now, lamps or other devices be introduced into circuit, so as to raise the resistance to its normal, the flow in 1 and 4 will increase and in 2 and 3 diminish, thus restoring the polar conditions of the magnet to their proper state. The coils in the derived circuit are of fine wire, and are sufficient to produce magnetism, or to have the same magnetic effect under normal conditions of the working-circuit, as the main-circuit coils. In this case, as before, it will be observed that the regulation is effected, not by changing the total magnetizing-current for the field-magnet coils, but merely by changing or varying the distribution of the magnetism in the field-magnet, without necessarily varying its strength.

I make no specific claim herein to the arrangement shown in Fig. 4, as it forms the subject of a separate application for patent filed by me June 12, 1883, Serial No. 97,861. It is merely described herein as illustrating one of the ways in which the broad invention herein claimed may be carried out. Nor do I make any specific claim herein to shifting the consequent points, or points of greatest magnetization, backward or forward simultaneously in the same direction, as this also will be claimed specifically in another application, although it is one phase of the broad invention herein claimed.

What I claim as my invention is—

1. The combination, with a dynamo-electric machine having two field-magnetizing current coils or sets of coils working in harmony to produce the field magnetism in which the armature moves, of means for increasing one magnetizing-current and simultaneously decreasing the other magnetizing-current to the same extent, so as to keep the total magnetizing influence of the currents or coils the same, whatever the adjustment, but at the same time to shift the poles of the field-magnet.

2. The combination, with a dynamo-electric machine having two paths or circuits in its field-magnet carrying currents that act in conjunction in producing the field magnetism, of means for increasing the flow of the current in one circuit and simultaneously decreasing the flow in the other to the same extent, without varying the total magnetizing-current, substantially as and for the purpose described.

3. The combination, with a dynamo-electric machine having two field-magnet circuits, of a reciprocating adjustable resistance device interposed in said circuits, and arranged and constructed in the manner described, to increase the resistance in one circuit simultaneously with producing a decrease in the other, without, however, disturbing the total amount of current-circulation in the two circuits.

4. The combination, in a dynamo-electric machine, of two field-magnet circuits and an automatic current-distributer, whereby the magnetizing effects of one circuit may be increased simultaneously with a corresponding decrease in the other circuit, as and for the purpose described.

5. The combination, with a dynamo-electric machine, of two sets of field-magnet circuits

carrying currents that act in conjunction to produce the field magnetism in which the armature moves, and a current-regulator for increasing the magnetizing action in one circuit and simultaneously and to the same extent decreasing the magnetizing effects in the other, and vice versa.

6. The combination, with two sets of field-magnet coils acting in conjunction to produce consequent polarity in the field-of-force pole-pieces, of two adjustable resistances, one for each set, and means for increasing one resistance and simultaneously and to a corresponding extent decreasing the other.

7. The combination, with two sets of field-magnet coils, of the two carbon resistances and the intermediate pressure-bar, E, as and for the purpose described.

Signed at New York, in the county of New York and State of New York, this 4th day of June, A. D. 1883.

ADDISON G. WATERHOUSE.

Witnesses:
THOS. TOOMEY,
ERNEST ABSHAGEN.