(No Model.)

4 Sheets—Sheet 1.

W. SEAFERT.

DYNAMO ELECTRIC MACHINE.

No. 414,659. Patented Nov. 5, 1889.

Fig. 1.

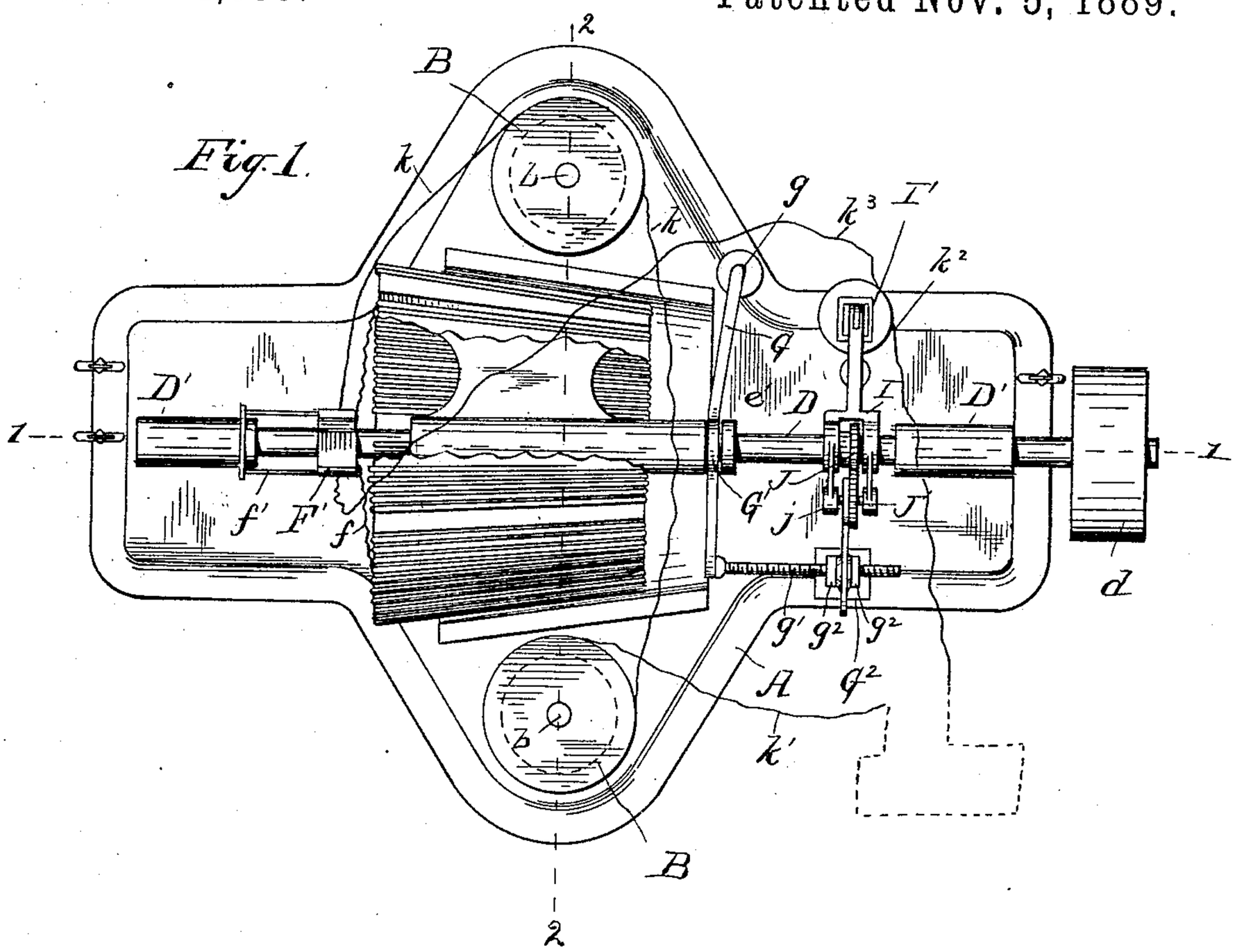
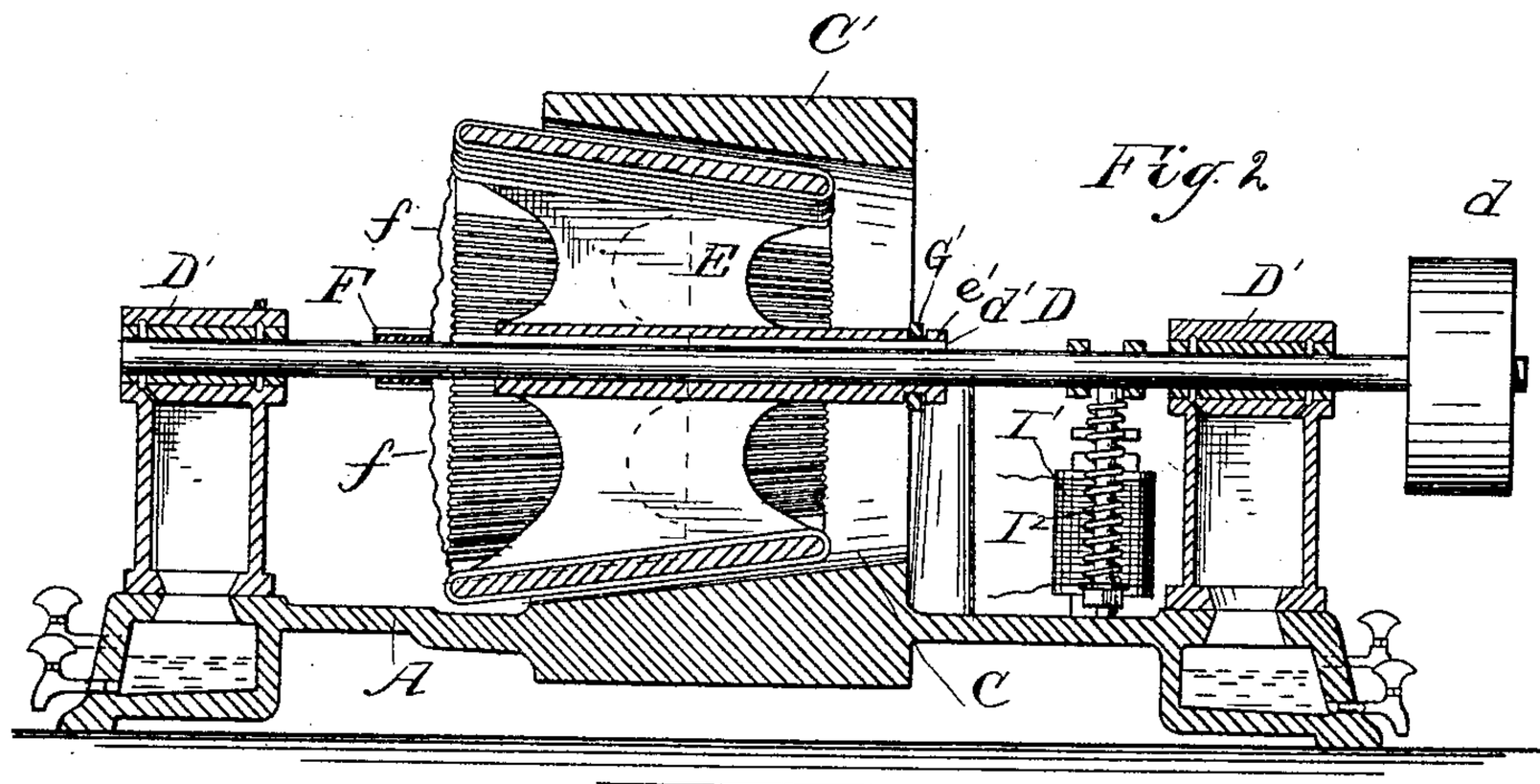


Fig. 2.



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(No Model.)

4 Sheets—Sheet 2.

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DYNAMO ELECTRIC MACHINE.

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Fig. 3

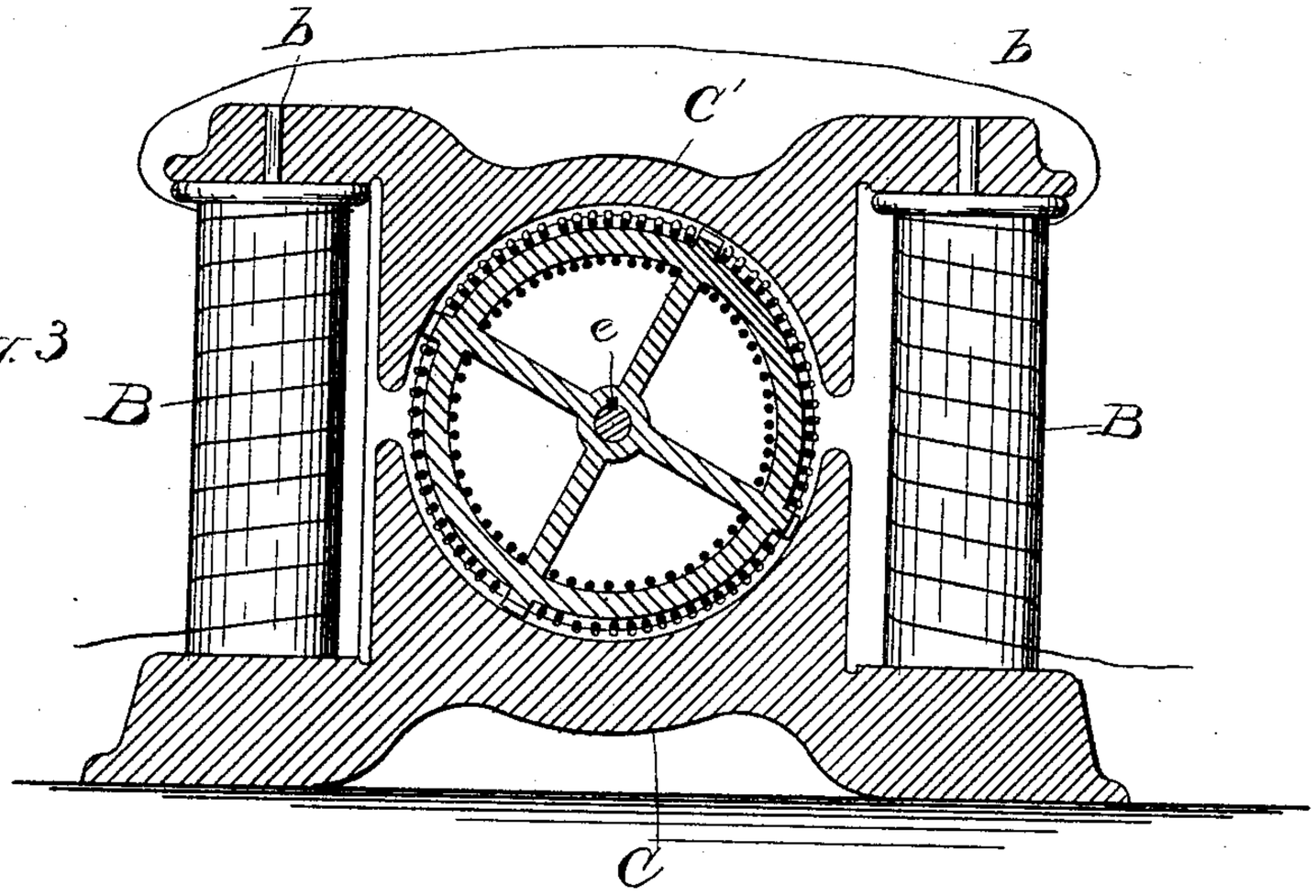
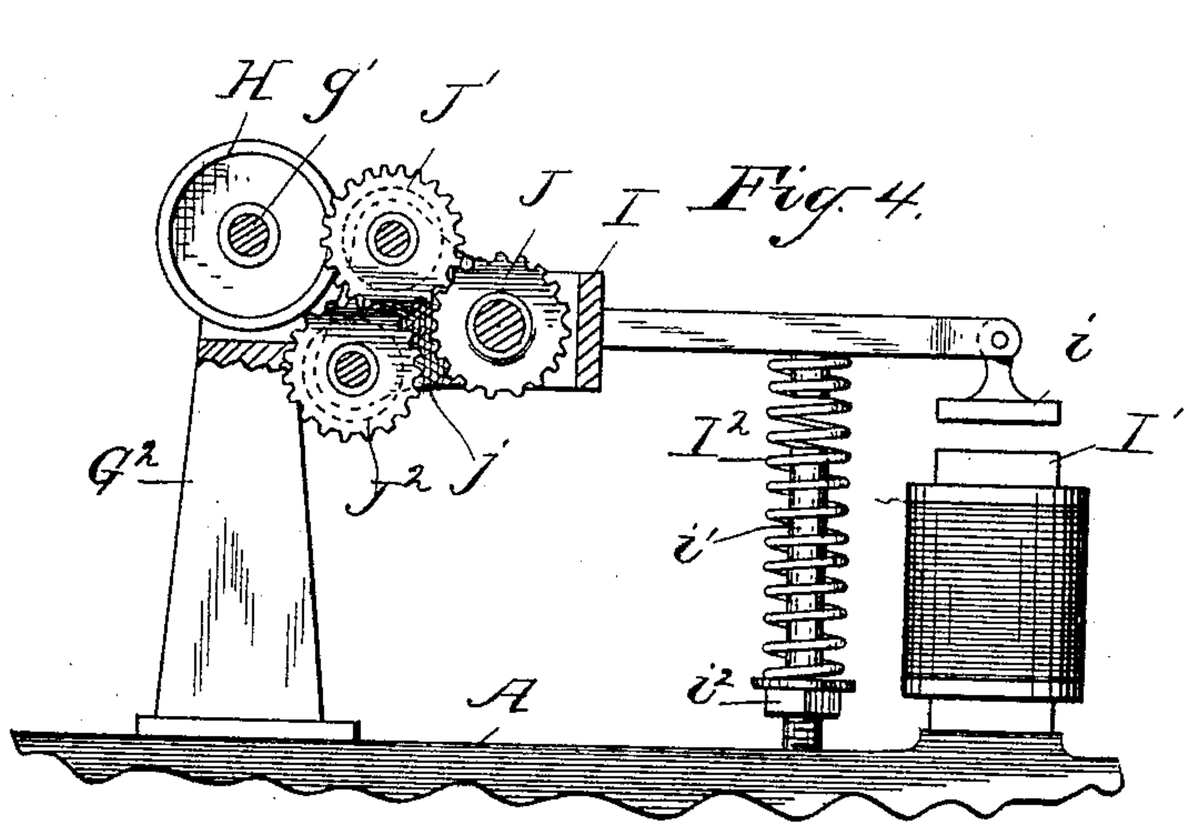


Fig. 4.



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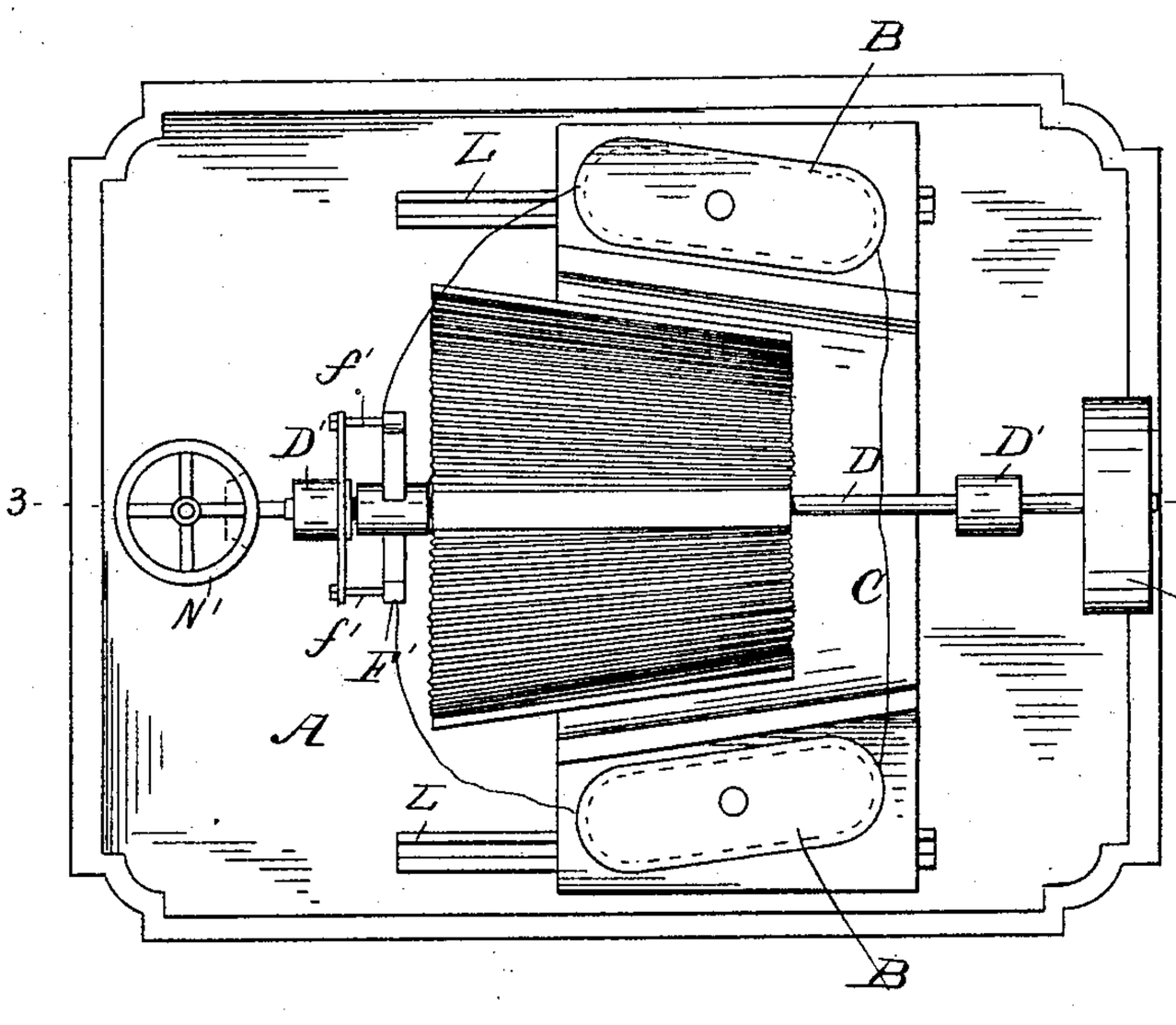

Fig. 6.

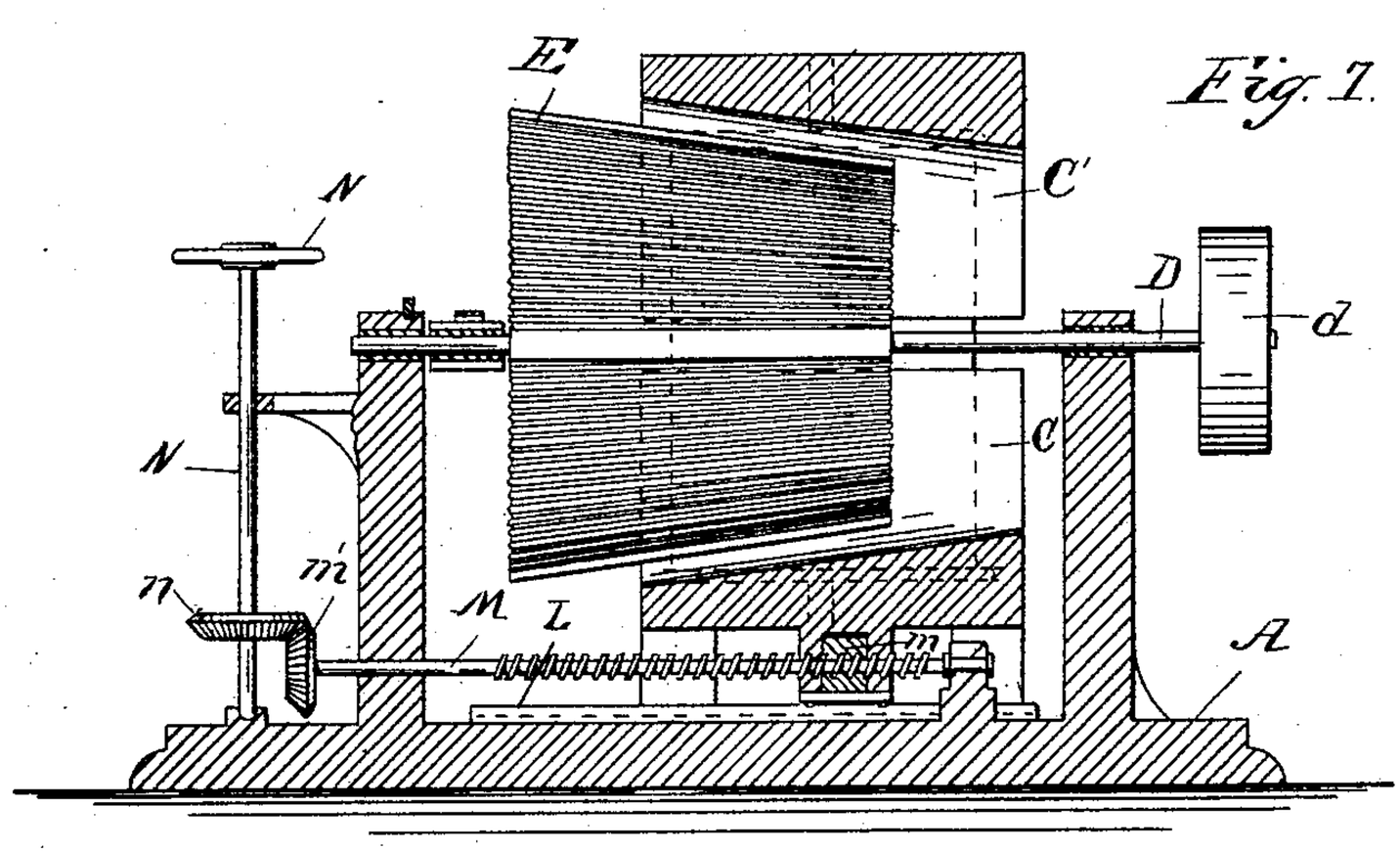

Fig. 7.

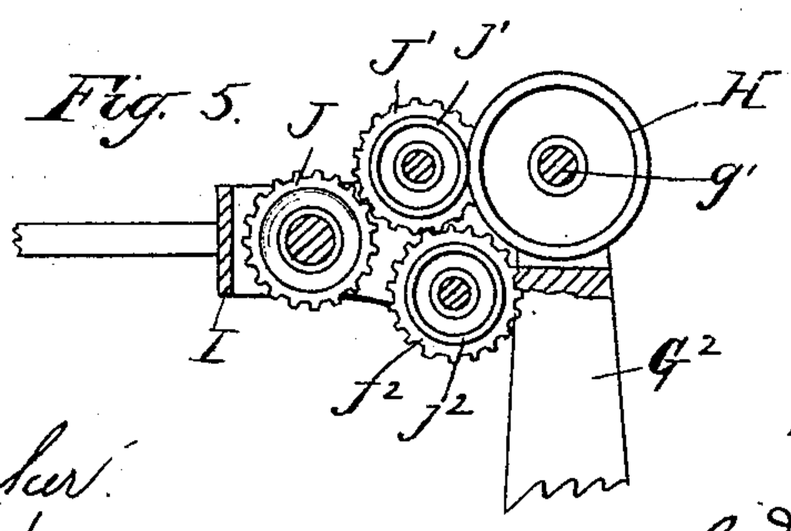

Fig. 5.

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DYNAMO ELECTRIC MACHINE.

No. 414,659. Patented Nov. 5, 1889.

Fig 8

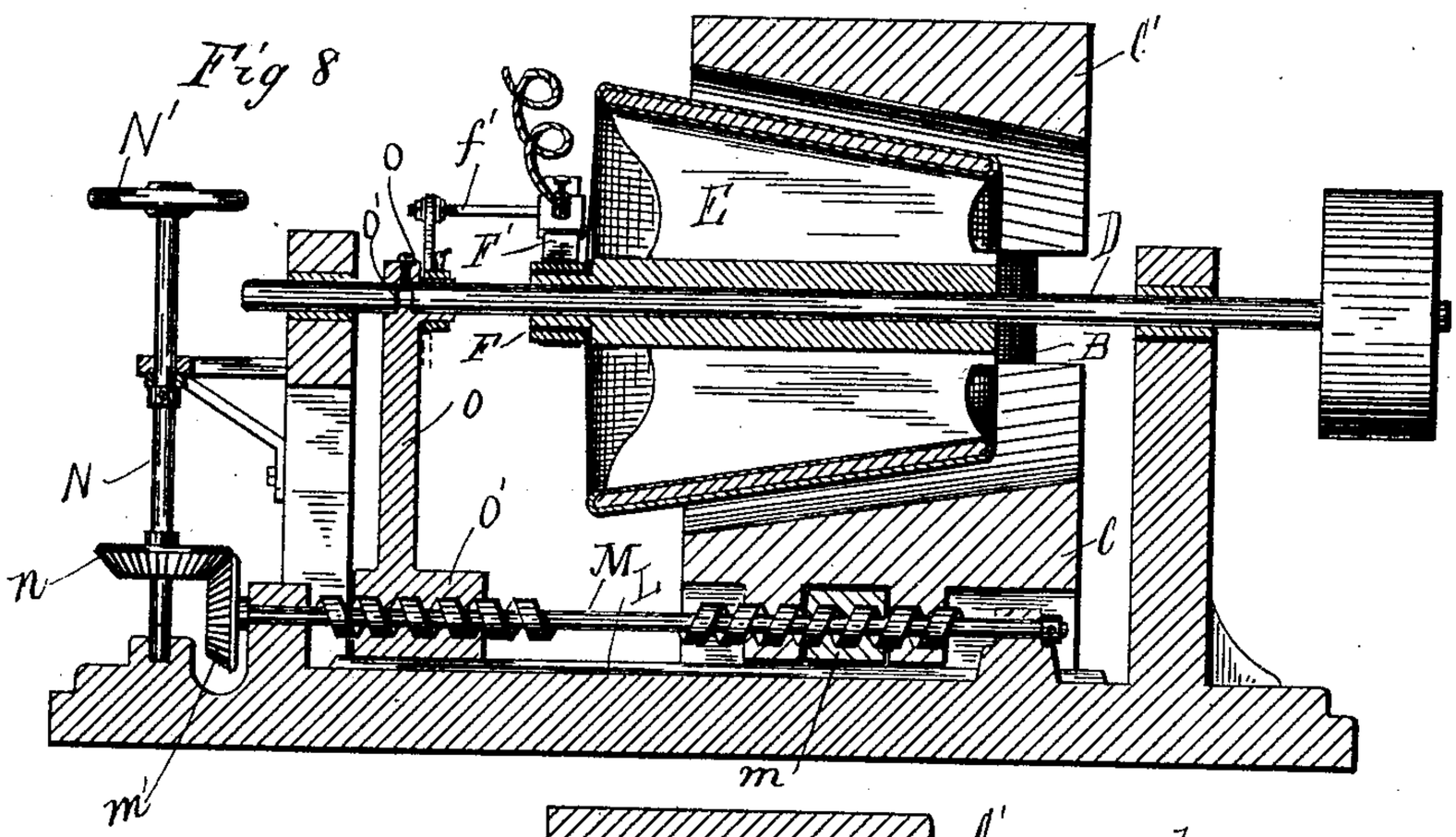


Fig 9

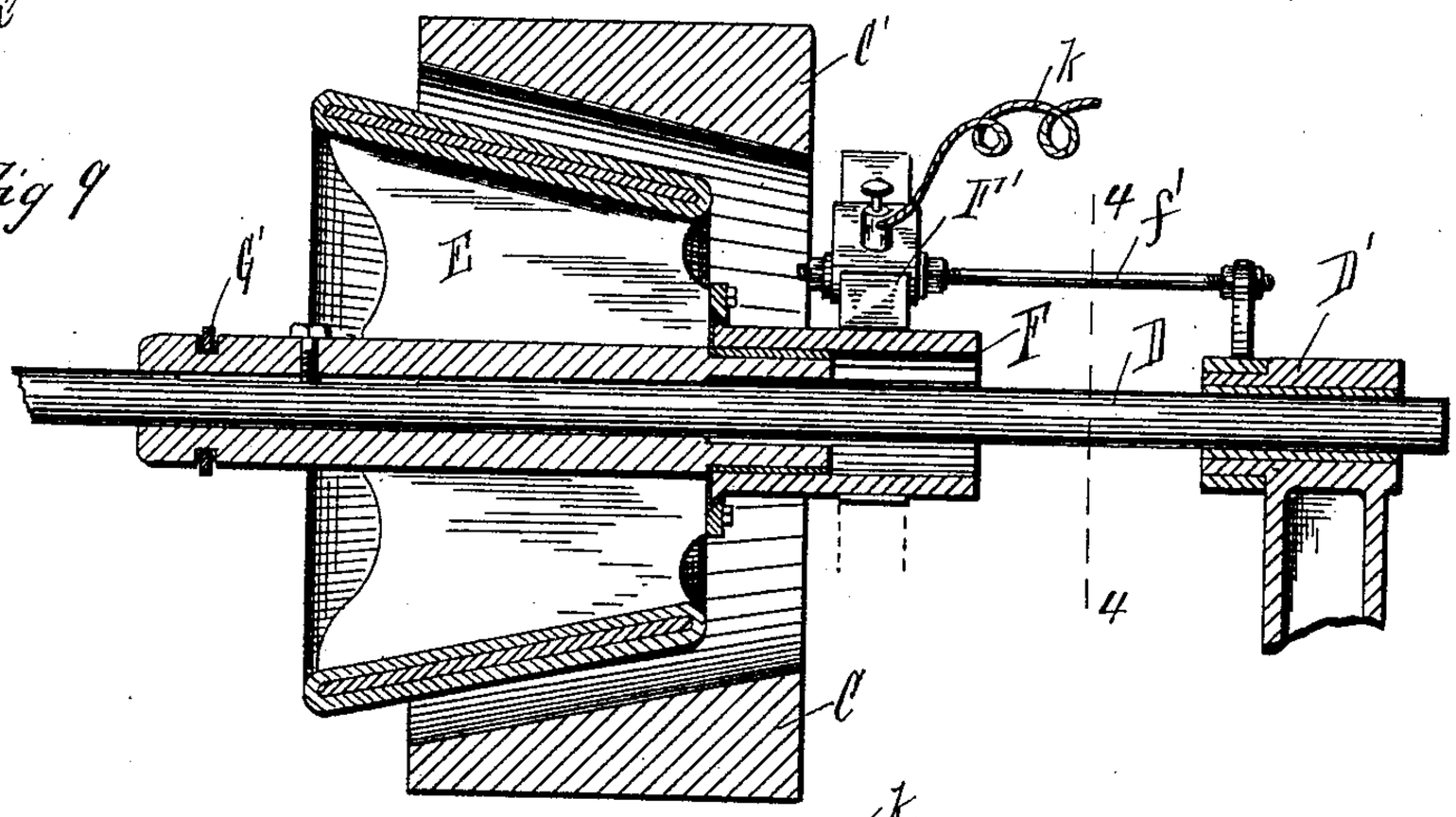
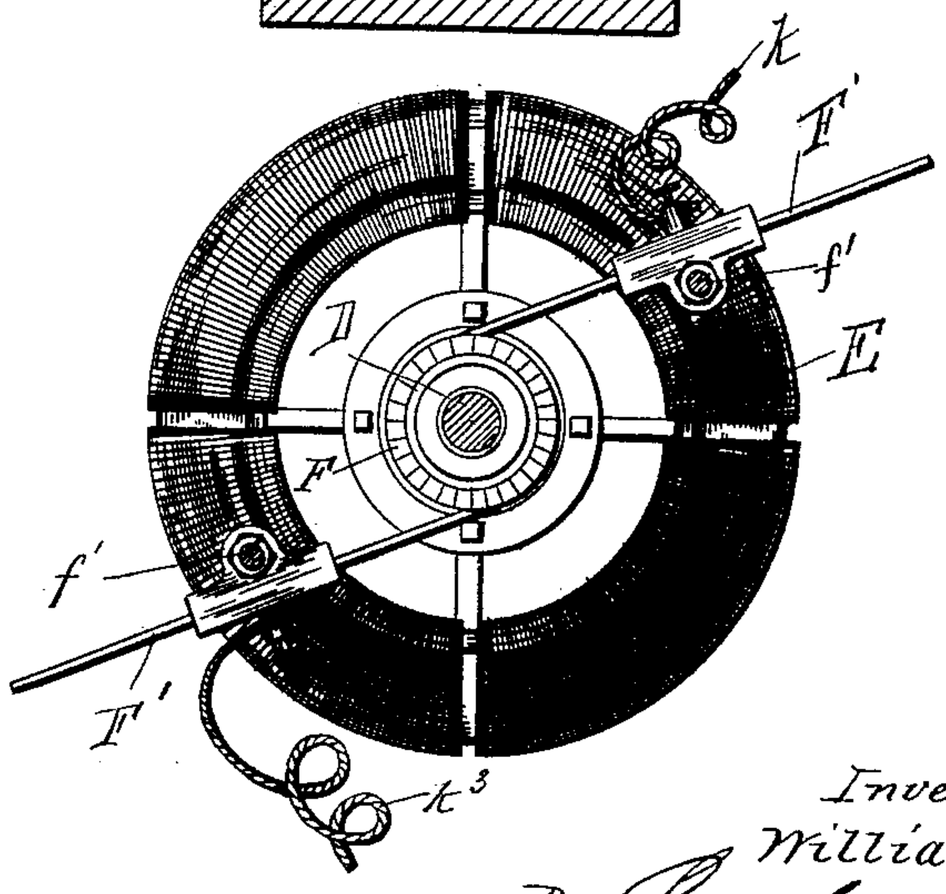


Fig 10



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UNITED STATES PATENT OFFICE.

WILLIAM SEAFERT, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-FOURTH TO FRANK M. STAPLES, TRUSTEE, OF SAME PLACE.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 414,659, dated November 5, 1889.

Application filed September 10, 1888. Serial No. 285,083. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM SEAFERT, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Dynamo-Electric Machines, which is fully set forth in the following specification, reference being had to the accompanying drawings, in which—

Figure 1 is a plan view of an apparatus embodying my invention, the upper pole-piece being removed; Fig. 2, a sectional view of the same taken on the line 1 1 of Fig. 1; Fig. 3, a sectional view taken on the line 2 2 of Fig. 1; Fig. 4, a detail sectional view showing the mechanism by means of which the armature is moved; Fig. 5, a similar view taken from the opposite side; Fig. 6, a plan view of a modified form of apparatus, the upper pole-piece removed; Fig. 7, a sectional view taken on the line 3 3 of Fig. 6; Fig. 8, a view similar to Fig. 7, showing another modification; Fig. 9, a sectional view similar to Fig. 2, and illustrating a modification of the construction therein shown; and Fig. 10, a detail sectional view taken on the line 4 4 of Fig. 9, the field-magnets and pole-pieces being omitted.

Like letters refer to like parts in all the figures of the drawings.

My invention relates to dynamo-electric machines, and has for its object to produce an apparatus of this description capable of use either as a generator or as a motor, wherein the electro-motive force may be regulated with great nicety and without the disadvantages attendant upon the ordinary methods employed for this purpose.

To this end my invention consists in certain novel features, which I will now proceed to describe, and will then particularly point out in the claims.

I will first describe a construction embodying my invention as applied to a dynamo-electric machine of any well-known type, wherein an armature is caused to revolve between the pole-pieces of suitable electro-magnets, premising that my invention is in no way limited to that particular type of machine, but is equally applicable to other well-known forms.

In the drawings, A represents a suitable base, upon which are mounted the magnets B.

C and C′ represent the pole-pieces, the former being in the present instance formed in one piece with the base, and the latter being mounted on top of the magnets B and connected thereto by suitable pins *b*. In this construction the position of the pole-pieces is such that one is above and the other below the armature, which is inclosed between them.

D represents the armature-shaft, provided with a suitable driving-pulley *d*, and mounted in suitable bearings D′.

E represents the armature, which is mounted on the shaft D, so as to rotate along with said shaft, but at the same time be free to move longitudinally thereon in case the said shaft has no endwise motion, as in the construction shown. This result may be effected by means of a spline *d′* on the shaft, which enters a corresponding groove *e* in the hub of the armature. The armature-shaft D may be, of course, capable of longitudinal motion, if desired, in which case the armature will be fixed thereon.

The armature E may be of any suitable construction so far as its structural elements are concerned, my present invention relating solely to the external configuration thereof. As to this latter feature, the armature may be described as being of a varying diameter from end to end, the diameter decreasing gradually from one end to the other thereof. The form which I prefer is that which is shown in the drawings, in which the armature has the form of the frustum of a cone, or in the case of an armature of a radial structure the form will be such that the armature will describe in its revolution the frustum of a cone. The diminution of the diameter of the armature may be a step-by-step diminution, but this is obviously an equivalent of the frusto-conical shape shown, since the latter may be considered as composed of an infinite number of infinitely small steps. The pole-pieces C and C′ are shaped to conform to the shape of the armature or to the body generated by the revolution thereof—in other words, their surfaces may be said to be parallel to the surface of the armature—and they inclose and

define a space or field of force which liminishes in diameter from end to end, and which in the construction shown has a frusto-conical form proportionate in its dimensions to that of the armature.

F represents the commutator, which in the present instance is shown as mounted rigidly on the shaft D and connected to the armature by flexible wires *f*, so that the armature may be moved relatively to the commutator without affecting the connection between the two. The brushes F′ are of any suitable construction, and are shown in the present instance as supported by a fixed yoke *f′*, mounted on one of the bearings D′. These connections may be effected in various other manners—as, for instance, by elongating the commutator and causing it to move with the armature—such a construction being shown in Figs. 9 and 10 of the drawings, in which the elongated commutator is shown as connected to the hub of the armature.

It will be seen from the preceding description that the armature is free to move in the direction of its axis of rotation. Various means may be employed, either automatic or under the control of the operator, for effecting this movement. In the present instance I have shown an automatic mechanism controlled by the current for effecting this result.

G represents a lever pivoted on a suitable support *g* and provided about midway of its length with a yoke G′, which embraces a groove *e′* in the hub of the armature E. A screw *g′* is attached to the free end of the lever G and passes through suitable guide-bearings g^2 on a support G^2, mounted on the base A.

H represents a friction-wheel threaded internally to correspond with the screw *g′*, and mounted on said screw between the bearings g^2, so that the rotation of said friction-wheel in one direction or the other will move the screw *g′* one way or the other.

I represents a yoke-lever mounted loosely on the shaft D as a fulcrum, and provided at one end with an armature *i*, below which is located an electro-magnet I′, arranged in the main or in a shunt circuit.

I^2 represents a spring arranged to thrust the lever I normally upward and move the armature *i* thereof away from the electro-magnet I′. This spring is preferably a coiled spring mounted on a supporting-rod *i′*, which rod is threaded at its lower end to receive a nut i^2, by means of which the pressure of the spring I^2 may be adjusted.

J represents a gear-wheel secured on the armature-shaft D, between the arms of the lever I.

J′ and J^2 represent gear-wheels mounted in the yoke *j* of the lever I, and meshing with each other, while one of them—in the present instance, the gear-wheel J′—meshes with the gear-wheel J, so that the said gear-wheels J′ and J^2 revolve in opposite directions. The gear-wheel J′ is provided with a friction-wheel *j′*, and the gear-wheel J^2 is provided with a similar friction-wheel j^2, said friction-wheels being so arranged that as the lever I is moved upon its fulcrum either one of said friction-wheels may be brought into contact with the friction-wheel H to rotate the same. The connections may be as shown in Fig. 1, a wire *k* leading from one of the brushes to the field-magnets, and a wire *k′* leading from these latter to the outer circuit. A return-wire k^2 leads to the electro-magnets I′, and a wire k^3 leads from said magnet to the other brush, thus completing the circuit.

The apparatus thus organized operates in the following manner: Let it be supposed that the armature is rotating and furnishing the normal output, which is sufficient for the purposes required. When this condition of affairs obtains, the current passing through the electro-magnet I′ causes said electro-magnet to just balance, by its attraction of the armature *i*, the force of the spring I^2. The lever I is therefore held in such a position that neither of the friction-wheels *j′* or j^2 is in contact with the friction-wheel H. When from any reason—such, for instance, as the increase in the number of elements in the circuit—a larger output of electrical energy is called for, there will be a corresponding decrease in the strength of the current passing through the electro-magnet I′. This decrease will permit the spring I^2 to vibrate the lever I upon its fulcrum, and thereby bring the friction-wheel *j′* into contact with the friction-wheel H. A rotary movement will thus be imparted to the said wheel H, which will effect a movement of the screw *g′* to the right in Fig. 1, which movement will be transferred through the medium of the lever G to the armature E, and the armature will also be moved to the right. Owing to the conformation of the armature and of the pole-pieces of the field-magnets, hereinbefore described, this movement of the armature will bring its peripheral surface nearer to the surface of the pole-pieces, and the armature will thus be caused to cut a greater number of lines of force, thereby increasing the output. When the armature has been moved sufficiently close to the pole-pieces of the field-magnets to bring the current up to its normal strength, the electro-magnet I′ will again overcome the pressure of the spring I^2, and the lever I will resume its normal position, thus arresting the longitudinal movement of the armature. Conversely, when the strength of the current is too great, the electro-magnet I′ will draw the armature *i* farther down against the action of the spring I^2, and will bring the lower friction-wheel j^2 into contact with the friction-wheel H. This latter will then be rotated in the opposite direction to that previously described, and, through the medium of the connecting mechanism, will move the armature along its shaft in the opposite direction, or to the left. It will be seen at once that this motion of the armature will increase the distance between its peripheral surface

and the surface of the pole-pieces of the field-magnets, whereby the armature will cut a less number of lines of force, and the strength of the current will be correspondingly reduced until it reaches the normal strength, when the electro-magnet and spring will again balance each other, and the armature will remain stationary, so far as longitudinal motion is concerned. It will thus be seen that with the construction which I have devised the armature may be made to cut a greater or a less number of lines of force in the magnetic field in a given time without necessarily changing the number of its revolutions, or, in other words, its speed, and this result may be accomplished either at the will of the operator or automatically. In the case of a motor the armature may be caused to be acted upon by a greater or less number of lines of force, and the power of the field-magnets may be increased or decreased, as is necessary. In either case the apparatus will be caused to yield just the amount of mechanical or electrical energy it may be called upon to furnish, thus establishing a mutual and dependent relation between the generator and motor, or between the generator and any other element or elements in the external circuit employed in converting electrical energy into light, heat, or mechanical motion. Thus two or more motors or other elements may be operated in series, and the motor or element most distant from the source of energy may be operated to consume the most energy, irrespective of the energy consumed by any one or more of the intervening elements, and irrespective of the position of such element in the series. Thus each motor or other element will make a distinct call upon the generator for the exact amount of energy it needs, and the sum total of the output of the generator will be the sum total of the combined calls plus the necessary resistance of the conductor, forming the path of the current.

In the method usually employed in regulating the current artificial resistance of some kind is inserted in the circuit, and the useless work done in forcing the current through this resistance is of course lost. By reason of the construction which I have devised this disadvantage is entirely obviated and the entire output may be used for useful work.

It is obvious that my invention is not limited in its application to a dynamo-electric machine employed for the production of electric energy, but is equally applicable to electric motors. It is also obvious that it is equally applicable both to direct and alternating current machines. Moreover, although I have described the armature as being movable relatively to the field-magnets—a construction which I prefer, owing to the obvious mechanical advantages which it presents—it will be seen at once that by a mere reversal the field-magnets may be moved relatively to the armature. Such a construction I have shown in Figs. 6 and 7, in which the armature E is fixed upon the shaft D, while the field-magnets B, with their pole-pieces C and C′, are mounted upon suitable ways L, upon which they may move in a direction parallel to the axis of rotation of the armature. This movement may be effected in any suitable manner, and in the present instance I have shown mechanism by which this motion may be accomplished by hand at the will of the operator, although, of course, some such automatic means as that previously described may be applied thereto. In this construction M represents a threaded shaft mounted in suitable bearings upon the base A and passing through a fixed nut *m*, attached to the pole-piece C. At its outer end the screw-shaft M is provided with a bevel-gear *m′*, with which meshes a corresponding bevel-gear *n*, mounted on a vertical shaft N, which is provided at its upper end with a hand-wheel N′, by means of which it may be rotated. It will be at once seen that the movement thus imparted to the electro-magnets and their pole-pieces is just as effective in increasing or decreasing the lateral distance between the armature and pole-pieces as is the movement of the armature itself. It may be advisable to move both the armature and the magnets, and my invention also contemplates such an apparatus. Such a construction I have shown in Fig. 8 of the drawings, the construction being substantially the same as that shown in Figs. 6 and 7 and just described, with the exception that the armature-shaft D is capable of longitudinal motion in its bearings, and there is connected thereto an arm O, provided with a base O′, mounted on the ways L. The shaft M passes through the base O′, which is suitably threaded to receive it, and the thread on this portion of the shaft is the reverse of the thread which passes through the nut *m*. The arm is so connected to the shaft D as to permit this latter to rotate freely therein, but to cause it to move longitudinally along with said arm, the connection shown in the present instance being by means of a screw *o* passing downward through the arm and entering a circular groove *o′* formed in the shaft. In this construction the yoke *f′*, which supports the brushes F′, is attached to the arm O, so as to move therewith, while the commutator is connected to the shaft and armature in the usual manner. It will be at once seen that by rotating the hand-wheel N′ in one direction or the other the armature and magnets may be caused to approach or recede from each other.

My invention is also applicable to that type of machines wherein a rotating armature surrounds and incloses a fixed central field-magnet or field-magnets, it being only necessary to construct these elements so that they will have a diminishing diameter from end to end and render one of them movable with respect to the other.

Various modifications in the details of the

construction shown and described will readily suggest themselves, and I therefcre do not wish to be understood as limiting myself strictly to the precise details hereinbefore described, and shown in the drawings.

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

1. In a dynamo-electric machine, the combination, with an armature of diminishing diameter from end to end, of a field-magnet or field-magnets having pole-pieces of corresponding shape, one of said elements being movable with respect to the other in the direction of the axis of rotation of the armature, whereby the lateral distance between the surfaces of the armature and pole-pieces may be varied, substantially as and for the purposes specified.

2. In a dynamo-electric machine, the combination, with the armature of diminishing diameter from end to end, of a field-magnet or field-magnets provided with correspondingly-shaped pole-pieces, one of said elements being free to move relatively to the other in the direction of the axis of rotation of the armature, and means controlled by the current for automatically effecting said movement, substantially as and for the purposes specified.

3. In a dynamo-electric machine, the combination, with the stationary field-magnet or field-magnets provided with pole-pieces inclosing a magnetic field of diminishing diameter from end to end, of a revolving armature diminishing in diameter from end to end, said armature being free to move longitudinally or in the direction of its axis of rotation, substantially as and for the purposes specified.

4. In a dynamo-electric machine, the combination, with the frusto-conical armature, of the field-magnets provided with correspondingly-shaped pole-pieces inclosing the same, one of these elements being movable relatively to the other in the direction of the axis of rotation of the armature, substantially as and for the purposes specified.

5. In a dynamo-electric machine, the combination, with the field-magnets and their pole-pieces, of the armature-shaft, the commutator fixed on said shaft, and the armature splined on its shaft free to move longitudinally thereon and flexibly connected to the commutator, substantially as and for the purposes specified.

6. In a dynamo-electric machine, the combination, with the rotating armature diminishing in diameter from end to end, of the field-magnets having correspondingly-shaped pole-pieces inclosing said armature, said armature being free to move in the direction of its axis of rotation, and means controlled by the current to move said armature into or out of the field of force upon a decrease or increase of the current strength, substantially as and for the purposes specified.

7. In a dynamo-electric machine, the combination, with the frusto-conical revolving armature and the field-magnets having correspondingly-shaped pole-pieces, of a lever connected to the hub of the armature, a screw connected to said lever, a friction-wheel mounted on said screw to impart longitudinal motion to it in either direction, a second lever provided at one end with two friction-wheels rotating continuously in opposite directions, and a spring and electro-magnet arranged in the circuit to control said lever and cause either of said friction-wheels to engage with the friction-wheel on the screw upon a corresponding variation in the current strength, substantially as and for the purposes specified.

8. In a dynamo-electric machine, the combination, with the field-magnets and the armature movable in the direction of its axis of rotation, of the lever G, screw g', and friction-wheel H for operating said screw, the lever I, provided with the continuously-rotating gear-wheels J′ and J², having friction-wheels j' and j^2, the gear-wheel J, mounted on the armature-shaft to actuate said gear-wheels J′ and J², the armature i, the electro-magnet I′, arranged in the main or a shunt circuit, and the spring I², provided with means for adjusting its pressure, substantially as and for the purposes specified.

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