(No Model.) 3 Sheets—Sheet 1.

E. THOMSON.

CONTINUOUS CURRENT TRANSFORMER.

No. 485,669. Patented Nov. 8, 1892.

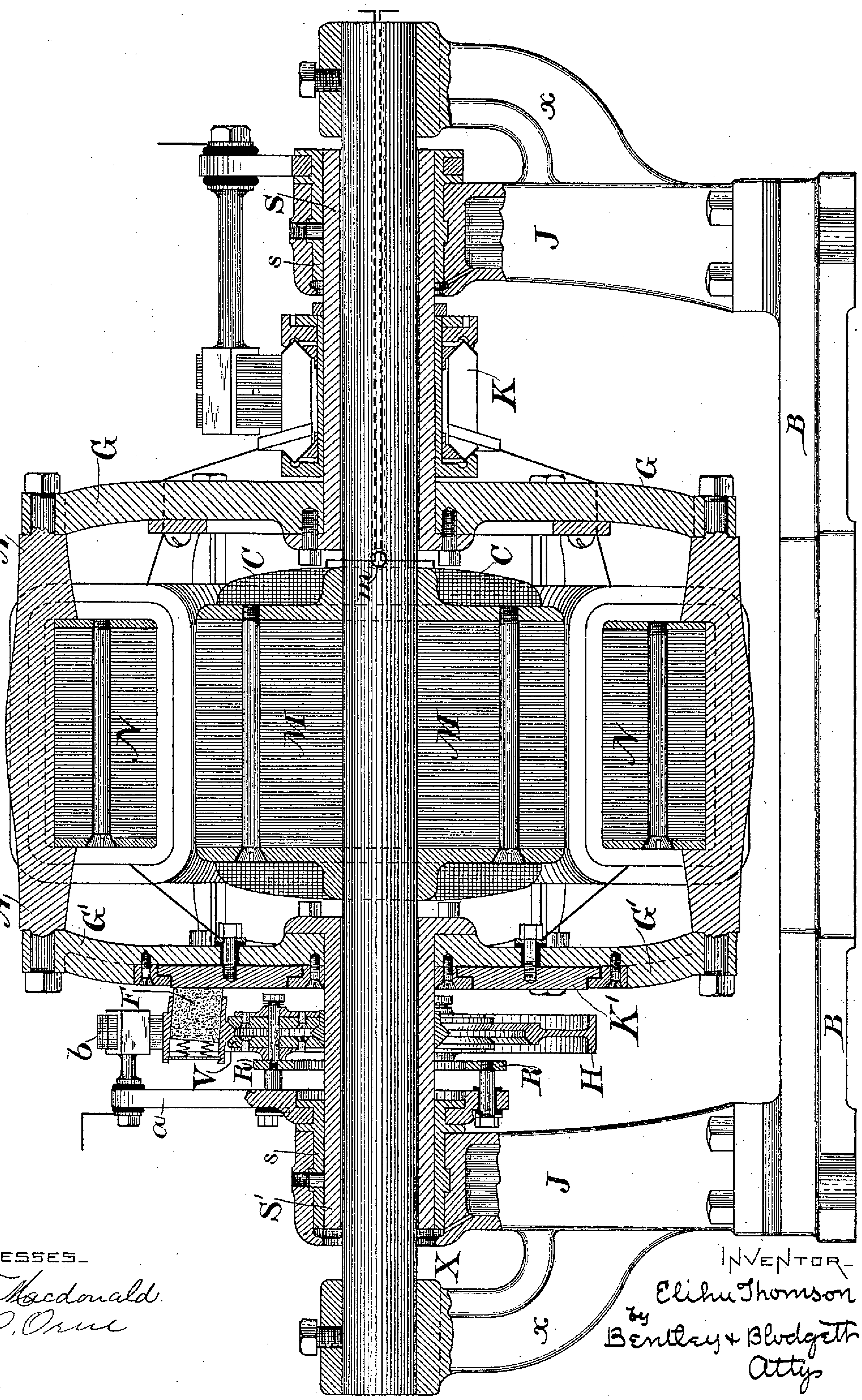

Fig. 1.

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FIG. 2.

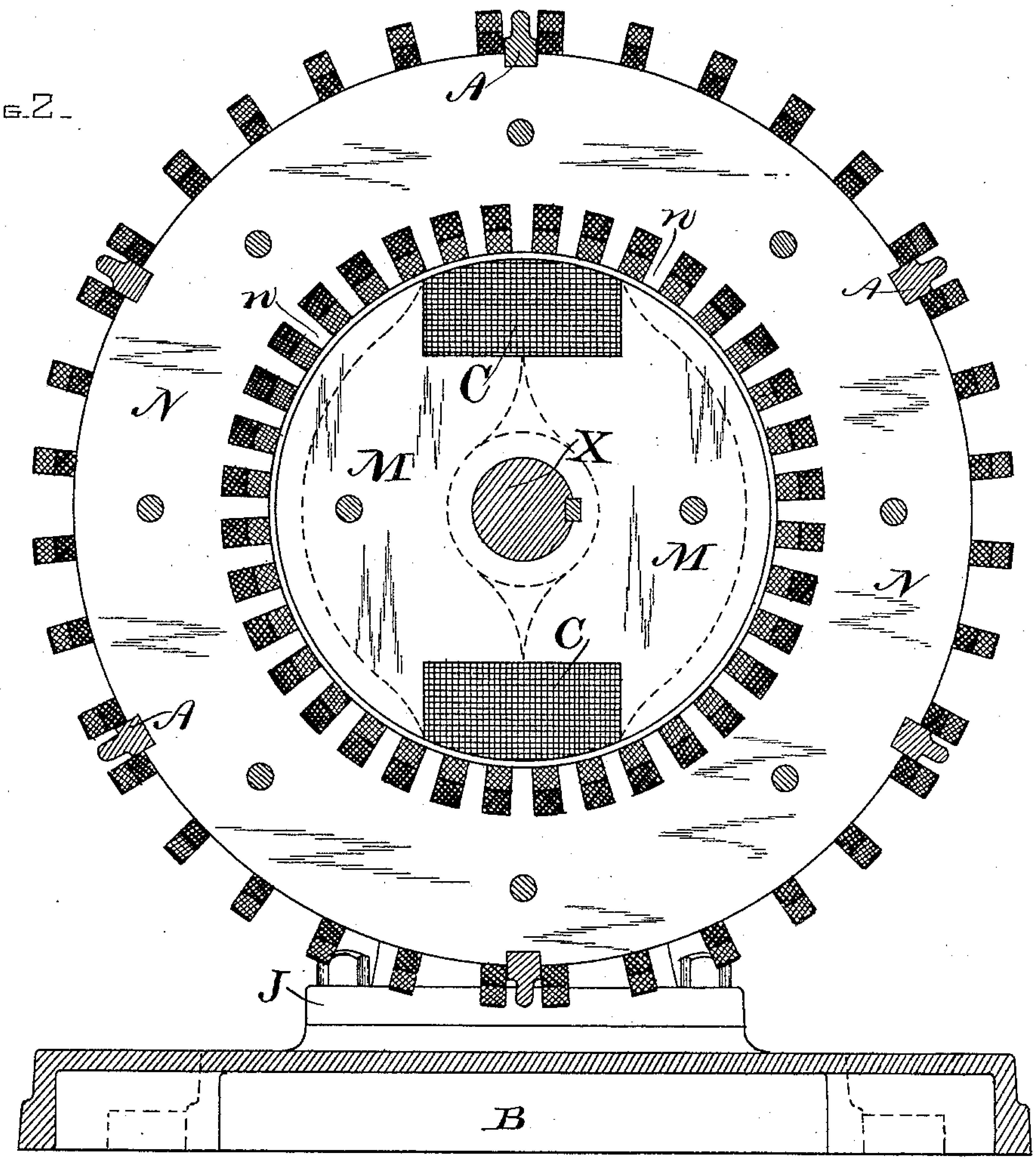

FIG. 4.

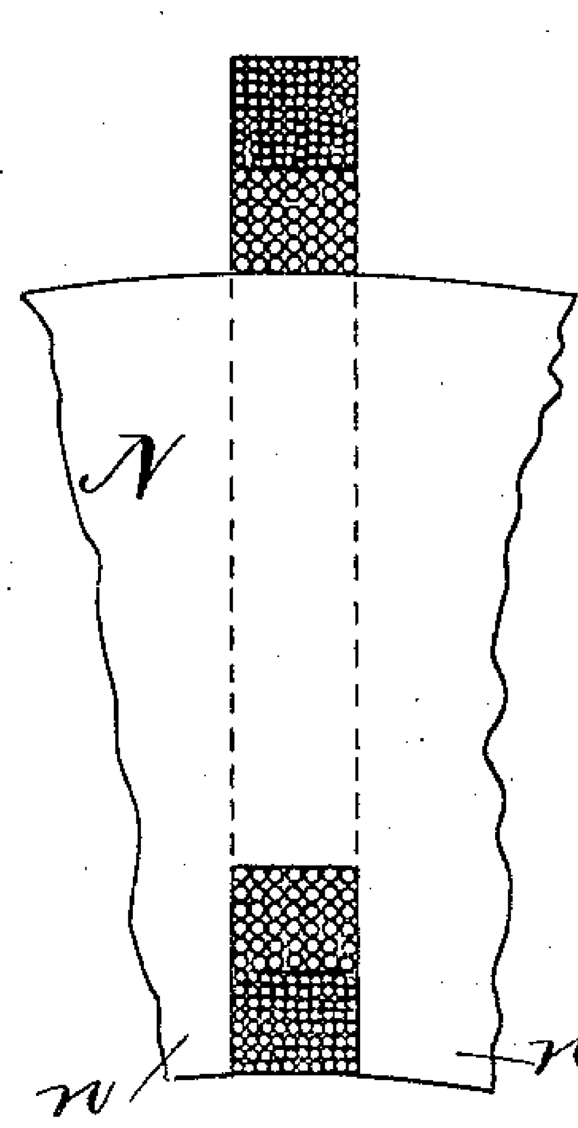

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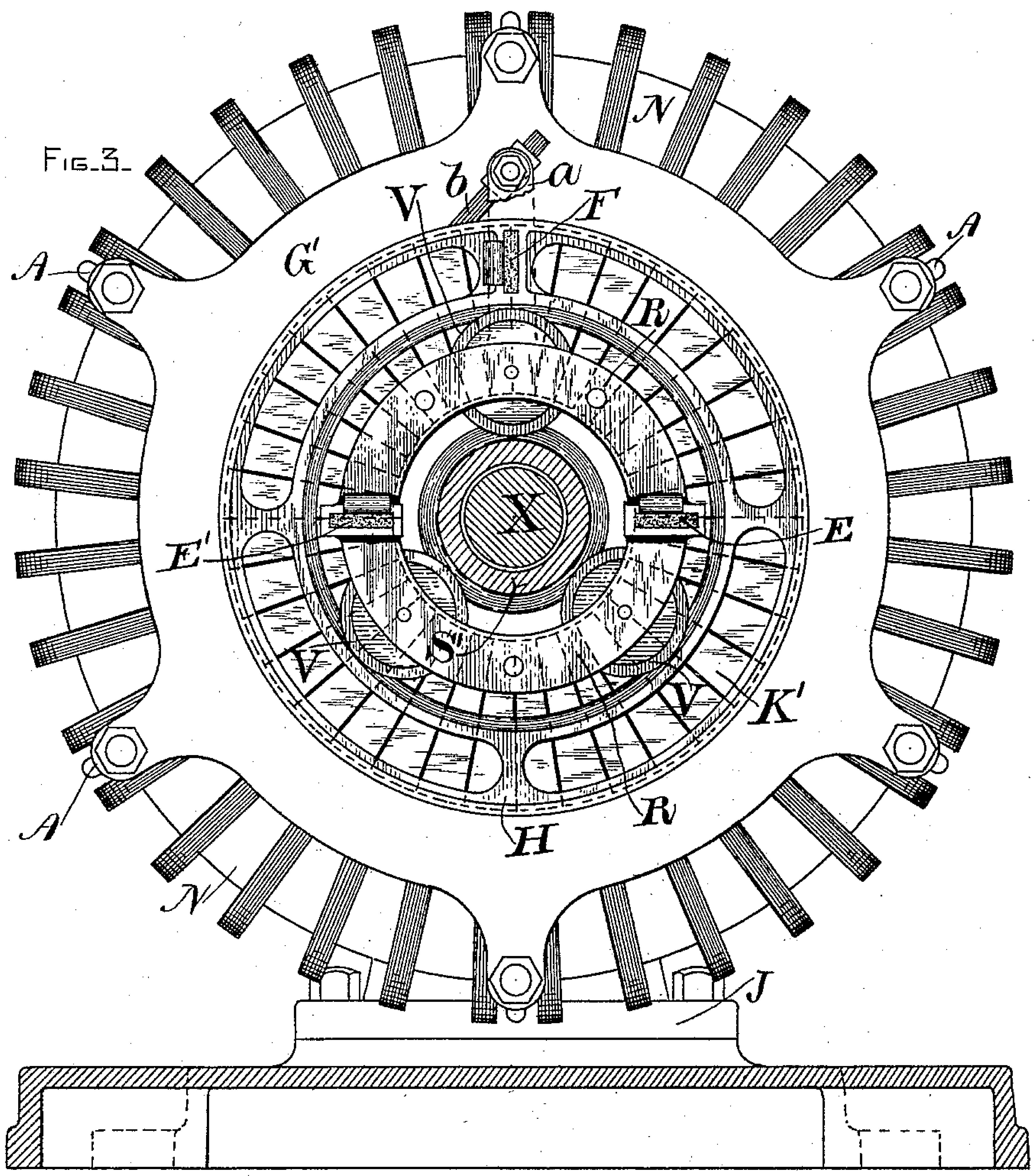
FIG. 3.



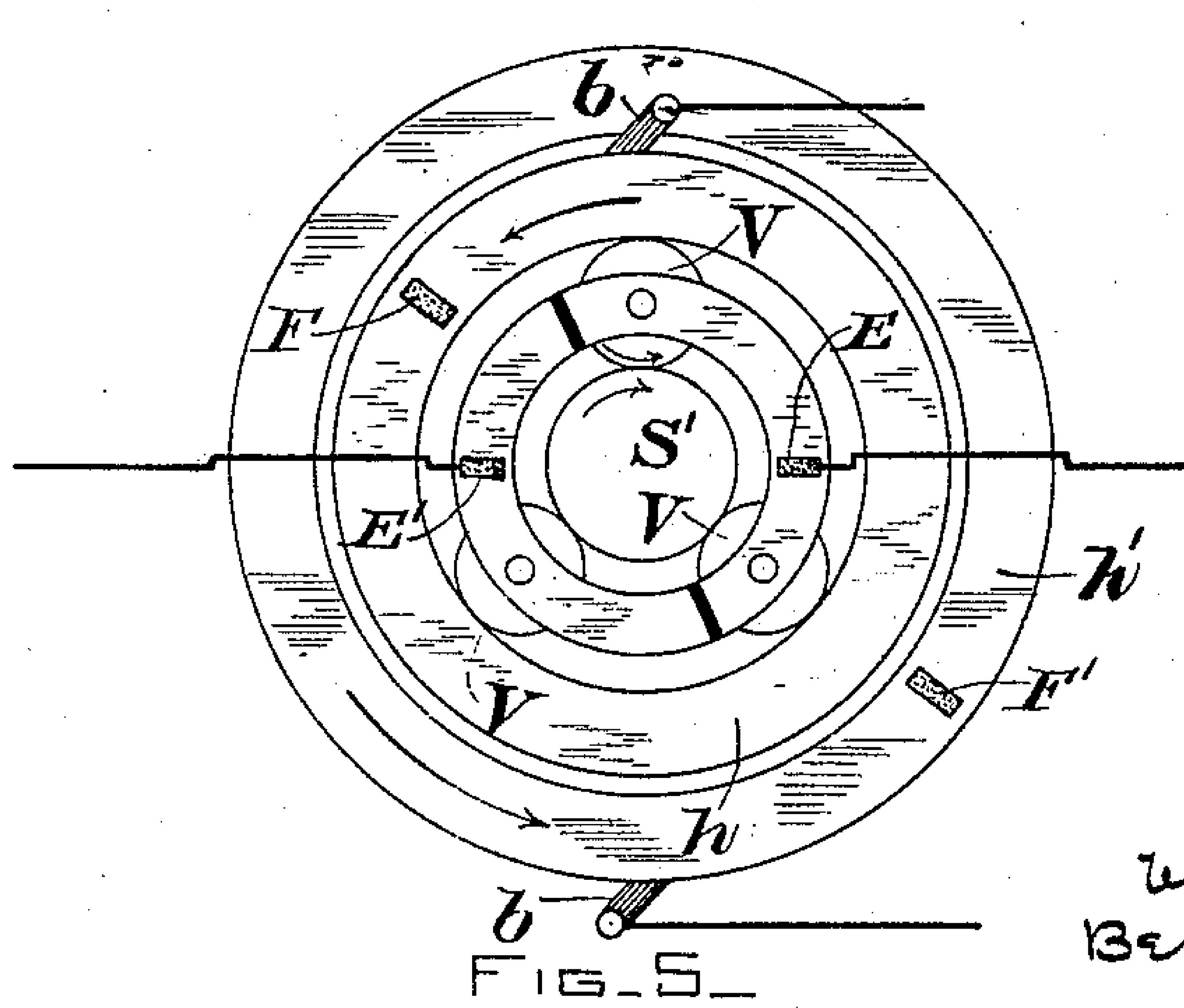


FIG. 5.

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UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

CONTINUOUS-CURRENT TRANSFORMER.

SPECIFICATION forming part of Letters Patent No. 485,669, dated November 8, 1892.

Application filed August 28, 1891. Serial No. 403,953. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, in the county of Essex and State of Massachusetts, have invented a certain new and useful Improvement in Continuous-Current Transformers, of which the following is a specification.

The present invention relates to improvements in continuous-current transformers. Some of the improvements are useful, generally, in the construction of such machines. Others are for the purpose of adapting such transformers to special uses, such as the obtaining of secondary currents of slow rates of pulsation such as are adapted to be used in the operation of reciprocating drills and other reciprocating tools.

In the accompanying drawings, Figure 1 is an axial section of a continuous-current transformer. Fig. 2 is a transverse section, and Fig. 3 an end elevation, of the same. Figs. 4 and 5 show details.

In Fig. 1, B B is a base-plate having mounted upon it standards J J, from each of which an arm *x* projects for sustaining a central shaft X in a fixed position or without revolution. These standards J J also support journals or boxes *s* for a hollow shaft or hollow sleeves S S′, which carry the revoluble portion of the apparatus. These hollow sleeves surround the shaft X, but clear the same by a small space. On the shaft X X and between the sleeves S S′ is fixed and sustained an iron body M, preferably constructed of laminated iron and which forms a source of field energy in the machine, or, in other words, is the field-magnet. This field-magnet has its coil wound in diametrically-opposite notches, as in the old Siemens H-armature. This magnetic body M is surrounded by the armature N of the machine, which is also a laminated body of iron in the form of a ring or constructed of sections of rings of sheet-iron. These laminations or rings are bolted together in the ordinary way to keep them in place and form a massive laminated ring. The armature-body N is preferably provided with long projections *n n n n*, &c., extending radially toward the inner field-core M and clearing it by a very small space. By this means the magnetic circuit of the field-magnet M is very thoroughly and completely closed without the necessity for any considerable air-gap. In this respect my invention differs from the ordinary dynamo-machines, which do not operate properly unless the air-gap is made considerable, experience having shown that it is necessary to have a certain air resistance between the field and the armature core if the armature is to carry any considerable load of current. This is owing to the distortive effects of the armature-currents on the field, or owing, more accurately, to a cross-inductive action, which breaks down the magnetic field in which the armature exists. This cross-inductive action is relieved by allowing a large clearance. In my invention only that amount of clearance which is requisite for mechanical reasons is needed. Hence I operate in my transformer with practically a closed magnetic circuit, thereby saving energy which would be required to be put into the field-coil C C saving the metal, which would otherwise be required in the field-magnet M M, and saving considerably in the wire, which would be required to magnetize the same, at the same time that I can bring the iron to a high degree of magnetization. The present invention relating to continuous-current transformers, the armature-core N is wound with two sets of coils, preferably superposed in the spaces provided and passing outwardly over the exterior and separated. These coils are connected into a closed series, as in the Gramme winding, each forming a separate closed series while insulated one from the other and from the core N N. The coils do not require any binding to keep them in place interiorly, because of the fact that the centrifugal force tends to keep them between the projections *n n n n*. The structure so wound with coils, the gage of wire of which may be selected in accordance with the relative potentials of the windings, is mounted in a framework consisting of exterior metal pieces A A A, &c., set into notches on the exterior surface of the laminated structure N N, as indicated in Fig. 2. They may be made to project out laterally, as in Fig. 1, and be formed with a thread and shoulder, allowing them to enter into corresponding holes in end plates or spiders G G′, provided for their reception. These plates or spiders G G′ are centered upon the sleeves S S′, to which they are firmly secured, as shown in Fig. 1. The armature is thus carried during revolution by the parts A A, mounted on the plates or spiders G G′, which, with the sleeves S S′, revolve in the bearings in the upper parts of the standards J J and around the stationary field M M. A commutator K, provided with brushes bearing thereon in the usual manner, is mounted upon the sleeve S and has its segments connected, respectively, to the coils of one of the windings on the armature-body N N, while another commutator K′ has its segments similarly connected to the other winding. The commutator K may be that belonging to the high-potential winding, receiving, say, five hundred, one thousand, or more volts of current and transforming it and delivering it at a lower potential to the commutator K′, upon which rests in suitable position a set of brushes for taking up the current and delivering it to the secondary circuit. The field-magnet coil C C is energized by wires carried through a hole *m* in the shaft X from one end, and this current may be taken from any suitable source. On the completion of the circuit through the windings and the excitation of the field the armature revolves at a speed dependent upon the counter electro-motive force developed in its turns in relation to the applied electro-motive force.

Referring now to Fig. 3, G′ represents the supporting-spider, and the coils of the armature-body N N are seen in place with the supporting-frame or metallic bars A A sustained in the spider G′. The segments of the commutator K′ are also partly visible in that figure. The brushes resting on the commutator K′ K′ are seen in Fig. 3 at E E′ and are shown as carbon brushes mounted in holders sustained in the frame or ring R and insulated therefrom. This frame or ring R (see Fig. 1) is shown supported from the journal-box *s s*, and from this support extends upward an arm *a*, carrying a collector-brush *b*, as seen, also, in Fig. 3. This brush *b* is attached to a support and a wire connection carried therefrom wherever desired. It rests by spring-pressure upon a circular ring or frame H, Figs. 1 and 3, which frame H carries another brush F, resting on the commutator K′ and electrically connected with the frame H. The ring R sustains a set of three grooved rolls V, preferably of insulated material, which are constructed with a **V**-groove bearing on the inner double-cone surface of the ring H and sustaining it. They also bear on a double-cone surface carried on the sleeve S′. Hence when the sleeve S′ revolves motion is communicated to the rolls and thereby to the ring H; but its rate of rotation is slower and opposite to that of the sleeve S′. This results in carrying the brush F around the commutator during the action of the machine, and since the brushes on the commutator K, as well as those on the commutator K′—namely, E E′—are stationary the revolution of the brush F will deliver to the brush *b* alternating potentials at rates dependent upon the rate of its revolution over the commutator-surface, and if the connection be made through a circuit from the brush *b* to either of the brushes E E′ the effect will be to send through such circuit pulsating currents at a speed dependent upon the speed of revolution of the brush. If two brushes F were mounted on the ring H H and similarly revolved, it is evident that if they are kept insulated and separate means—such as two outer surfaces and two separate brushes, as *b*—were provided, alternating impulses or alternating currents of slow period might be taken in like manner to the pulsating currents between the two brushes mounted like F and their connections exteriorly. This is rendered more plain by reference to Fig. 5, where the brushes F F′, bearing on opposite parts of the commutator K′, are mounted on the frame H and connected, respectively, to two insulated rings *h h′*, from which brushes *b b′* lead to the two sides of the secondary circuit.

Fig. 4 simply shows the winding of coarse and fine wire in coils, which are to be laid upon the armature and between the projections *n n* of the armature-body N. On account of the fact that the armature-currents in the two windings are proportionate to each other and that they are counter-distortive, so far as the field is concerned or tendency to shift the magnetism in opposite directions, the machine becomes free from distortion, the brushes may be placed on the middle line between the field-poles or the wire connections from the commutator to the coils may be twisted to place them in any favorable position, and they will not require to be afterward adjusted during changes of load. At the same time the full effect of the comparatively-small field-magnet M is obtainable, working over a substantially-closed magnetic circuit without distortion or cross-induction. I am thus enabled to provide space for a large amount of armature-wire, to provide ample section for carrying heavy currents therein, and at the same time to magnetize the armature to the fullest extent by a very moderate expenditure of energy in the field-magnet coil. My construction also gives a very thoroughly-ventilated armature, or one which during revolution gives a free exposure of the coils to the air on its exterior. The machine is also adaptable, as is evident, to transforming for difference of potential between the two windings and to deliver pulsating or alternating currents of slow period from the secondary winding while taking comparatively-high potentials in the primary winding. The devices for rotating the brushes on the commutator K' are simple and efficient.

It is apparent that some of the features of construction hereinbefore set forth are applicable to other kinds of electro-magnetic induction-machines—as, for example, dynamo-electric machines or motors.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination, with a circuit supplying direct current, of a rotary transformer having an armature with a winding connected through commutating devices to such circuit and a secondary winding connected to independent commutating devices, and additional commutating devices rotatable relatively to the aforesaid commutating devices and connected with a separate circuit and with the secondary winding, and means for rotating said additional commutating devices.

2. The combination, with a circuit supplying direct current, of a rotary transformer having a field-magnet and a rotary armature with two insulated windings, a commutator connecting one of such windings to the supply-circuit, and a commutator connected to the other winding and having two sets of collecting devices, one of which is fixed, while the other is rotatable relatively to said commutator.

3. The combination, with a circuit supplying direct current, of a rotary transformer having a field-magnet and a rotary armature carrying two separate windings, each having a commutator, one of which connects its winding with the supply-circuit, two sets of collecting devices bearing on the other commutator, one set being fixed and the other rotatable, and means for driving said rotatable collecting devices, substantially as described.

4. The combination, with a circuit supplying direct current, of a rotary transformer having a field-magnet and a rotary armature with two insulated windings, a commutator connecting one of such windings to the supply-circuit, and a commutator connected to the other winding and having two sets of collecting devices, one of which is fixed, while the other is rotatable and is mechanically connected to the rotating armature through speed-reducing mechanism.

5. An electro-magnetic induction-machine having a fixed field-magnet mounted on a central shaft, an exterior rotary armature surrounding said field-magnet and carrying two windings, sleeves surrounding said shaft, but supported out of contact therewith, and carrying said armature, a commutator for each winding, and two sets of current-collecting devices bearing on one of said commutators, substantially as set forth.

6. An electro-magnetic induction-machine comprising a fixed field-magnet and a rotating armature having interior radial projections clearing the field-magnet by only a small air-space and having two sets of coils superposed in the spaces between the projections, substantially as described.

7. The combination, with the rotary armature of an electro-magnetic induction-machine, of a commutator connected to the winding thereof and two sets of collecting devices bearing on said commutator, one of which is rotatable relatively to the other, each set being connected with an independent circuit.

8. The combination, with the rotary armature of an electro-magnetic induction-machine, of a commutator connected to the winding thereof and two sets of collecting devices bearing on said commutator, one of which is rotatable relatively to the other, each set being connected with an independent circuit, and means for driving such rotatable collecting devices.

9. The combination, with the rotary armature of an electro-magnetic induction-machine, of a commutator connected to the winding thereof and two sets of collecting devices bearing on said commutator, one of which is rotatable relatively to the other and is connected to the armature through speed-reduction mechanism, each set being connected with an independent circuit.

10. A current-collecting apparatus comprising a rotary commutator mounted on a shaft and current-collecting devices bearing on said commutator and supported on a ring surrounding said shaft and fixed wheels engaging with said shaft and ring to support the latter and drive it at a reduced speed.

11. A rotary transformer comprising an interior cylindrical field-magnet having its winding in two diametrically-opposite notches, and a ring-armature surrounding such field-magnet and having interiorly-projecting teeth extending close to the periphery of the field-magnet, and primary and secondary coils wound around the armature and in each space between such teeth and commutating devices for such coils.

In witness whereof I have hereunto set my hand this 25th day of August, 1891.

ELIHU THOMSON.

Witnesses:
JOHN W. GIBBONEY,
BENJAMIN B. HULL.