(No Model.)

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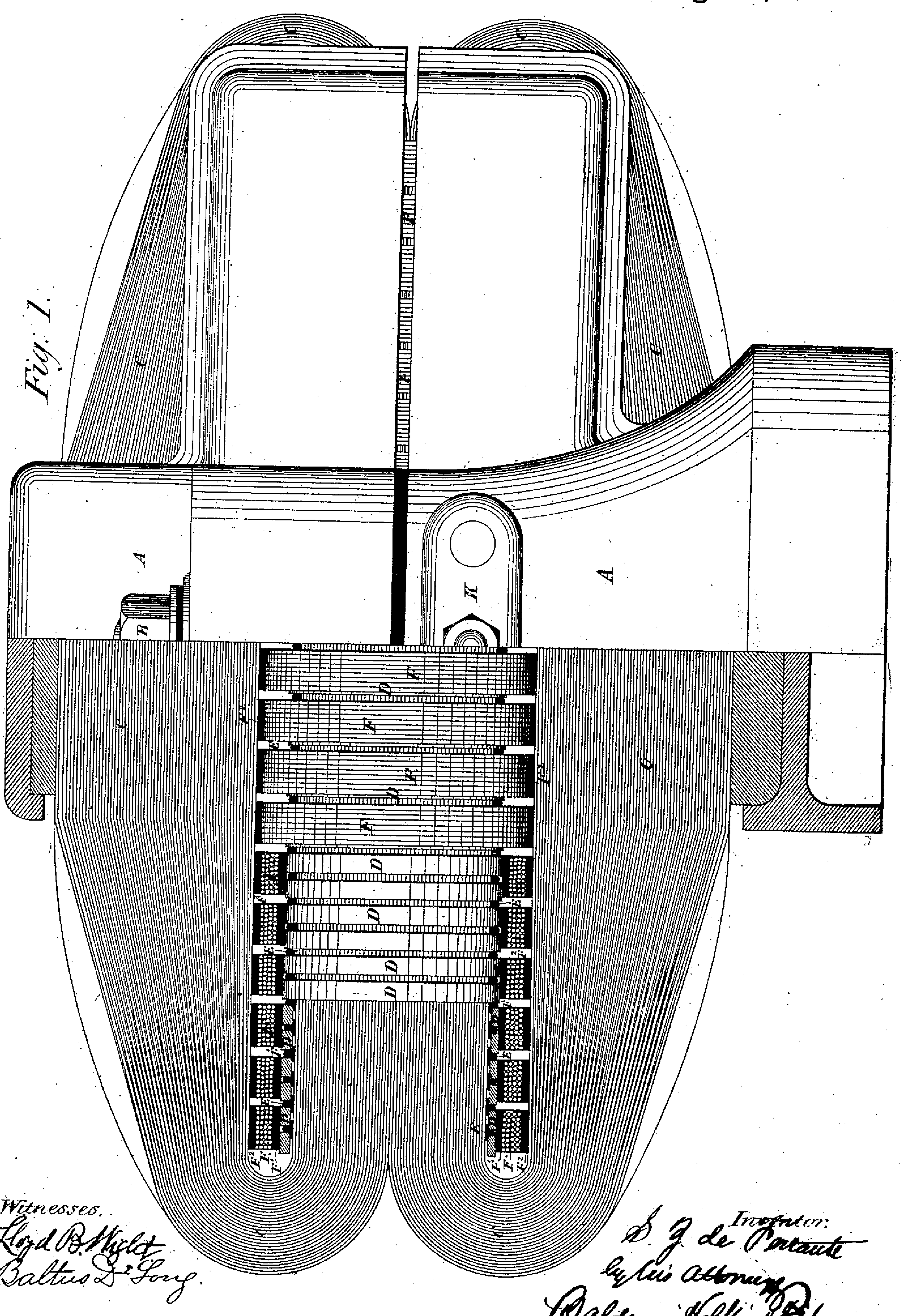
S. Z. DE FERRANTI.

MEANS FOR DISTRIBUTING ELECTRIC ENERGY.

No. 435,114. Patented Aug. 26, 1890.

Fig. 1.



Witnesses.
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(No Model.)

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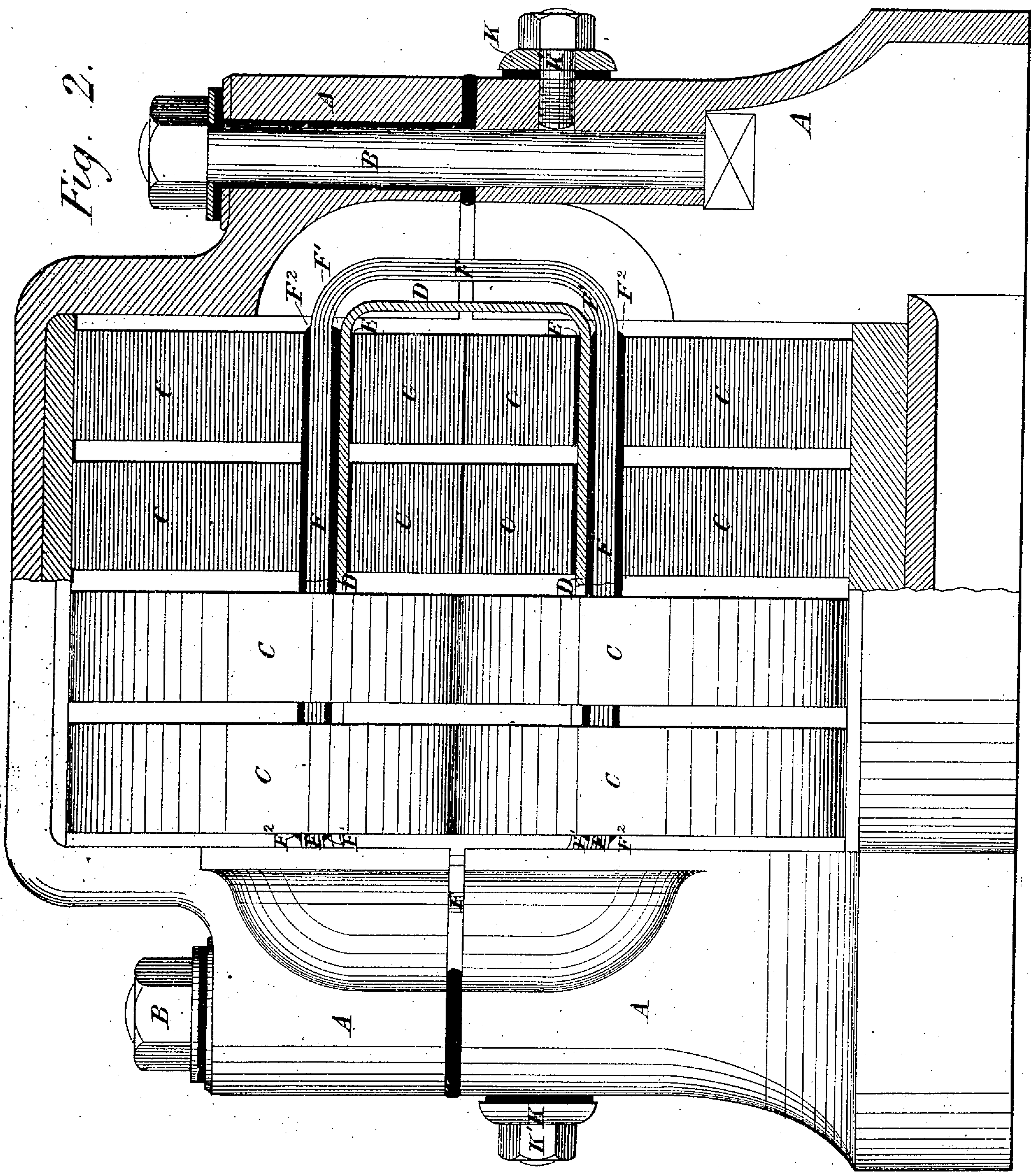
Fig. 2.



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(No Model.) 5 Sheets—Sheet 3.

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MEANS FOR DISTRIBUTI[illegible]G ELECTRIC ENERGY.

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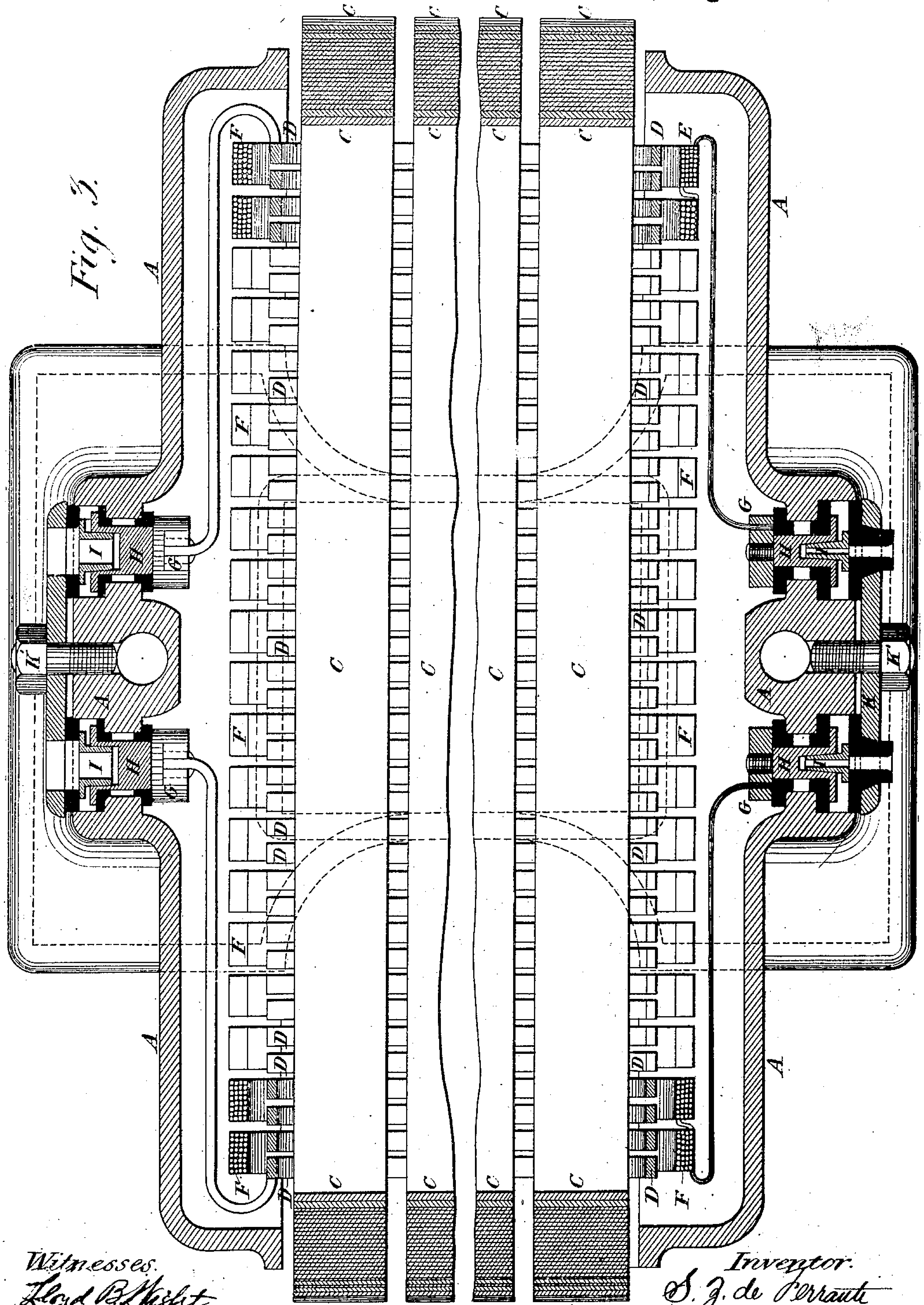

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MEANS FOR DISTRIBUTING ELECTRIC ENERGY.

No. 435,114. Patented Aug. 26, 1890.

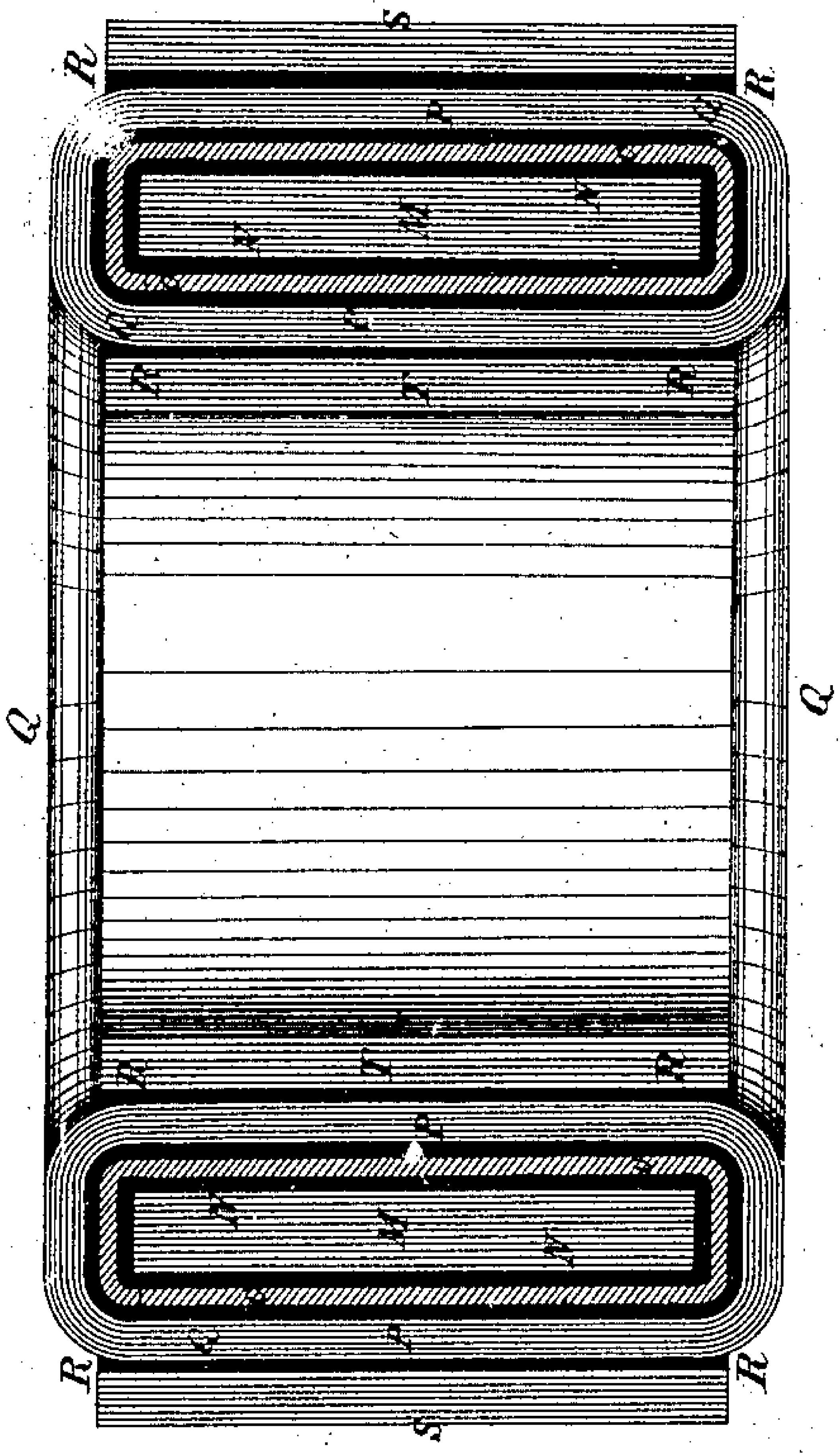

Fig. 5.

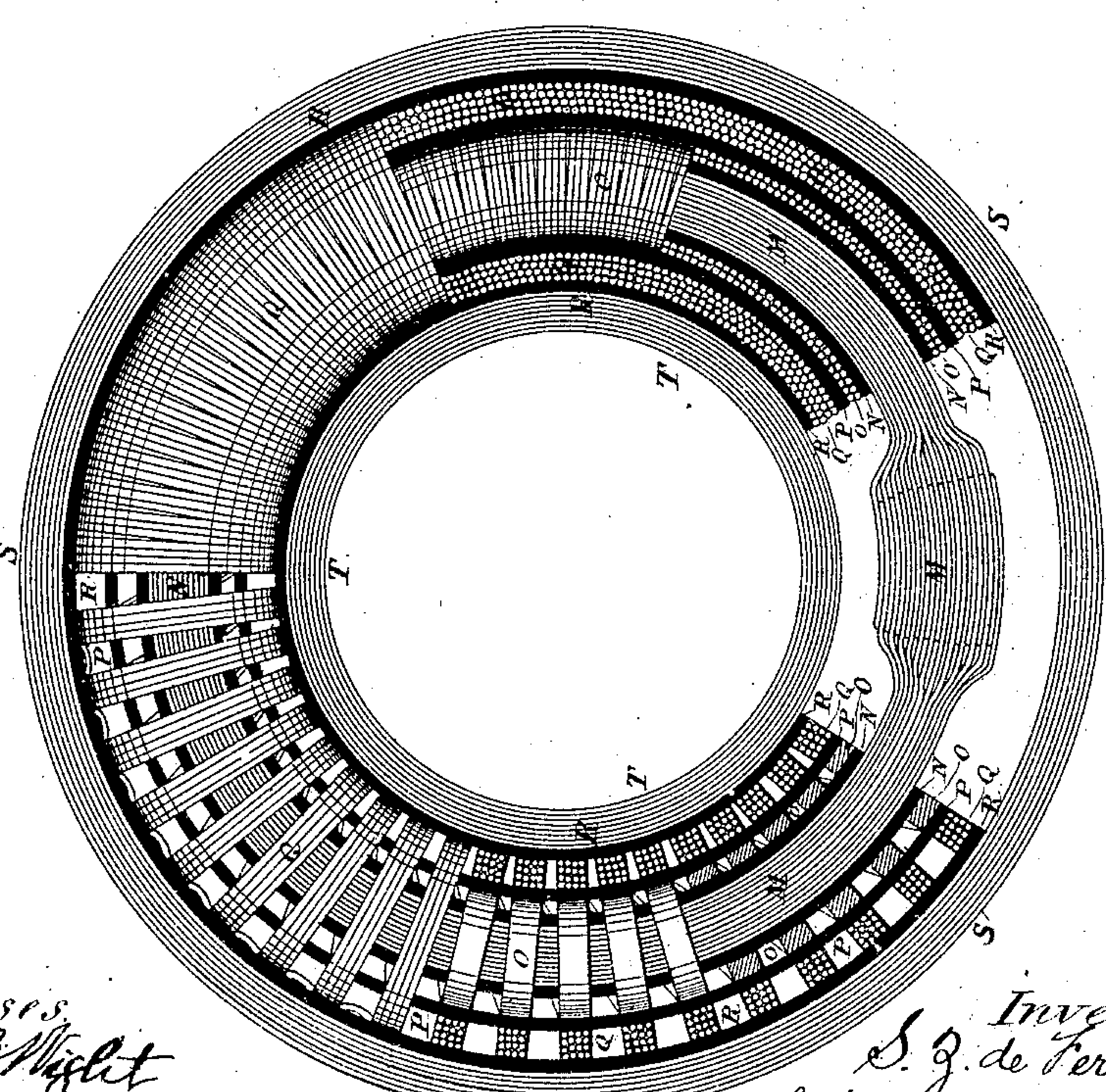

Fig. 4.

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S. Z. DE FERRANTI.

MEANS FOR DISTRIBUTING ELECTRIC ENERGY.

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Fig. 6.

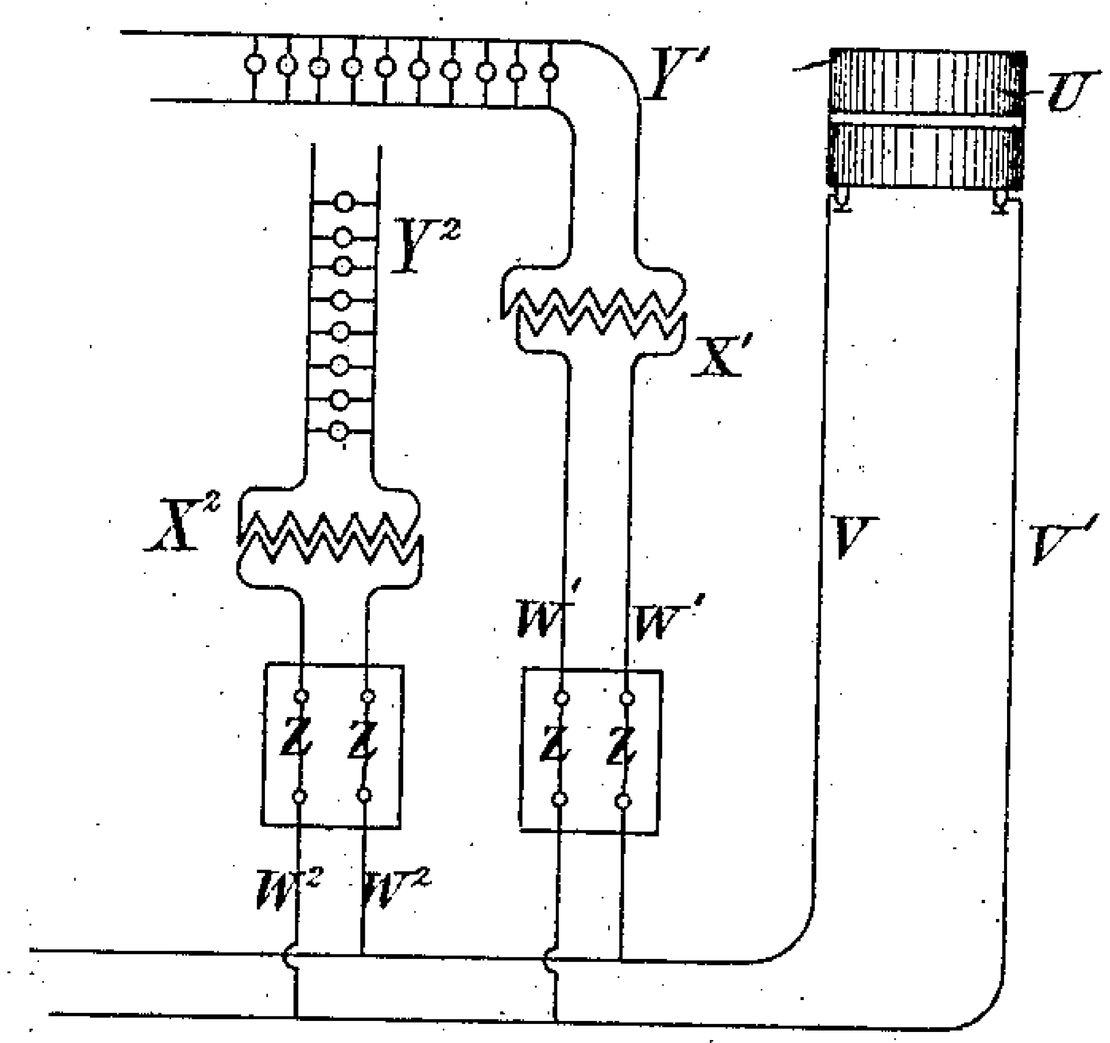
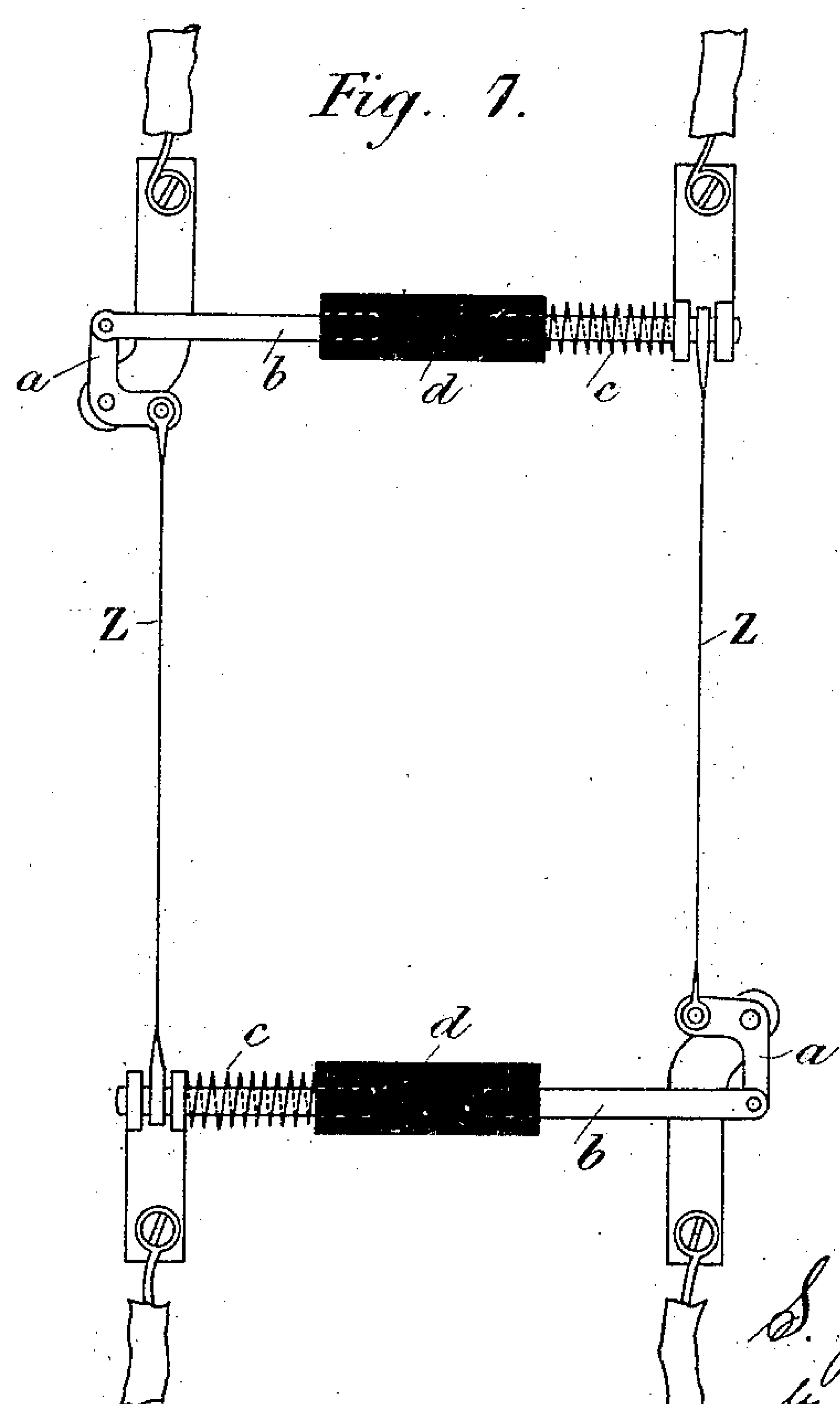


Fig. 7.



Witnesses.
Lloyd B. Wight.
Baltus De Long.

Inventor:
S. Z. de Ferranti
by his Attorneys
Baldwin, Hopkins & Peyton

UNITED STATES PATENT OFFICE.

SEBASTIAN Z. DE FERRANTI, OF LONDON, ENGLAND.

MEANS FOR DISTRIBUTING ELECTRIC ENERGY.

SPECIFICATION forming part of Letters Patent No. 435,114, dated August 26, 1890.

Application filed April 18, 1887. Serial No. 235,192. (No model.) Patented in England December 9, 1885, No. 15,141, and December 11, 1885, No. 15,251; in France December 9, 1886, No. 180,176; in Belgium January 8, 1887, No. 75,875, and in Italy March 31, 1887, No. 21,119.

To all whom it may concern:

Be it known that I, SEBASTIAN ZIANI DE FERRANTI, electrician, a subject of the Queen of Great Britain, residing at St. Benet Chambers, Fenchurch Street, in the city of London, England, have invented certain new and useful Improved Means for Distributing Electric Energy, of which the following is a specification.

Letters Patent on this invention have been granted to me in the following countries: in Great Britain, No. 15,141, dated December 9, 1885, and No. 15,251, dated December 11, 1885; in France, No. 180,176, dated December 9, 1886; in Italy, No. 21,119, dated March 31, 1887, and in Belgium, No. 75,875, dated January 8, 1887.

In the distribution of electric energy for electric lighting, or, it might be, as a source of motive power or for other uses, I employ a dynamo-electric machine generating alternating currents of high intensity, and by means of converters which I have invented I obtain from these currents other alternating currents, of lower intensity in each case, in or near the building or place where the lights are to be exhibited or the energy utilized.

To insure safety, I provide fuses or automatic cut-outs in the connections between the dynamo and the converters. If short-circuiting occurs in the secondary or light circuit, the fuse or cut-out in the primary or dynamo connection immediately acts and prevents damage. For greater security I so arrange the fuses that when they operate both of the connections between the converter and the dynamo-circuit are severed nearly simultaneously.

In the annexed drawings, Figure 1 shows a side elevation, one-half in section, of a converter constructed in accordance with my invention. Fig. 2 is an end elevation, one-half in section. Fig. 3 is a horizontal section of the same. A portion is broken out or omitted from the center of the apparatus to reduce the dimensions of the figure. Figs. 4 and 5 show a modification. Fig. 6 shows the general arrangement of the circuits, together with the safety cut-out. Fig. 7 shows the arrangement of fuse or cut-out which is preferred. Figs. 1, 2, and 3 are drawn to about one-fourth the actual size, and show a converter suitable for supplying on a secondary circuit in which, say, seventy incandescent lamps are included, and to maintain a tension between the leads of the lamp-circuit of one hundred volts, the tension of the alternating current in the primary or dynamo circuit being two thousand four hundred volts.

A A is a cast-iron frame or casing made in two main parts, which are held together by bolts B B. By way of precaution the parts of the frame are more or less insulated from each other.

C C C represent ribbons of soft Swedish iron about one thirty-second of an inch in thickness formed into bundles. The different ribbons in each bundle are not in metallic contact, being separated by paper. The paper is cemented to the ribbons. Each ribbon is thus covered on one side for one half of the length and for the other half it is covered upon the other side. The ribbons after receiving the windings upon them are bent round and made to overlap at their ends, and where they so overlap the two ends of each ribbon are in metallic contact; but every ribbon is separated by the paper from the other adjacent ribbons. Thus each ribbon forms a ring in which there is a complete magnetic circuit. In the converter shown by the drawings four such bundles of ribbons C C are indicated; but the number and dimensions will vary according to the size and capacity of the converter. Around the central part of each bundle a taping is applied to keep it together, and then before the ends of the ribbons are brought together the coil or spiral of copper rod D is passed around the bundle so that the coil D surrounds the central parts of the four bundles.

To separate the coil D from the bundles, short insulators or chairs E E, of vulcanized fiber or vulcanite, are inserted. Over the coils D, I apply rings F F, previously prepared and wound upon a former. Each ring consists of an inner layer F′ of insulated material. (Paper saturated with shellac varnish is that which I employ.) Over this is a winding of copper wire insulated in the usual way with cotton, and over this again is another layer F^2 of the same insulated material. The insulating material F' F^2 is applied only at the upper and under surfaces of the ring. At the ends of the ring, where the wire is at a distance from other metal, it has no other covering but the cotton wound around it. The wire which I employ in the converter shown by the drawings has a sectional area about one twenty-fourth that of the rod D, and the number of convolutions is twenty-four for each turn which the spiral D makes around the core of iron ribbons C.

As shown in the drawings, each ring is made to overlap two convolutions of the coil D, and it contains forty-eight turns of wire. The rings F F should be applied around the bundle C while the shellac insulation is still in a more or less plastic condition. The wires of the rings F F are then connected electrically from ring to ring, so as to form a continuous circuit through all the rings from end to end of the apparatus. The terminal wires of the series of rings are then brought out and are electrically connected with the metal blocks G G, which are secured in their places by the screw-pieces H H. These pieces have flanges upon them, and insulated washers are embraced between the flanges and the blocks G. These insulating-washers are inserted into apertures provided in the frame A to receive them.

In each piece H there is a conical recess adapted to receive a ferrule I. To these ferrules the electric leads from the dynamo are attached in such manner as to insure a good connection.

K is a cover-plate with apertures in it, through which these leads pass. The holes in the cover-plate are bushed with insulating-washers to insure due isolation of the leads. The coupling of the leads with the rings F F is thus effected simply by screwing up the bolt K', which secures the cover, and thereby forcibly thrusting the ferrules I into the conical recesses in the screw-pieces H H. The copper coil or spiral D, intended to form part of the lamp-circuit, is similarly brought to terminals on the other side of the machine. The connections are made in the manner already described, except that the dimensions of the leads are different, and that this being the low-tension circuit the thickness of the insulating material is diminished. A lesser separation of the metallic parts will here suffice.

It will be observed in this machine free spaces for ventilation are left between the several bundles C, and between these and the coil D, and again between the coils and the rings of coiled wire F. This is an important feature in converters of which the dimensions are at all considerable, as it allows currents of air to pass freely through and to carry off the heat which is generated in working.

Fig. 4 is a plan, partly in section, of a converter in the form of a Gramme ring. The figure shows two forms, the one to the left and the other to the right of the figure. Fig. 5 is a transverse vertical section.

I will describe first the arrangement shown on the left side of Fig. 4. M is the central bundle of soft-iron ribbons. Over this there is applied on insulation N, consisting of a lapping of paper and shellac. Upon this the copper spiral O is wound. Outside the copper there is another insulating-covering P. Q Q are rings formed of insulated wire and corresponding to the rings F in Figs. 1, 2, and 3. They are coupled together to form the primary or dynamo circuit, as already explained. R is an outer covering of insulated material separating the rings Q from an outside jacket S, formed of thin sheets of soft iron, either made into rings or simply wound upon the outside of the converter, so as to form a magnetic circuit outside the rings Q continuous from end to end of the winding. T is a similar hoop or hoops of soft iron within the rings Q, and there also forming a closed or partially-closed magnetic circuit.

The description already given applies to the arrangement on the left side of the figure. On the right side the primary and secondary wires are wound upon the ring as an ordinary Gramme ring is wound. The former arrangement, however, is preferable, because the construction is easier, and also because ventilation-spaces are left, which is a matter of much importance. The ends of the core-ribbons M are brought together after the coils or rings are upon them, and the two ends of each ribbon are placed in metallic contact, while by an insulation of paper each ring is separated from its neighbor. The part of the ring in which this overlapping takes place is left unwound.

The converters which I have described in this specification may be used not only for reducing from a high tension to a low, but also for increasing from a low tension to a high, or simply for transferring energy from one circuit to another. Thus, for example, in electric lighting it may sometimes be convenient to use dynamo-electric machines which maintain a potential of one hundred volts only and to increase this potential in the main conductor by means of a converter, say, to two thousand four hundred volts. In such a case a converter such as is shown by Figs. 1, 2, and 3 would be suitable, the dynamo being then connected with the copper coil D and the high-tension main to the rings F F. I make these converters of all sizes, from a few ounces in weight, for telephonic use and for other purposes where the amount of electrical energy to be converted is small, up to a ton or more in weight, where the electrical energy to be converted is large. Beyond the latter dimensions it may perhaps be more convenient to employ several converters to supply the same main circuit.

Fig. 6 shows the way in which fuses or cut-outs may be applied to prevent an undue amount of energy being developed in any converter and to prevent loss by leakage. U is the dynamo. V V′ are the high-tension mains. They are connected by branches W′, W′ and W^2 W^2 with the converters X′ and X^2, which are represented as in connection with lamp-circuits Y′ Y^2. Z Z are fuses which I introduce into the branches W′ and W^2. They are copper wires so proportioned that if an undue amount of energy is exerted through them they become heated and break or burn away.

In an arrangement such as that shown, where the conductors of a high-tension circuit are connected through fuses with the primary conductors of electric converters, and where the secondary conductors of the electric converters are connected with low-tension circuits, if by any accident a short circuit is established through the secondary conductor the fuse in the high-tension branch, although in a different circuit, is immediately destroyed and the apparatus disconnected. But for some such provision so much energy would be developed that the apparatus would be destroyed and there might be risk of injury to other property.

In place of a fuse it is possible to employ other apparatus which operates to open the high-pressure branch when too much energy is being exerted in it and in the corresponding low-pressure circuit. Thus an electro-magnet may be provided in the high-pressure circuit with an armature which is normally held off by a spring, but when undue energy is developed is attracted, and in moving opens the high-pressure branch circuit.

Fig. 7 is a plan of the fuse apparatus as I prefer to construct it. Each fuse Z is attached at one end to a right-angled lever *a*, and at the other is retained by a bolt *b*, passing through an eye at the end of the fuse. A coiled spring *c* tends to withdraw the bolt from the eye; but the bolt is kept in place by being connected through an insulating-block *d* with the angle-lever *a* belonging to the other fuse. When one fuse breaks, the retaining-bolt is instantly withdrawn from the other, and the circuit is opened in both branches practically simultaneously.

The general construction of converter shown in Figs. 1, 2, 3, 4, and 5, involving the closed magnetic circuits, is claimed in my Patents Nos. 389,795 and 389,838, granted upon applications that were divisions of this case.

I claim—

1. An electrical converter consisting of a core composed of strips, ribbons, or layers of iron forming closed magnetic circuits, and primary and secondary coils, one superposed upon the other, and each wound in sections or convolutions, the adjacent sections, convolutions, or portions of each coil being separated by air-spaces, and air-spaces being left between the inner coil and the core and the outer coil and the core, substantially as set forth.

2. A converter consisting of a core having primary and secondary coils, one superposed upon the other, and each wound in sections or convolutions, the adjacent sections, convolutions, or portions of each coil being separated by the air-spaces, and the convolutions of the outer coil bridging the spaces between the convolutions of the inner coil, whereby air-spaces are left between the core and outer coil, substantially as set forth.

3. In a converter, a core made up of magnetically independent sections or layers of iron arranged in several groups, the groups being separated from each other by intervening air-spaces, in combination with coils, each wound in sections or convolutions, and having the adjacent sections or convolutions of each coil separated by air-spaces.

4. A cut-out apparatus consisting of two fuses, one in each branch of the circuit, and springs held compressed or strained by such fuses, and mechanism worked by the spring liberated by the burning of a fuse to instantaneously disconnect the other fuse substantially as described.

5. The combination, in an electrical converter, of a core composed of strips or layers of iron forming a series of insulated closed metallic circuits, a spiral copper rod forming the secondary coil of the converter surrounding the core, insulating-chairs supporting the rod and preventing contact with the core, an insulating-covering over the spiral, and the primary coil covering the spiral.

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