

C. M. BALL.

MAGNETO ELECTRIC MACHINE.

No. 290,199.

Patented Dec. 18, 1883.

Fig. 1.

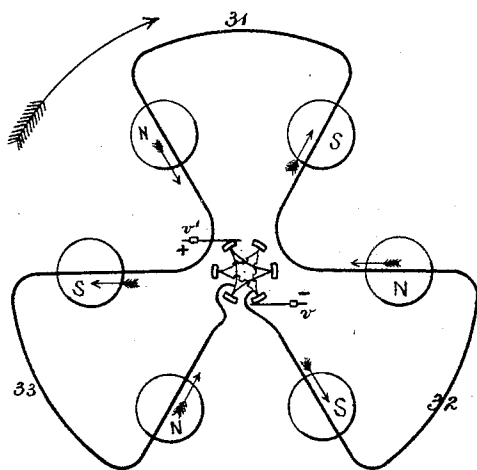


Fig. 2.

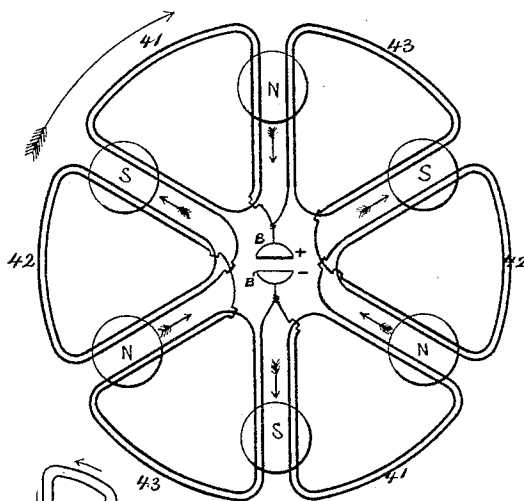


Fig. 3.

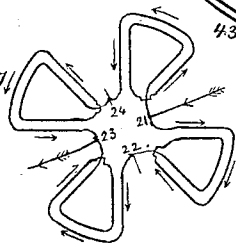


Fig. 4.

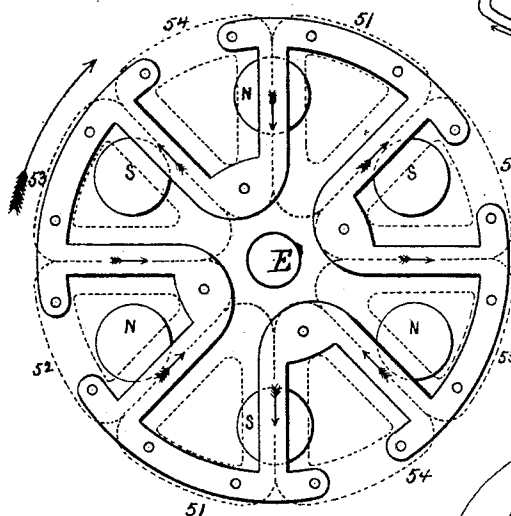
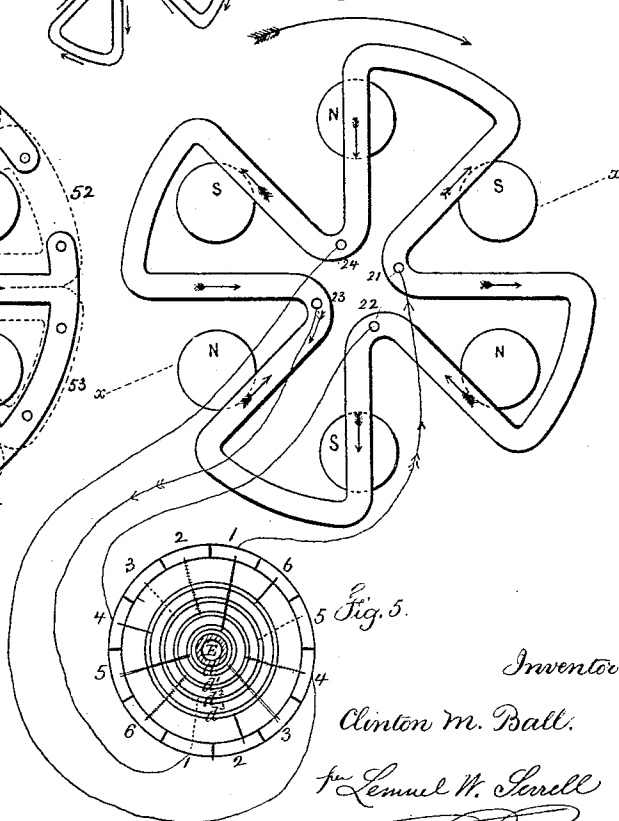


Fig. 5.



Witnesses

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att'y.

(No Model.)

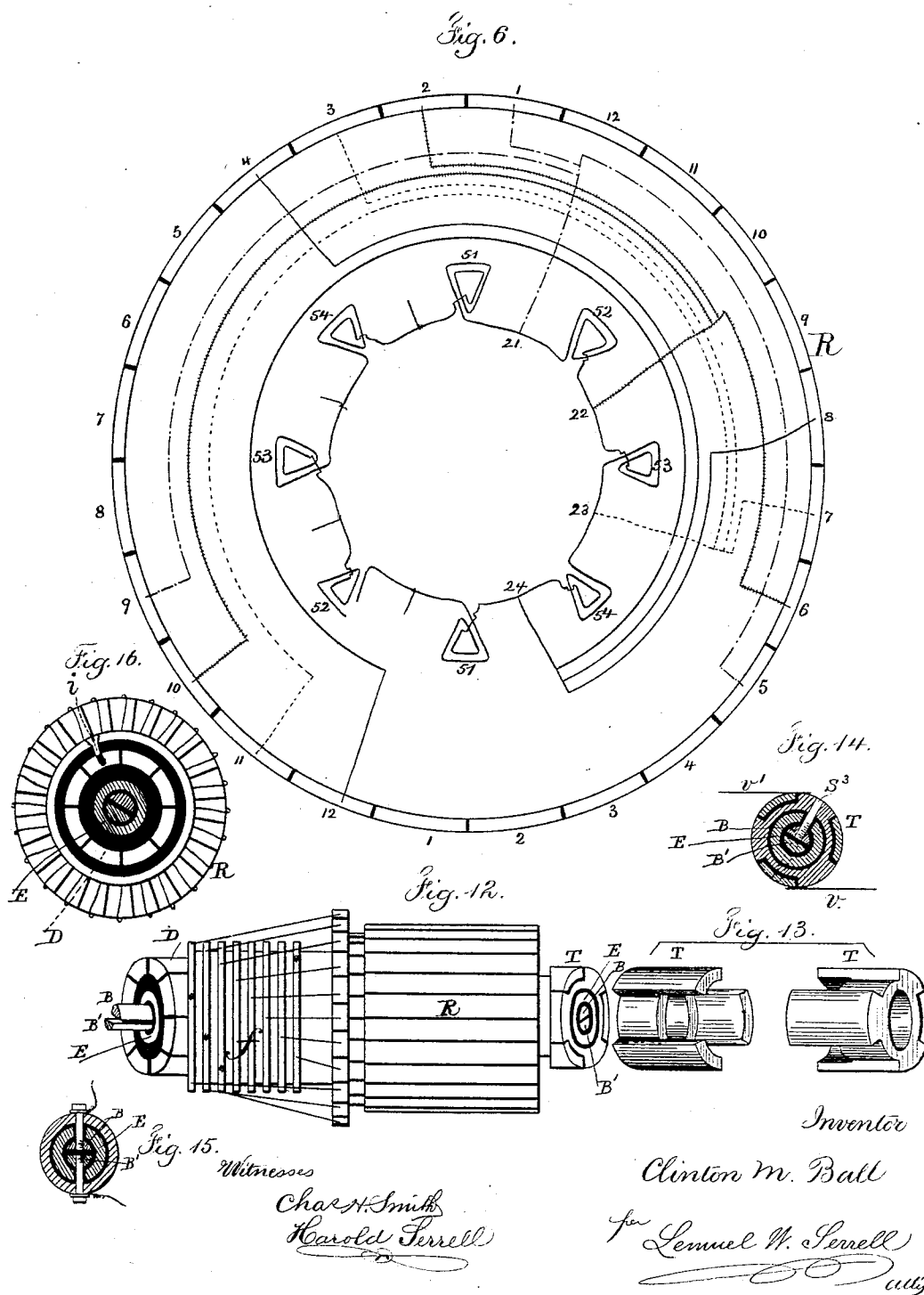
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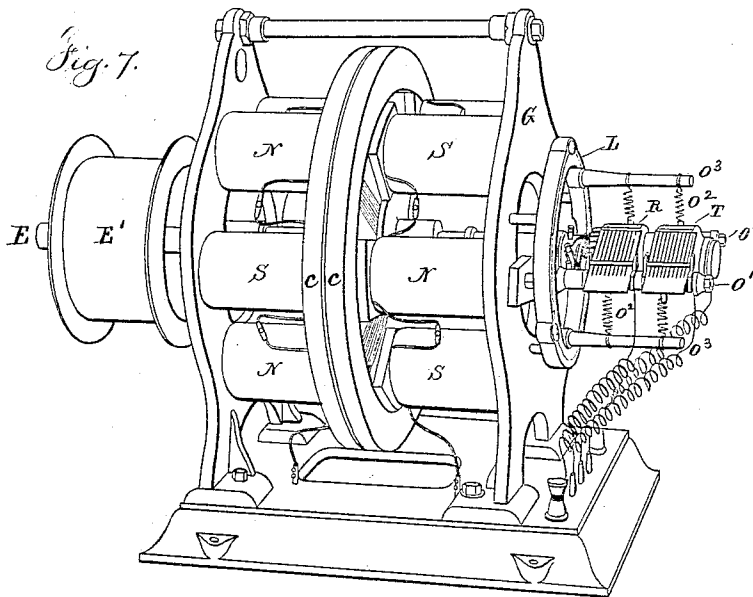
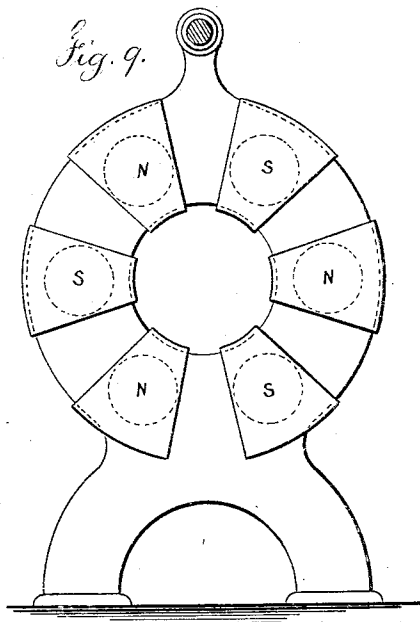
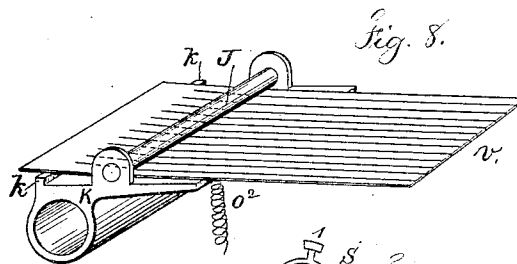
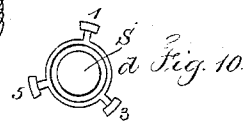
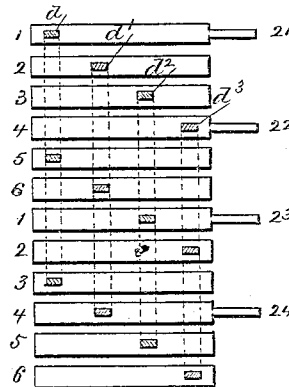


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Witnesses

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UNITED STATES PATENT OFFICE.

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MAGNETO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 290,199, dated December 18, 1883.

Application filed February 25, 1882. Renewed February 27, 1883. (No model.)

To all whom it may concern:

Be it known that I, CLINTON M. BALL, of Troy, in the county of Rensselaer and State of New York, have invented an Improvement in Magneto-Electric Machines, of which the following is a specification.

Magneto-electric machines have been made with armature-wheels that revolve between field-magnets, and such armature-wheels have been provided in some instances with helices in a circular or in an elliptical form, and sometimes metallic cores have been used with such helices, and in other instances such cores have been omitted and in their places have been plates or cores of wood. In these cases the wires or helices have not been disposed so as to have the most powerful induced current set up in them.

The object of my present invention is to construct an induction-wheel without requiring any metal cores, and in such a manner that the magnetism of a circular range of field-magnets will be employed to the greatest advantage in setting up currents in the helices that shall be powerful and free from any reactionary tendency, so that continuous or alternating currents can be taken off from such induction-wheel in one, two, or more circuits. Two or more currents can be taken off that will be continuous and uniform in one direction, and adapted to telegraphic purposes, to plating, or to independently energizing the field-magnets, or for electric lights. Other currents—one, two, or more—may be taken off, so that the polarity alternates, and currents of this latter character may be used for carbon-arc lamps or for incandescent lamps. The various currents are all set up in the induction-wheel on the same principles or mode of operation, and their development in the different forms set forth results from the commutator-connections and from the relative number of field-magnets and coils in the induction-wheel.

I will first describe by means of diagrams the manner in which the current is set up in the coils or bars of the induction-wheel, and then set forth the peculiarities in the construction of the machine in which the induction-wheel is employed.

In the drawings, Figures 1, 2, 3, 4, 5, 6 are

diagrams, more fully explained hereinafter, to illustrate the manner in which the currents are set up and the connections made to the commutators. Fig. 7 is a perspective view of the machine itself; Fig. 8, a perspective view of one of the commutator-brushes. Fig. 9 shows the faces of one of the circular ranges of magnets. Fig. 10 is an end view of commutator-bars and their connecting-ring. Fig. 11 illustrates the different plates and their connecting-rings in the commutator, adapted to the frame of loops shown in Figs. 3 and 4. Fig. 12 shows the commutator-bars for an armature-wheel with a continuous current. Fig. 13 is a perspective view, and Fig. 14 a cross-section, of the commutators adapted to the coils and magnets illustrated in Fig. 2. Fig. 15 shows the connections from the induction-coils, Fig. 2, to the conductors passing to the commutators, Figs. 13 and 14; and Fig. 16 shows a section of the shaft and circuit-bars to the two commutators; and Fig. 17 is a diagram of wire coils, wound to correspond to the loops shown in Fig. 3.

I remark that the induction-wheel is to be revolved in front of the poles of a circular range of field-magnets, or else between the poles of two circular ranges of field-magnets that are placed so as to face each other, as illustrated in the perspective view, Fig. 7, of the machine. The poles in each circular range alternate N S, and these are placed so that the poles which face each other are of opposite polarity. It has been known heretofore that if a bar or wire occupying a position similar to the spoke of a wheel is revolved in front of a circular range of magnet-poles, that on passing a north pole the current would be set up in the wire in one direction, and on passing a south pole in the other direction. Efforts have been made to utilize this phenomenon by employing either circular or elliptical helices, with or without metal cores, and in some cases a flat layer of numerous radial wires, placed about equidistant and connected up into coils, has been made use of. In the latter instance the different parts of the same helix are at the same time under various magnetic influences, and in the elliptical or circular helices the wires are not disposed in such a manner as to

cut the entire magnetic field at the place of greatest energy. I have discovered that by the use of radial or nearly radial bars or groups of wires connected alternately at the outer and inner ends in a revolving induction-wheel, one or more electric currents are developed of great quantity and tension, and with the expenditure of much less power in the rotation of the wheel than in the machines heretofore made. This result I attribute to the fact that the coils or loops of wires or bars are of a triangular or sectoral form; that the induction is effected simultaneously in the two limbs of the triangle that are radial, or nearly so, and there is no portion of the coil or loop in which a counter or neutralizing inductive current can be set up.

In the diagram Fig. 1, I have represented three loops or triangular coils and three magnets with their six poles N S placed in a circular range and at equal distances apart. I remark that the pole-faces are by preference sectoral or trapezoidal in form, as hereinafter illustrated; but for convenience of illustration they are represented in the diagrams as being circular. The radial portions of the triangular helices or loops are equidistant; hence the radial portions pass the field-magnets simultaneously. The currents set up by N are supposed to be moving outwardly, and those set up by S will consequently be inwardly. By following the arrows, it will be seen that the currents flow throughout the loops in the same direction, and at the ends of the loops the circuit-connections are made to six commutator-plates, three of these plates being connected to the end of the loop 32, and the other and alternating three commutator-plates are connected to the end of the loop 33. The brush *v'* will take off the positive current and the brush *v* the negative. When the radial wires are in a position midway between N and S, there will be no induced current, and when the loops pass from S N to N S the current in each loop will be reversed, and so, also, will be the connections to the commutator-springs, so that although the current pulsates and is reversed in the loops it is in a uniform direction at the commutator-springs. The field-magnets being in circular ranges, the respective magnetic fields become neutral at the radial lines equidistant between the respective poles; hence the radial portions of the triangular loops harmonize with the magnetic fields, and enter or leave such fields bodily. In my improved induction-wheel there are no neutralizing influences, in consequence of a current being set up in one part of a coil in opposition to the main induced current, and all the magnetic energy is exerted upon the loops of the induction-wheel. In the form shown by the diagram Fig. 1, the induced current is augmented to the maximum of one polarity when the radial wires are centrally in front of the cores, and then the current subsides to the minimum when the radial wires

are midway between the cores, and then the current is augmented to the maximum of the opposite polarity as each wire passes, respectively, from N to S; but the current in one part of one loop is always in harmony with the current in the other part of the loop, because when one radial wire is in front of S the opposite radial wire is in front of N, and the current passes across the outer sides of the triangles of the loop in the same direction as in the other parts of the wires of the loop. The before-described features and mode of operation prevail throughout all the forms of induction-wheels herein described and represented, and by bearing these in mind the mode of operation of the devices shown in the other diagrams will be easily understood.

In the diagram Fig. 2, I have represented six loops in the induction-wheel, three field-magnets, with their six poles, alternating N S N S around the circular range. The currents set up by S are represented as flowing inwardly and by N as flowing outwardly, and the loops or coils are in a closed circuit around the induction-wheel. The outer ends of the two coils or loops 41 and 42 are brought together. Then the inner ends of the loops 43 and 42 are united, and the outer end of 43 and inner end of 41 are brought together, and to one of the conductors B and B'. By following the arrows, it will be seen that the currents always flow toward and from the respective conductors through each half of the induction-wheel. When the adjacent radial portions of the loops 41 and 43 are in front of S and N, respectively, as shown, the conductor B will be plus (+) and the conductor B' will be minus (-); but when the armature-wheel makes one-sixth of a revolution the direction of current will be reversed; hence, if the insulated conductors B and B' are connected to insulated rings upon the shaft of the induction-wheel, and springs rest thereon, the currents taken off to a circuit with lights or other working devices, will alternate in polarity. If, however, the conductors B and B', Figs. 2 and 15, are connected to rings with alternate commutator-plates, as illustrated by the perspective view, Fig. 13, and section, Fig. 14, the currents taken off by the respective springs *v v'* will in this case pass always in the same direction, but will be intermittent in character, owing to the fact that the change of current-direction in the conductors of the induction-wheel is simultaneous in all the radial parts. Currents of this character may be required for some purposes. They, however, are not suited to the energizing of field-magnets where a continuity of strength is required. I prefer to use armature-wheels in which the number of loops or coils does not correspond to the number of field-magnets in the circular range. I therefore now describe another of the forms in which I have constructed my induction-wheel, as shown in Fig. 3, in which the induction-loops are represented as trian-

gular, with the radial parts at forty-five degrees apart. This has been made of metal bars, to form a frame, and it will be seen that they have the appearance of a Maltese cross.

5 The loops may, however, be made of numerous wires bunched together and bent into the same form, and all the wires connected together at the points 21 22 23 24. This form of loop is adapted to induced currents of
10 quantity; but if each loop is composed of a triangular coil of insulated wire, and the outer and inner ends are connected, as indicated in the small diagram Fig. 17, the same will be adapted to currents of intensity.

15 In Fig. 3, I have represented four induction-loops and six field-magnet cores in the circular range; and I remark that two radial bars with the outer connection between them forming one complete loop should be regarded as one
20 element of the electric-induction system, and two adjacent, NS, poles in the circular range as forming a complete magnet. In this Fig. 3 there are therefore four elements in the induction-wheel and three field-magnets, and there
25 will be six places in the revolution where the induced current will be the strongest in each element—that is to say, the radial portions of one loop in making a complete revolution will coincide nearly on six occasions with the six
30 poles. At that time the strongest current will be set up in that loop, and at the same time the loop at the other side of the axis of revolution will be in the same position to the opposite field-poles; but they are the reverse
35 in polarity; hence from one side will pass a positive and the other a negative current. By following out the arrows it will be seen that the currents set up flow toward the branch 23, and from the branch 21 in the two halves
40 of the induction-wheel divided by the imaginary line xx , and that the currents set up in the radial portions of the induction-wheel follow each other in one common direction throughout half the wheel, and that the currents follow each other in the other half of the
45 wheel but in the opposite direction; hence such currents unite at common points of positive and negative discharge through opposite connections to the commutator-plates, and although the direction of induced current is reversed as each radial portion of the induction-wheel passes from the field N to the field
50 S the currents will still follow each other throughout the respective halves of the induction-wheel and unite at opposite plus and minus connections to the commutator. The change of direction is progressive around the wheel, there being always two opposite radial bars in the most intense portions of the magnetic field, and as these pass out of such field
60 to the condition of neutrality or place of no magnetism, two other bars are coming into the intense portions of the magnetic field. At the same time two bars are at or near the place
65 of no magnetism and merely form conductors for the currents set up in the other bars;

hence there will be no interruption of the current flowing continuously to the commutator-plates. By multiplying the number of elements in the induction-wheel by the number
70 of cores composing the circular range, the product will represent the number of changes induced in one complete revolution of such wheel; but the commutator-plates will only equal half this number, because the same plate
75 that on one side passes a positive current to one of the springs on the other side passes a negative current from the other spring; hence with Fig. 3 twelve commutator-plates will be required, $(4 \text{ loops} \times 6 \text{ cores} = 24 \div 2 = 12)$
80 commutator-plates.

The diagrams Figs. 5, 10, and 11 represent one of the modes in which I connect my commutator-plates to the loops or induction-coils shown in Fig. 3, Fig. 10 being an end view
85 of three commutator-bars and their ring, and Fig. 11 is a diagram showing the parts as if the commutator-bars were laid out in one flat plane, instead of being in a circle. Each three bars are joined by a ring, and the parts are
90 threaded upon an insulating-cylinder around the shaft E, and insulating-washers are placed between the rings, and the bars are on short arms standing out from the edges of the rings, as seen in Fig. 10, so that the bars of one ring
95 do not touch the bars of another ring, and one bar of each group of three is attached to one of the connections between the loops. Thus the bars 1, 5, and 3, Figs. 5 and 11, are upon one ring, d , and the bar 1 is sufficiently long
100 to be attached at the point 21 of Fig. 3. The bars 2, 6, and 4 are on the ring d' , and the end of 4 is attached at 24. The bars 3, 1, and 5 are on the ring d'' , and the end of 1 is attached at 23. The bars 4, 2, and 6 are on the ring
105 d''' , and the end of 4 is attached at 24. This mode of connection is further shown in Fig. 5, where the diagram represents the respective rings, one inside the other, with their connections to the respective commutator-plates
110 numbered as aforesaid, and the lines leading to the induction-loops. 21, 22, 23, 24, Fig. 3, show the places where the ends of the respective commutator-bars in each group connect to said induction-loops.

115 The diagram Fig. 6 illustrates the connections for the generator, in which there are eight armature-helices and six field-magnet cores, the helices being arranged as shown in Fig. 4. In the diagram Fig. 6 the helices are
120 numbered 51 to 54, the same as in Fig. 4, so that the connections can be easily followed. There will be twenty-four commutator-plates, and three branch wires will be taken off between each two helices at the places marked
125 21 22 23 24, to the respective equidistant commutator-plates. Thus at the point 21 the wires will pass to the commutator-plates 1, 5, and 9, from point 22 to plates 2, 6, and 10, from point 23 to plates 3, 7, and 11, and from
130 24 to 4, 8, 12, and so on. Only the wires that have been named are represented in the dia-

gram Fig. 6 to avoid confusion. The other branch wires on the opposite sides are to be connected in the other places in the same order, and are a mere duplication of those represented.

I remark that the outer circles that are divided up illustrate the commutator-plates. They are numbered at opposite sides from 1 to 12, to indicate a repetition of the connections and electric conditions, and the numbers 21, 22, 23, and 24 on the inner circle show where the branch currents are taken off. The helices, Figs. 2, 4, and 6, are numbered at opposite sides with corresponding numbers, to indicate that they correspond in position and action, the current from one side always passing off as a negative current and on the opposite side as a positive current, in consequence of the polarities of the field-magnets, the pole on one side being N and that directly opposite in the circular range being S.

In Fig. 4 the full lines show an induction-frame similar to that represented in Fig. 3, and having the same capacity for use; but by providing the ears at the ends of the outer arcs and enlarging the connections between the inner ends of the radial bars I am enabled to use the same as a frame for carrying a number of triangular coils of wire to form an induction-wheel of great capacity, the triangular or sectoral coils of wire being attached by bolts passing through the holes, or by servings of wire passed around the parts; or one or more layers of these sectoral coils of wire may be placed between two cast-metal frames such as shown in this Fig. 4, and the respective frames can be used to set up separate induced currents in the manner before described; and the layers of sectoral wire-coils also set up induced currents. There, however, will be as many commutators as there are separate induction-frames and layers of coils. In an application of the same date as the present the sectoral coils are shown as secured by flanged rings surrounding them. Such rings are shown at *c*, Fig. 7. This feature is not claimed herein. Fig. 17 illustrates the manner of winding four insulated-wire coils that may be fastened, as aforesaid, to the frame, Fig. 4. By using the open frames shown in Fig. 4 there are numerous openings for the free circulation of air, and there is but little risk of the induction-coils heating.

The diagram Fig. 6 illustrates, as before stated, an induction-wheel with eight sectoral helices, and this is to be used with six field-magnet cores, Fig. 4, in the circular range. In Fig. 7 the induction-wheel is between the two circular ranges of magnets. This arrangement intensifies the action, but does not vary the operation or require any changes in the connections.

A convenient mode of making the circuit-connections from the eight armature-helices to the commutator-bars is to employ eight insulated parallel bars D, Figs. 12 and 16, around

the shaft E, connected at their inner ends at the eight places 21 22 23 24 in the closed circuit of the sectoral helices, and these bars pass along to the eight rings *f*. (See Fig. 12.) These rings are all insulated from each other and from the bars, except that each ring is connected to its bar by a screw passing through the ring and insulating material into the bar, as indicated at *i*, Fig. 16; and there are wires or other suitable connections taken off from the rings to the respective commutator-plates R in the order designated in the diagram Fig. 6.

In place of the rings *f* (seen in Fig. 12) the bars D may be provided with studs screwed into them, and to which studs branch wires are attached and extend to the respective commutator-plates in the order before specified.

The brushes *v v'* of the commutator are each formed of a plate of metal cut into strips by incisions extending nearly across the plate, (see Fig. 8,) and such plate is received into a stock, K, which is provided with a flat surface for the plate to rest upon, a bar, *j*, beneath which the plate is slipped, and a rib, *z*, at the back edge, which raises up the plate sufficiently to bend such plate into a slight curved form, as shown, so that it will be held by friction in the stock, and can be slipped out from time to time as the ends of the springs wear off by contact with the commutator-plates. Each stock is provided with a cylindrical sleeve that is slipped over one of the studs *o'*, Fig. 7, so that they are sustained at the proper place for acting with the commutator-plates, and there is a contractile spring, *o''*, for each brush to draw the same into contact with the commutator-plates. The springs *o''* extend from the respective stocks K of the brushes to the studs *o''*. These studs *o''* and the studs *o'* project outwardly and at right angles to the ring L, that receives its support from the base or frame G of one set of field-magnets. This ring L should be movable, so that it may be turned around (more or less) to bring the brushes into contact with the commutator-plates in which the induced current is the strongest.

The commutators may be applied in any known manner in my machine, and the mode of connection will vary according to the number of commutators and the position in which they are placed. In Fig. 7, I have represented the driving-pulley E' for the shaft E at one end of the machine and the two ranges of commutators at the other end of this shaft; but it will be apparent that the commutators may be upon the shaft E between its bearings and within the circular ranges of field-magnets.

A convenient way of connecting the commutator-plates T with the sectoral induction-coils is illustrated in Figs. 2, 12, 13, and 14. In these the two bars B B' are employed to connect the ends of the induction-coils, Fig. 2, with the commutators T, Figs. 12, 13, 14, said bars being insulated from each other and from the tubular portion of the shaft E, through

which such bars are passed between the induction-wheel and the commutator T, and these bars are connected, respectively, to the commutators, as shown in Fig. 14, by screws s^3 , passing in through the insulating material to the said bars.

In this machine the number of field-cores being different from the number of loops of the induction-wheel, the culminating points of the field-magnets coincide progressively with the radial portions of the induction coils or loops; and the number of field-cores may vary and the number of coils may vary so long as the aforesaid mode of operation is secured.

I claim as my invention—

1. The combination, with the field-magnets and commutators in a magneto-electric machine, of triangular armature-loops connected together and with the two terminals connected to commutator-bars corresponding in number to the field-cores, substantially as set forth.

2. The combination, with the field-magnets and commutators in a magneto-electric machine, of triangular armature-loops connected to each other at their inner ends to form an armature-wheel, and triangular coils of insulated wire receiving their support from such armature-wheel, and circuit-connections to the commutator-plates, substantially as set forth.

3. The combination, in a magneto-electric machine, of a circular range of field-magnets, an induction-wheel composed of a series of coils or loops connected in a closed circuit and differing in number from the number of field-

magnets, and commutator plates and brushes connected between the loops or coils, substantially as set forth.

4. The combination, with the circular range of field-magnets and commutators, of triangular induction-coils connected in a closed circuit with the opposite terminal connections composed of the outer end of one coil and the inner end of the next coil, substantially as set forth.

5. The combination, with the triangular induction-loops, of commutator bars and rings with which the bars are connected, there being as many rings as there are induction-loops, and commutator-bars being connected with said rings, substantially as set forth.

6. The combination, with two circular ranges of field-magnets facing each other, of two sets of triangular induction coils or loops, two sets of commutator bars and springs, and the longitudinal bars and circuit-connections to the commutators, substantially as set forth.

7. The commutator-brush formed of a slotted plate, v , in combination with the supporting-stud, the stock K, having the rib k , and the bar J, beneath which such plate v passes, substantially as specified.

Signed by me this 19th day of January, A. D. 1882.

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Witnesses:

GEO. T. PINCKNEY,
WILLIAM G. MOTT.