No. 664,247. Patented Dec. 18, 1900.

J. B. ENTZ.

DYNAMO ELECTRIC MACHINE.

(Application filed Nov. 27, 1897.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 5.

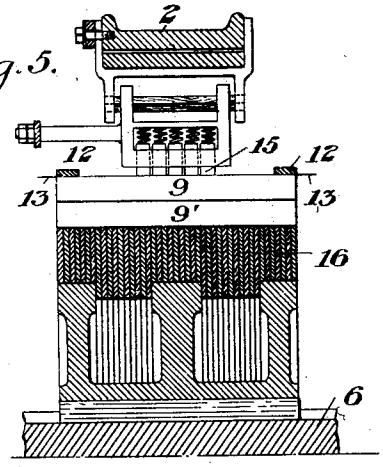



Fig. 2.

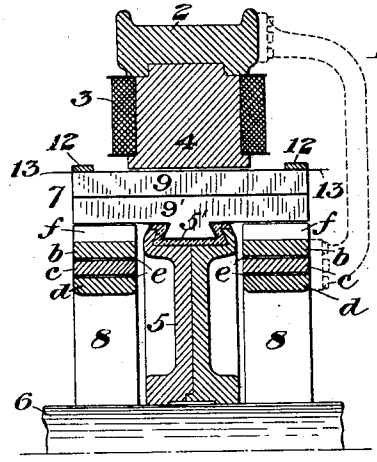



Fig. 1.

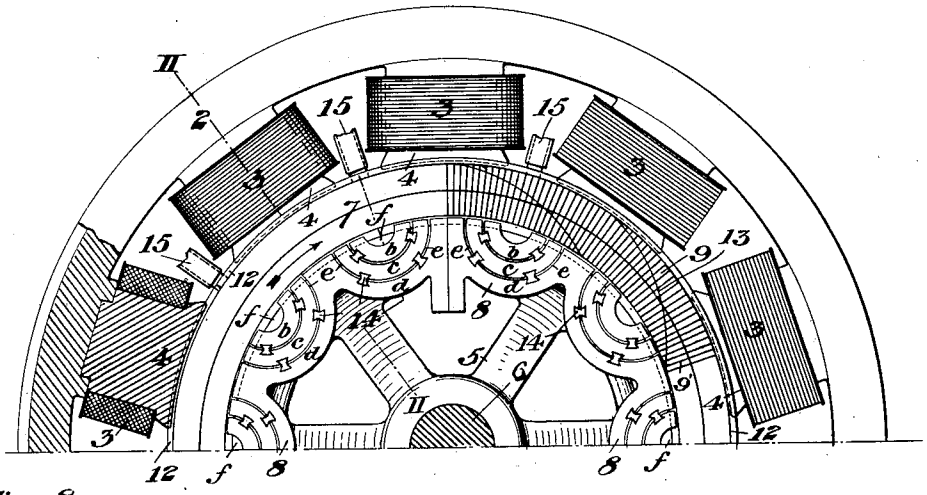



Fig. 8.

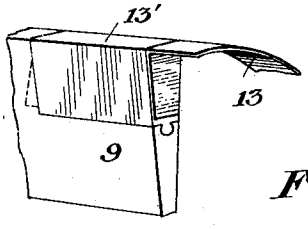



Fig. 6.

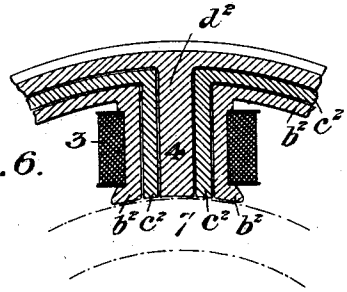
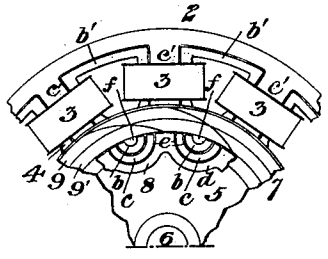



Fig. 7.




WITNESSES

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No. 664,247. Patented Dec. 18, 1900.

J. B. ENTZ.

DYNAMO ELECTRIC MACHINE.

(Application filed Nov. 27, 1897.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 3.

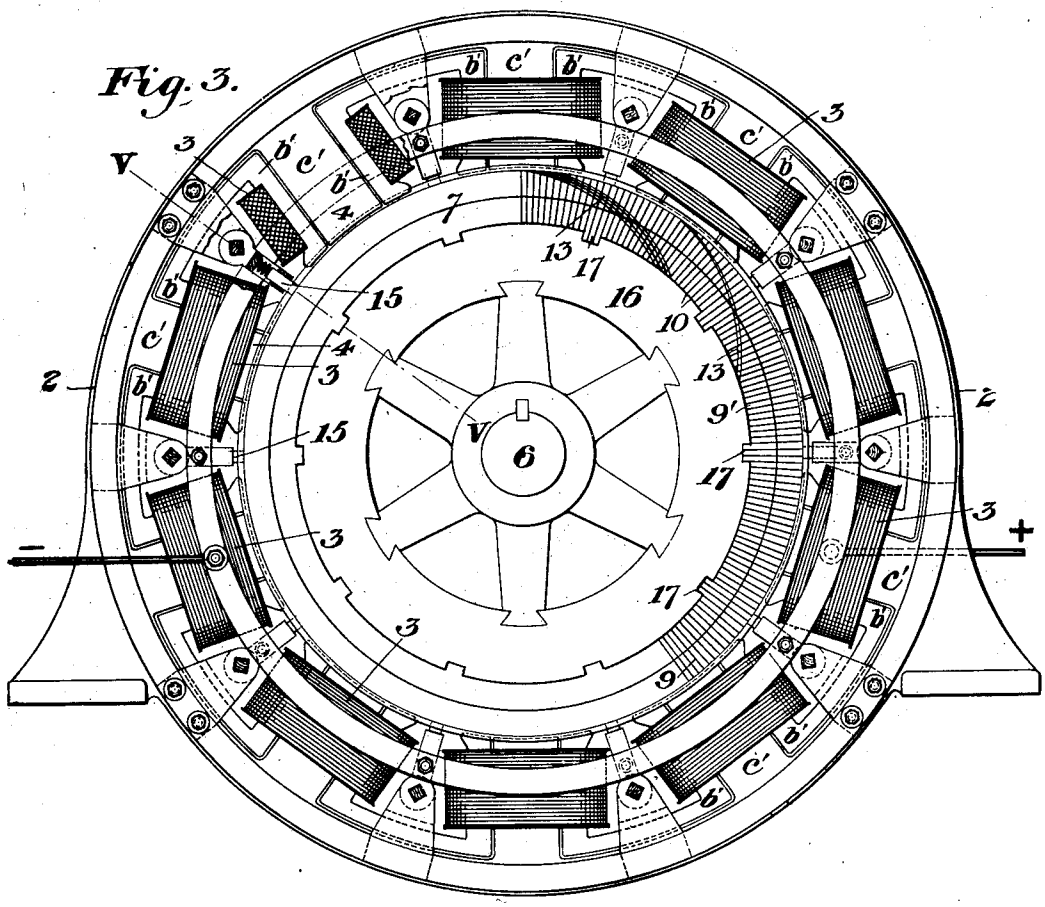
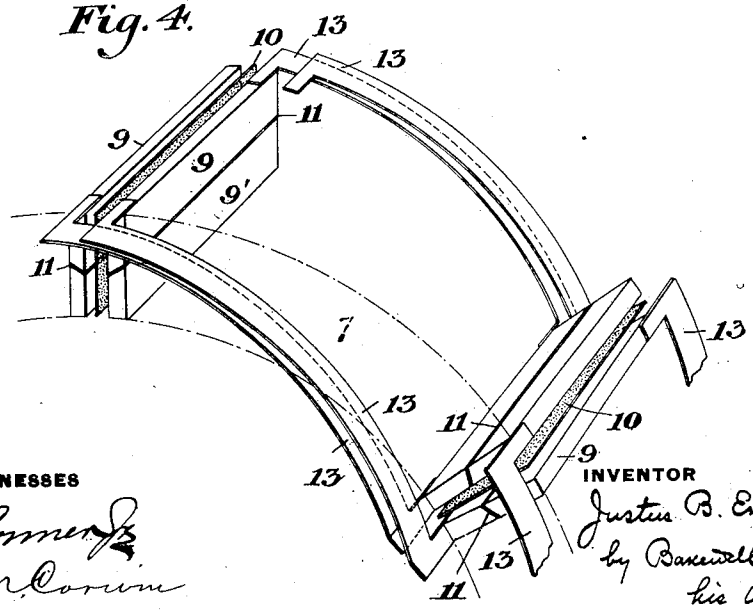



Fig. 4.

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# UNITED STATES PATENT OFFICE.

JUSTUS B. ENTZ, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO GUY F. GREENWOOD, OF ALLEGHENY, PENNSYLVANIA.

## DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 664,247, dated December 18, 1900.

Application filed November 27, 1897. Serial No. 660,008. (No model.)

*To all whom it may concern:*

Be it known that I, JUSTUS B. ENTZ, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Improvement in Dynamos, of which the following is a full, clear, and exact description.

One of the objects of my invention is to increase the output for a given size and weight over existing forms of dynamos, generators, and motors by lessening those conditions of generating electromotive force which cause impairment of efficiency and limit the current or work produced. Such reactions and evil effects are caused by unequal distribution of the magnetic field due to the armature magnetic effect when carrying current and which shifts the position of the neutral or commutating point. Hitherto attempts have been made to correct this by advancing the brushes on the commutator or by changing the distribution of the metal in the ends of the pole-pieces of the field; but such expedients have proved unsatisfactory and inefficient. Other purposes accomplished by my invention are the prevention of sparking in dynamos and the provision of armature-coils which will not only serve the ordinary function of generating electric currents, but which may act also as a commutator and being of low magnetic resistance will serve to bridge the magnetic circuit between the pole-pieces and the armature body or frame most efficiently.

My invention also is designed to effect other advantageous results hereinafter set forth.

In the accompanying drawings, Figure 1 shows in side elevation a semicircular segment of the armature and field of a dynamo-electric machine constructed in accordance with my invention. Fig. 2 is a vertical section on the line II II of Fig. 1. Fig. 3, Sheet 2, is a side elevation of a dynamo, showing a modified construction of the armature and field. Fig. 4 is a perspective view showing the winding of the armature of Figs. 1 and 3. Fig. 5, Sheet 1, is a vertical section on the line V V of Fig. 3. Fig. 6 is a sectional view illustrating a modified construction of one of the field-magnets of Fig. 3. Fig. 7 is a view of a modified construction wherein I combine parts of the structure of Figs. 1 and 3. Fig. 8 is a detail perspective view of one of the armature-strips, showing the commutator-strip secured at the end of the same.

In Fig. 1 of the drawings, 2 represents the frame of the field-magnets. 3 3 and 4 4 are the pole-pieces. 5 is a spider keyed to the shaft 6, carrying the armature 7, which, as shown, is insulated at 5′, Fig. 2, from the spider and rotates within the circle of the field-magnets. Inside the circumference of the armature is a stationary annular structure or frame shown as made in two parts 8 8, which being set on opposite sides of the spider constitute what I term the "armature-body" of the machine. The spider rotates between the parts of the stationary armature-body, causing the annular armature 7 to revolve around the periphery of the same.

The manner of constructing the armature is shown clearly in Fig. 4. It is composed of transverse strips or bars of material having low magnetic resistance, such as iron or steel, preferably of greater depth than thickness, set edgewise and parallel to each other in two annular concentric series 9 9′, the laterally-adjacent strips being separated from each other by insulating material 10, and the two series of strips being also separated by insulating material 11. In order to hold the two series in proper positions, I prefer to bevel their meeting edges or otherwise to interlock them, as shown in Fig. 4. These strips extend from end to end of the armature and are clamped or bound together in a strong solid structure by surrounding straps 12 of non-magnetic material or by other suitable means. Each strip 9 of the outer series is connected, respectively, at its opposite ends with two adjacent strips of the lower series 9′, distant from it a space equal to the distance between two pole-piece centers. These connections are made by metal strips 13, fixed to the ends of the strips 9 9′, and, as shown in Fig. 4, it is apparent that this arrangement of the connecting-strips joins the strips of the armature together in the manner of a continuous coil. This method of winding is what is known as the "multiple-path" winding; but this construction is equally well adapted to what is known as the "series" or "two-path" winding. For lightness and compactness I

make the connecting-strips 13 of copper, its high electrical conductivity rendering it superior to iron for that purpose. The construction of the armature of flat strips of iron renders the arrangement of the connecting-strips very simple and compact, and in this respect the armature is much superior to constructions heretofore known. In Figs. 1 and 3 I show only a few of these connecting-strips, limiting the number in the drawings for the purpose of preventing the construction from being obscure.

The armature-body 8 is composed of iron, chosen on account of its low magnetic resistance; but instead of forming the same in a single piece I make it in bridge-like sections *b c d*, the ends of which being directed toward the pole-pieces constitute parts of the magnetic circuit and bridge the lateral gap between parts of adjacent pole-pieces. Thus the section or bridge *d* has its ends directed toward the middle of adjacent pole-pieces, and each of the parts *c* and *b* has its ends directed respectively toward corresponding points on the adjacent halves of two neighboring pole-pieces. These sections are magnetically insulated from each other by intermediate air-gaps *e*, but may be held together by brass keys 14 or other suitable means. Opposite the neutral point between adjacent pole-pieces the armature-body is cut away or recessed, as at *f*.

When the armature is constructed as above described, I am enabled to dispense with a special commutator and to use the armature itself as its own commutator. I therefore apply the brushes 15 directly to the exposed surface of the armature, constituted by the outer edges of the strips 9, or, if desired, the strips may be extended out well beyond the limits of the field-magnets and the brushes applied to such extensions of the strips. Replaceable iron or copper strips 13′, Fig. 8, may be mounted upon the extensions of the strips 9 to serve as the commutator wearing-surface. I show the brushes in Fig. 5. They may be of any ordinary construction and need no special description here. They are placed between the pole-pieces and bear upon the surface of the armature at the neutral points.

By placing the brushes in contact with the armature itself I get an important advantage in the prevention of sparking at the brushes. In such case owing to its own current there are magnetic poles produced on the armature at the points where the brushes bear, and the lines of force so caused act as a magnetic blow-out to blow out any sparks which tend to form and which might under ordinary conditions assume dangerous proportions.

The subdivision of the armature-body and its arrangement so as to bridge the lateral gap between the pole-pieces entirely prevent evils arising from distortion or shifting of the lines of force emanating from the pole-pieces of the field. For example, with the armature rotating in the direction of the arrow in Fig. 1 the effect of the armature-current tends to increase the intensity of the field opposite the right-hand corner of each pole-piece and to correspondingly diminish the intensity at the left or rear corners. The lines of force, leaving the forward corners of the pole-pieces, are conducted magnetically by the bridge-section *b* to the rear corner of the next pole-piece in advance, and so with the lines of force opposite to the ends of the other bridge-sections, and as the different bridge-sections are separated by air-gaps the lines of force are not diverted from any section in their passage. In this way excess in the intensity of the lines of force at the forward edge of each pole-piece tends to produce corresponding conditions at the rear edge of the next succeeding pole-piece, thus balancing the action and causing the magnetic lines of force to pass with equal distribution or normally from the pole-pieces through the armature into the armature-body. This prevents entirely the evils above referred to and preserves at the proper position the neutral points or diameters of commutation at which the currents induced in the coils by the field are reversed.

The function of the gap *f*, formed in the armature-body, is to increase the magnetic resistance of the local magnetic circuit formed around the coils in the neutral plane, which is opposite to said gap, and thus to cut down the self-induction of the coil, which would oppose the normal change of direction of the current taking place in said neutral plane. Heating and sparking are thus prevented.

By making the armature itself of iron strips, the iron having sufficiently low electrical resistance and a very low magnetic resistance, the strips can be made of as great cross-section as desirable without the disadvantages which would arise from interposing a high magnetic resistance, such as copper, between the field and the armature-body. A low electrical resistance of the armature can thus be obtained without unduly increasing its magnetic resistance. The iron armature also is cheap, and an armature made up in this manner of iron conductors insulated from each other will stand a very much greater temperature than will copper conductors mounted on and insulated from an iron armature-body. The armature is exposed to the air, so that radiation can take place on both sides, on the inside as well as on the outside.

I derive a material advantage from making the revolving armature separate from the armature-body, for by having a stationary armature-body I can cut it away opposite to the neutral plane of the field, and other advantages follow, such as will be appreciated by those skilled in the art. I therefore intend to make special claim to this construction. I show, however, in Figs. 3 and 5 a modification in which some of the important advantages afforded by the construction of Fig. 1 are ob-

tained. In Figs. 3 and 5 the armature-conductors 9 9′ are constituted as in Fig. 1; but the armature-body 16 is fixed to the shaft 6 and is also fixed to the armature-strips by extending some of the strips of the armature into notches 17 on the armature-body or otherwise securing them together so that they will rotate in unison. In such case it is not feasible to subdivide the armature-body in the manner and for the purpose shown in Fig. 1; but I secure a like result by subdividing another portion of the magnetic circuit—namely, the field itself. For this purpose I make the iron pole-pieces of the field in bridge-like sections magnetically insulated from each other by air-gaps, each section constituting part of the pole-pieces of two adjacent magnets. Thus in Fig. 3 the section $b'$, which is in the form of a letter U, forms the adjacent sides of two neighboring pole-pieces and the section $c'$ forms the central part of each of two neighboring pole-pieces, the parts $c'$ in the figure mentioned being integral with or fixed to the iron frame of the pole-pieces.

In Fig. 6 I show a modified construction in which the pole-pieces are still further subdivided, each pole-piece having three sections $b^2$ $c^2$ $d^2$ connected, as by bridges, with parts of other pole-pieces. Such subdivision of the field operates in the manner explained with reference to Fig. 1 to make the lines of force at the pole-pieces uniform and radial in direction and to prevent distortion thereof.

If desired, I may combine the construction of Figs. 1 and 3 by employing a stationary armature-body, (by which I mean, broadly, the part which completes the magnetic circuit from the field,) subdividing said body into bridge-like sections, as in Fig. 1, and subdividing also the pole-pieces of the field, as in Fig. 3. This construction I illustrate in Fig. 7.

Those skilled in the art will be enabled by the foregoing description to modify the application of the principle of my invention in various ways, using some of the parts of my invention separately from the other, changing the form of the winding according to known methods, and altering the construction and arrangement of the other parts. The armature may be made to be stationary and the field revolved, and magnet-coils may be applied to the parts of the armature-body. By the word "armature" I intend to refer generically to the part of the apparatus on or in which are impressed or set up the electric current and electromotive forces. Such changes I intend to cover in the following claims. By suitable changes my invention may be applied to the construction of electric motors.

The advantages of the invention will be apparent to those skilled in the art.

I claim—

1. An electric generator or motor having the magnetic material of the magnetic circuit which is constituted by the field and armature magnetically subdivided as to one at least of its said parts by an interposed medium, such as an air-gap of relatively high magnetic resistance, the subdivisions so constituted extending in the direction of the desired magnetic circuit, and adapted thereby to direct and equalize the intensity of the field of force; substantially as described.

2. An electric generator or motor having the electric conductors of the armature made of material of low magnetic and low electrical resistance, and adapted thereby to serve as a conductor in both the magnetic and electric circuits, said armature made separate from the armature-body as regards rotation; substantially as described.

3. An armature having iron conducting-strips set in transverse position, and in two layers, the outer layer being interlocked to the inner layer and driven therefrom; substantially as described.

4. An electric generator or motor having in combination with the field-magnets, a revolving armature and stationary armature-body having its material subdivided magnetically to equalize the distribution or intensity of the field of force; substantially as described.

5. An electric generator or motor having the electric conductors of the armature made of material of low magnetic and low electrical resistance, and adapted thereby to serve as a conductor in both the magnetic and electric circuits, the magnetic material of the magnetic circuit which is constituted by the field and armature being magnetically subdivided as to one at least of its said parts and adapted thereby to equalize the intensity or distribution of the field of force emanating from or to the same; substantially as described.

6. An electric generator or motor having the electric conductors of the armature made of material of low magnetic and low electrical resistance, and adapted thereby to serve as a conductor in both the magnetic and electric circuits, the magnetic material of the magnetic circuit which is constituted by the field and armature being magnetically subdivided as to one at least of its said parts and adapted thereby to equalize the intensity or distribution of the field of force emanating from or to the same, and having gaps opposite to the points at which the currents induced in the armature by the field are reversed; substantially as described.

7. An electric generator or motor having the electric conductors of the armature made of material of low magnetic and low electrical resistance, and adapted thereby to serve as a conductor in both the magnetic and electric circuits, the magnetic material of the magnetic circuit which is constituted by the field and armature being magnetically subdivided and adapted thereby to equalize the intensity or distribution of the field of force emanating from or to the same, and brushes bearing directly on the armature as on a commutator; substantially as described.

8. An electric generator or motor having the magnetic material of the magnetic circuit which is constituted by the field and armature magnetically subdivided as to one at least of its said parts by an interposed medium, such as an air-gap of relatively high magnetic resistance, the subdivisions so constituted extending in bridge-like portions, such as *b*, *c*, *d*, adapted to span the space from one pole-piece to another; substantially as described.

In testimony whereof I have hereunto set my hand.

JUSTUS B. ENTZ.

Witnesses:
HENRY RAINEY,
G. F. GREENWOOD.