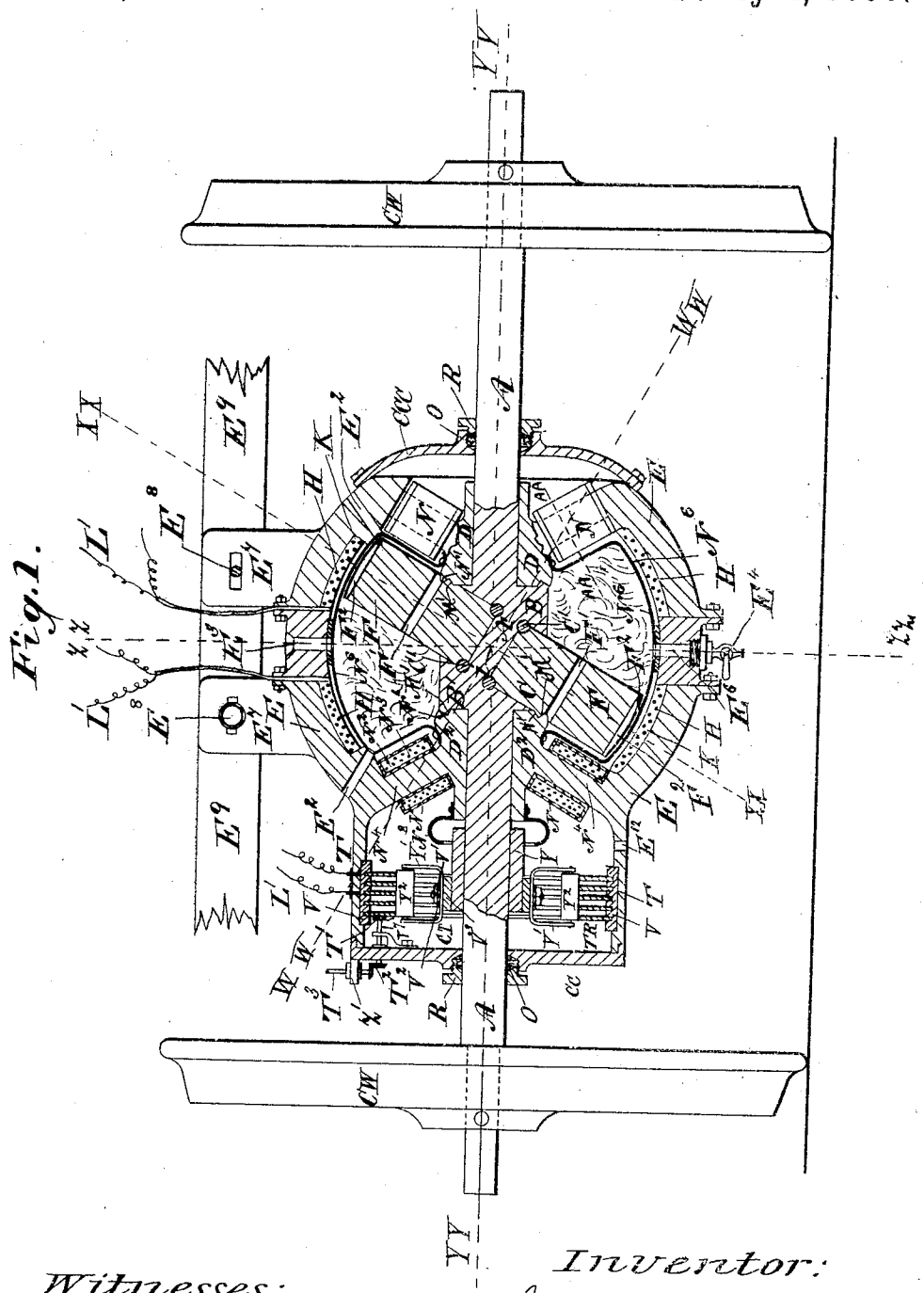
(No Model.) 12 Sheets—Sheet 1.

J. MACHAFFIE.

ELECTRIC MOTOR.

No. 500,663. Patented July 4, 1893.

Fig. 1.



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(No Model.) 12 Sheets—Sheet 2.

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ELECTRIC MOTOR.

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Fig. 2.

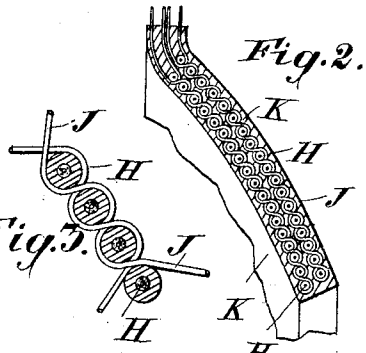


Fig. 3.

Fig. 4.

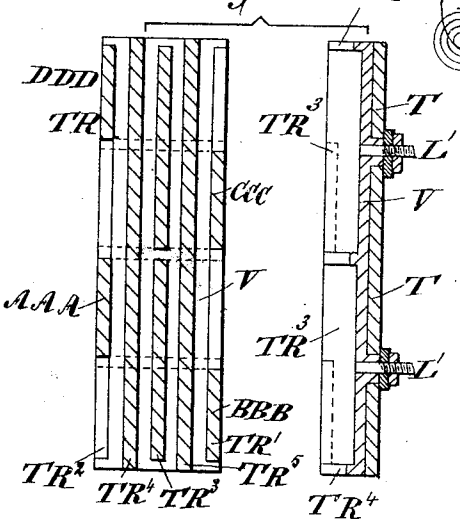


Fig. 5.

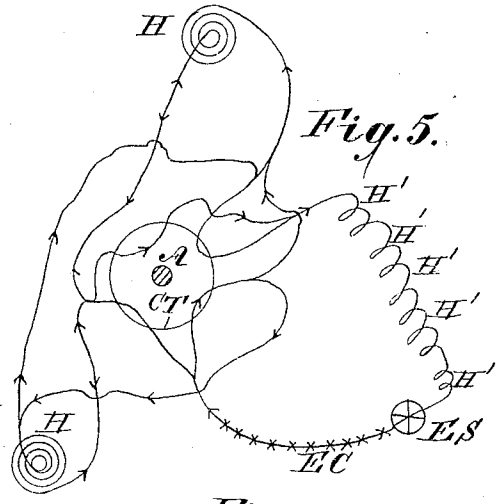


Fig. 6.

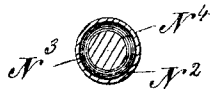


Fig. 7.

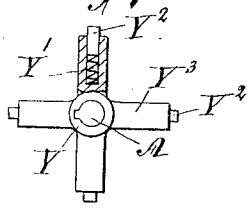


Fig. 8

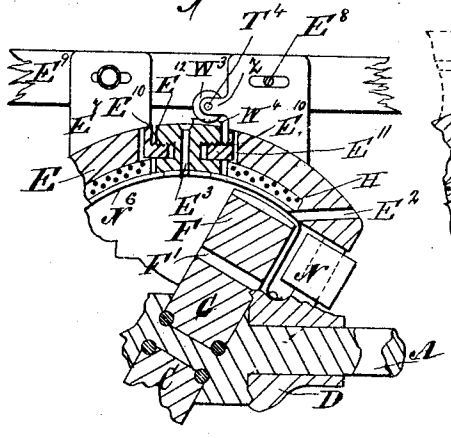
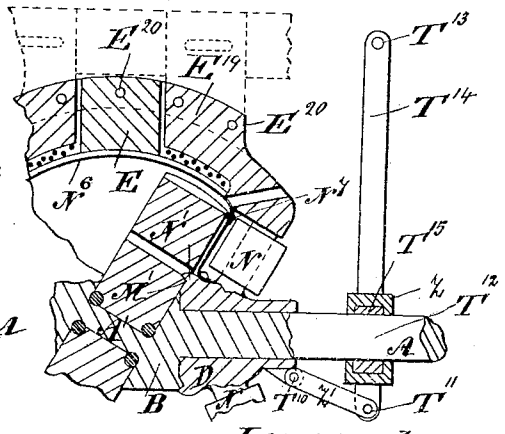


Fig. 9.



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ELECTRIC MOTOR.

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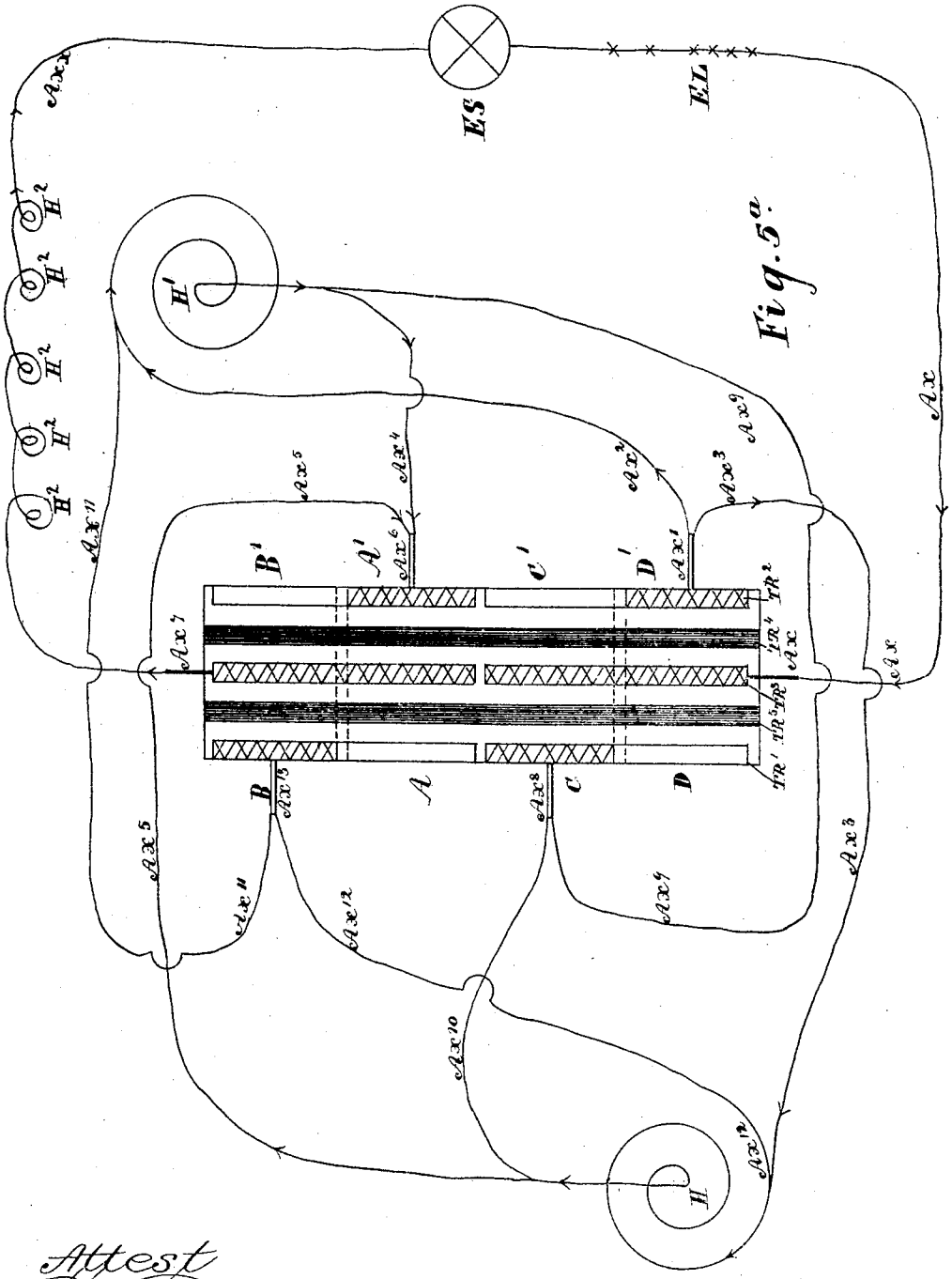

Fig. 5a.

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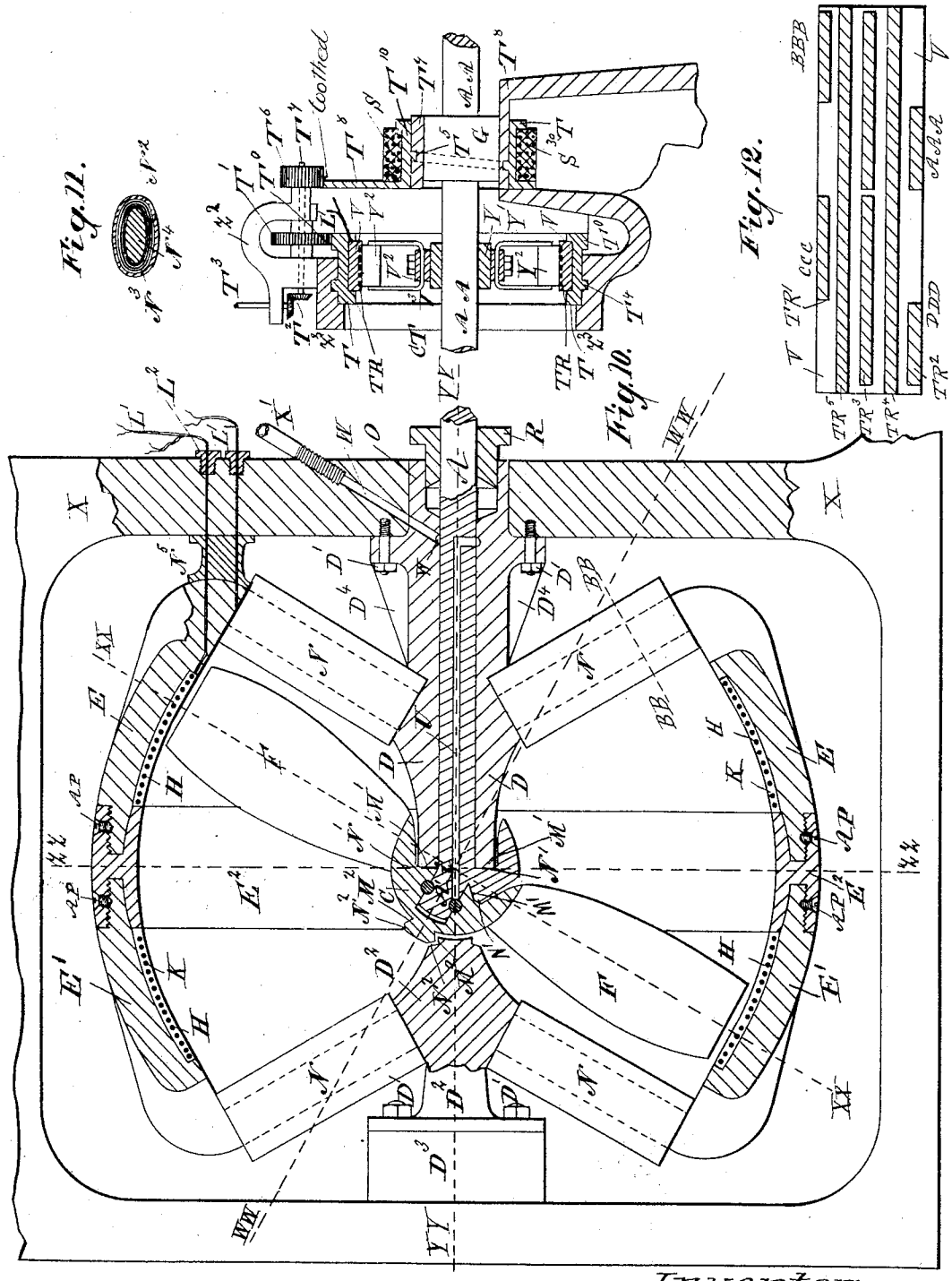

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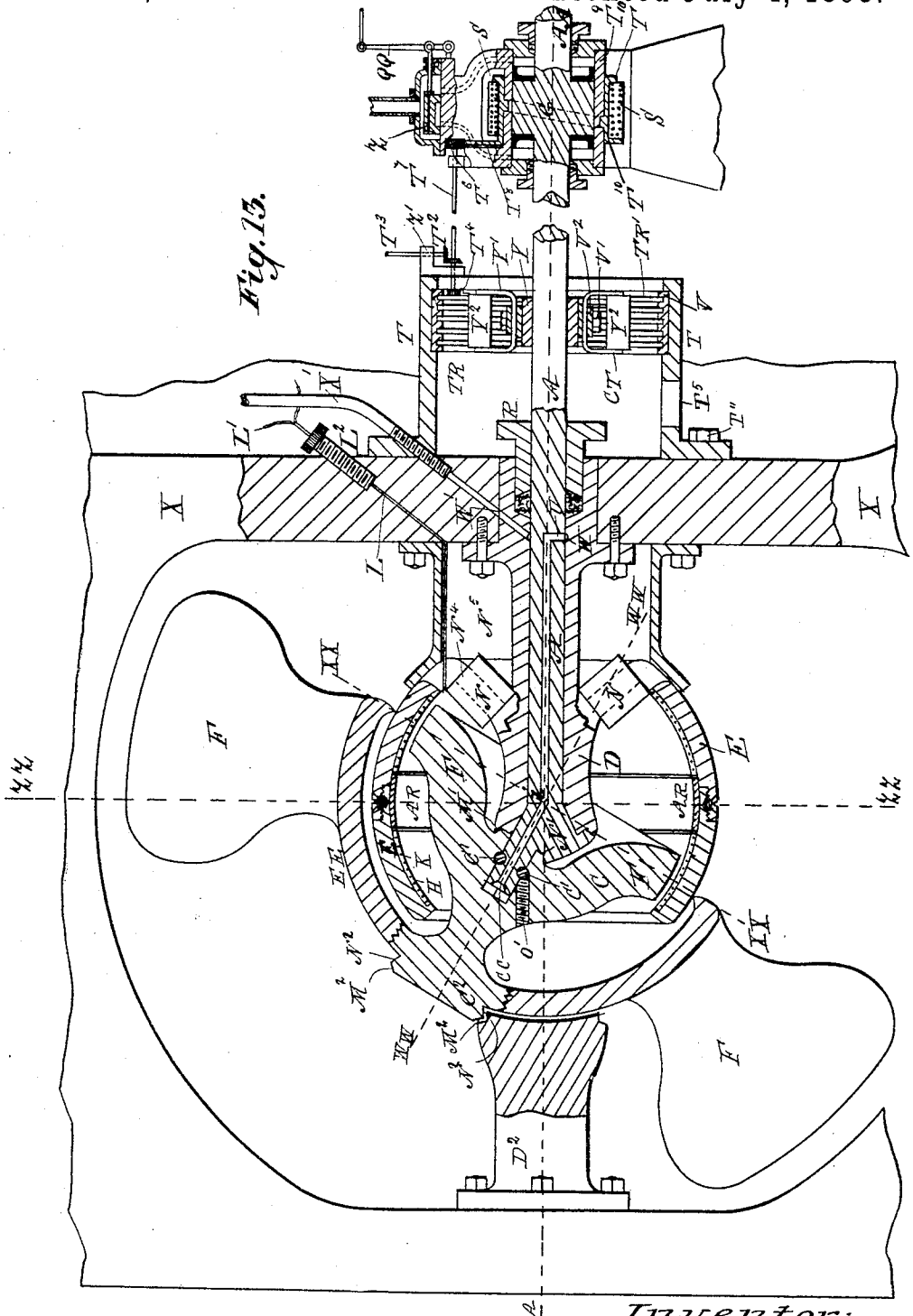
Fig. 15.



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ELECTRIC MOTOR.

No. 500,663. Patented July 4, 1893.

Fig. 14.

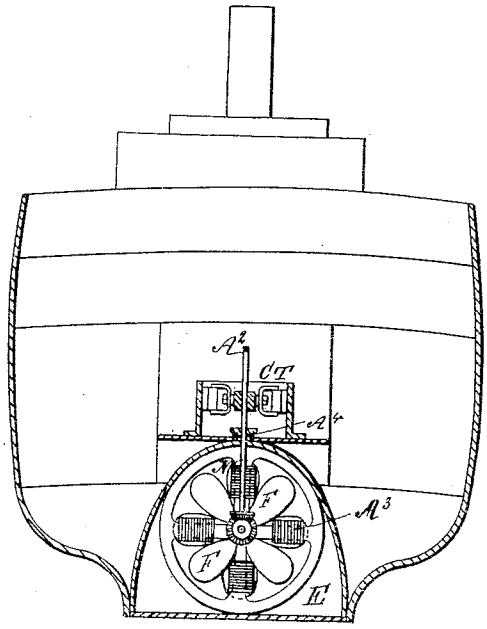
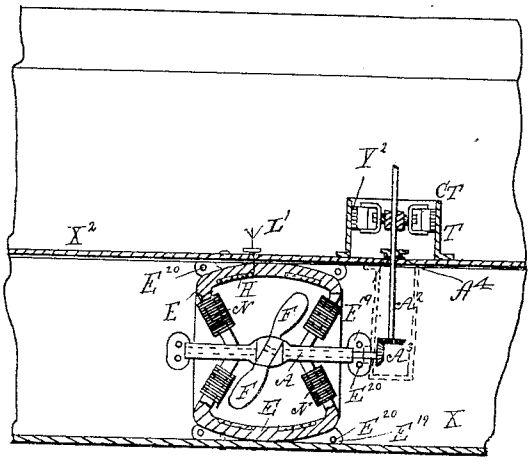


Fig. 15.



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(No Model.) 12 Sheets—Sheet 7.

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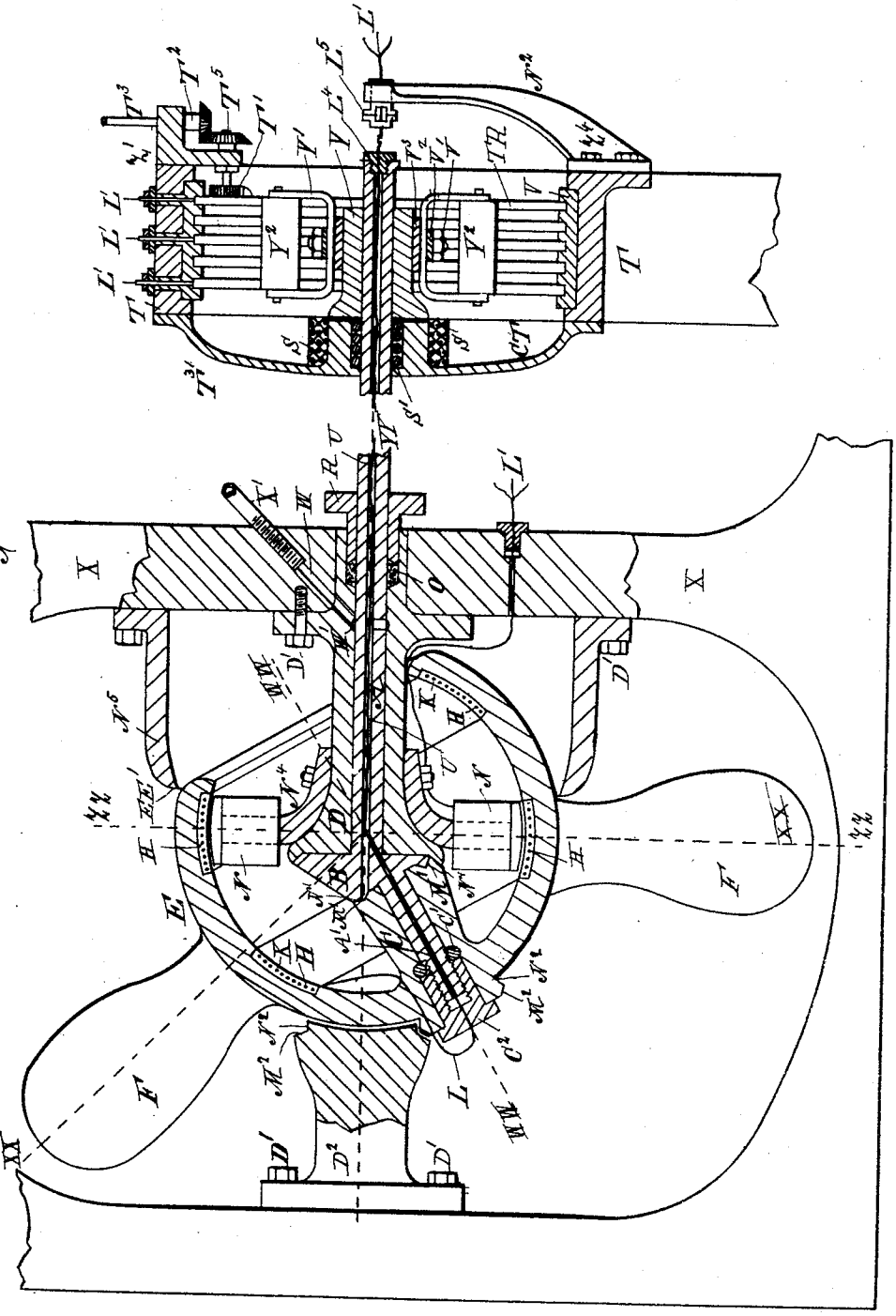
ELECTRIC MOTOR.

No. 500,663. Patented July 4, 1893.

Fig. 16.



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ELECTRIC MOTOR.

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Fig. 14.

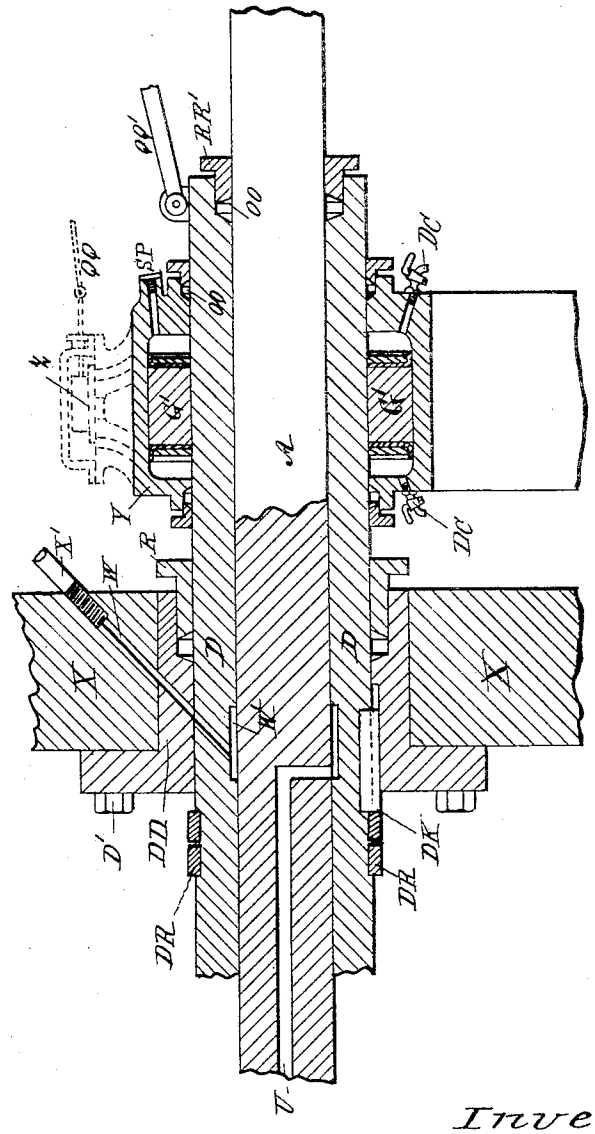

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Fig. 18.

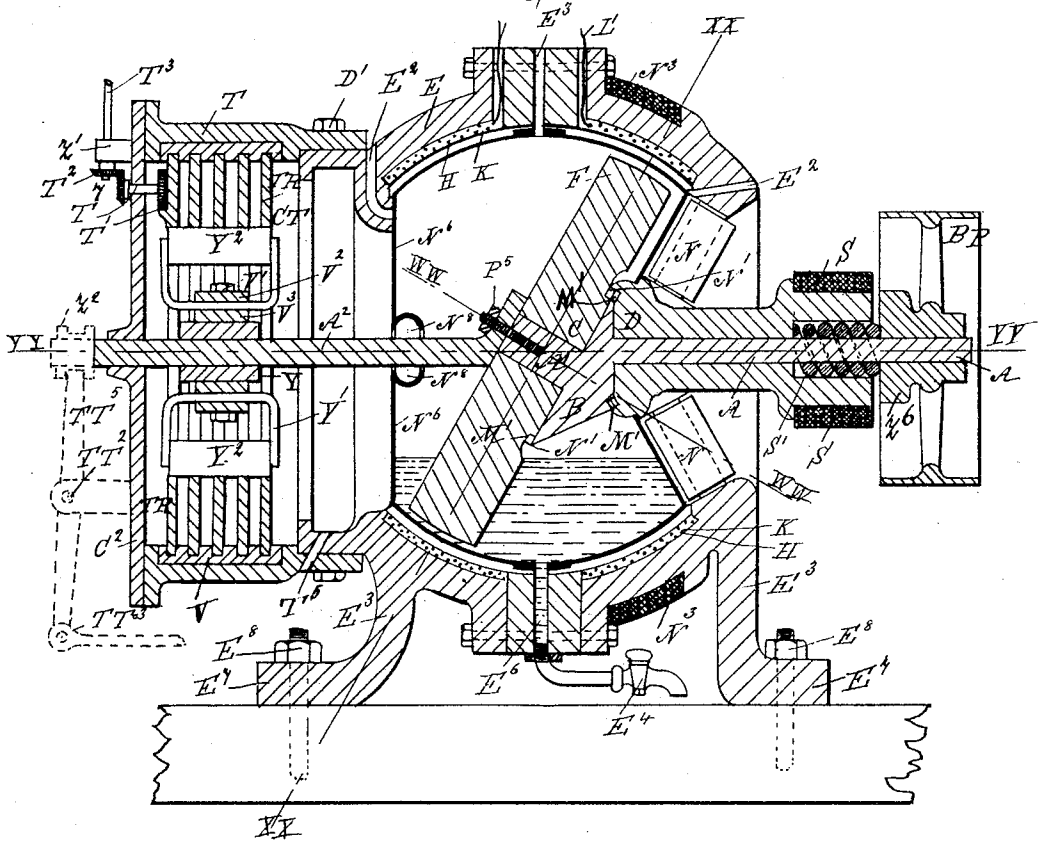


Fig. 19.

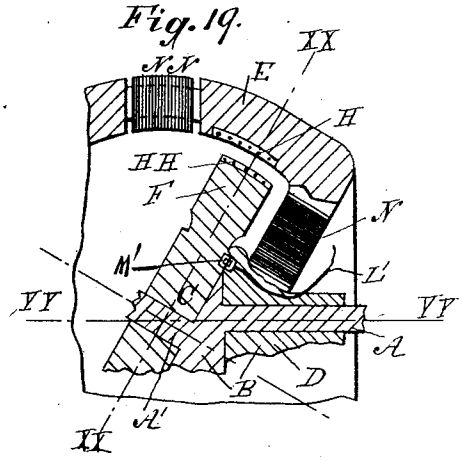
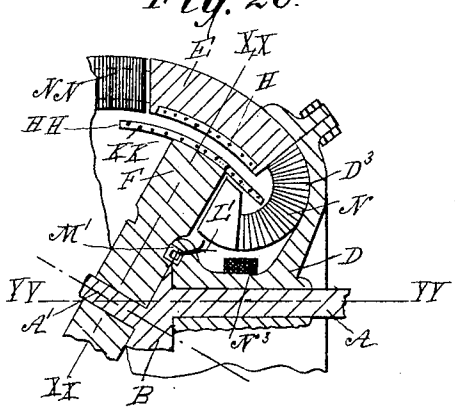


Fig. 20.



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(No Model.) 12 Sheets—Sheet 10.

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ELECTRIC MOTOR.

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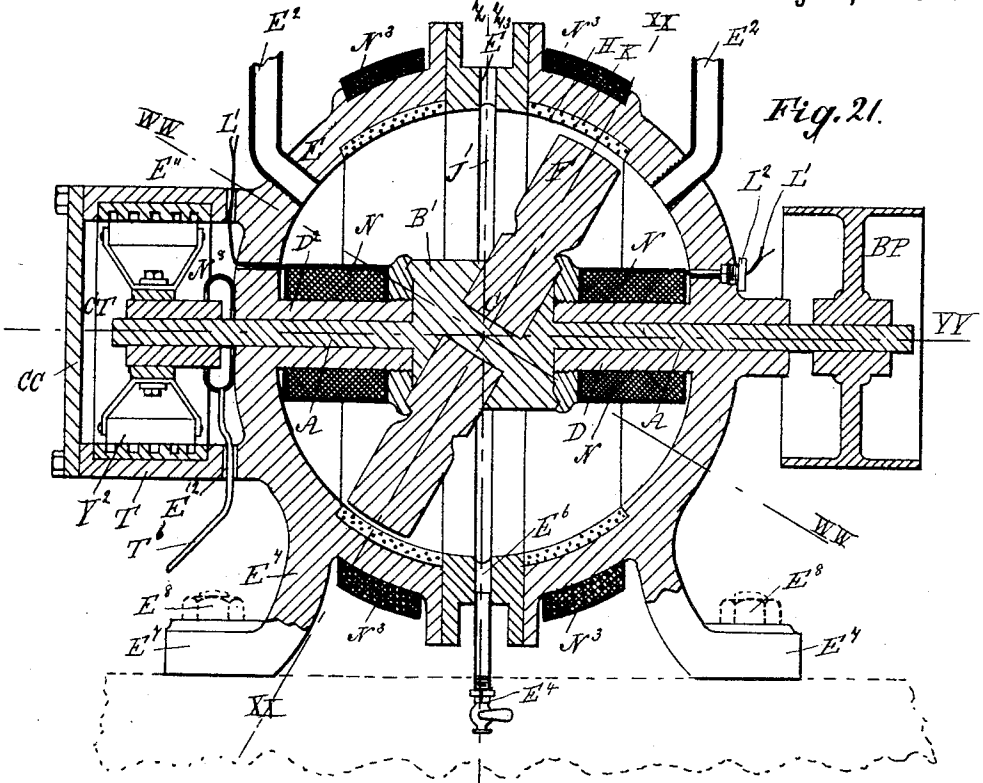

Fig. 21.

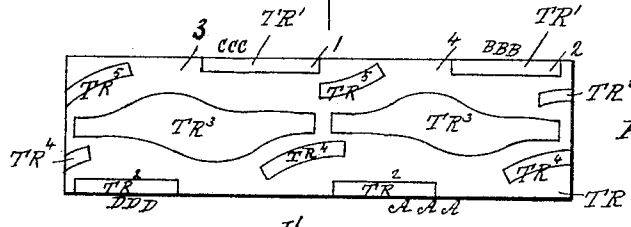

Fig. 22.

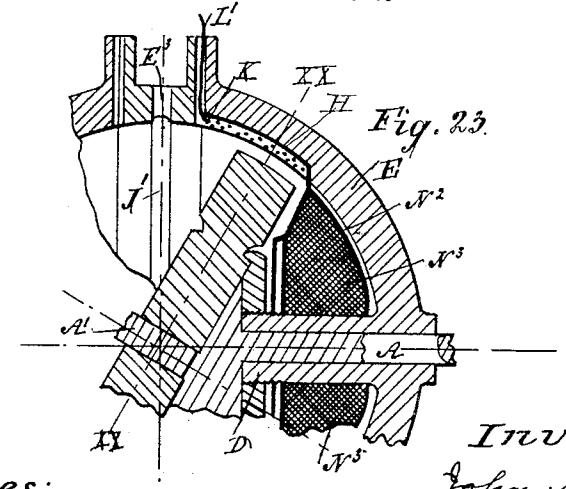

Fig. 23.

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ELECTRIC MOTOR.

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Fig. 24

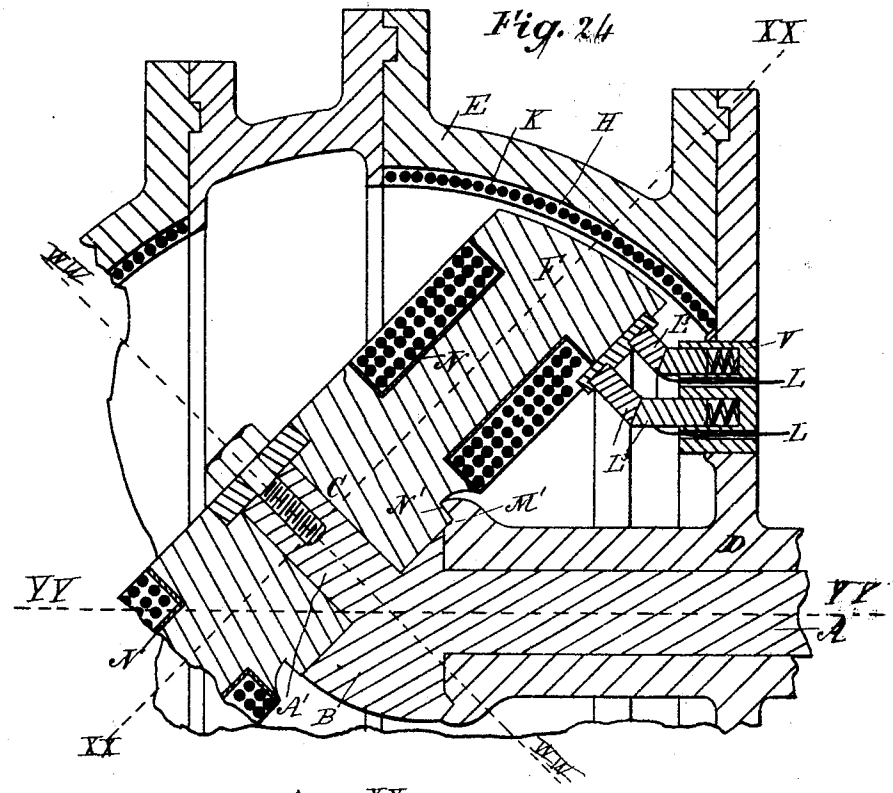


Fig. 25.

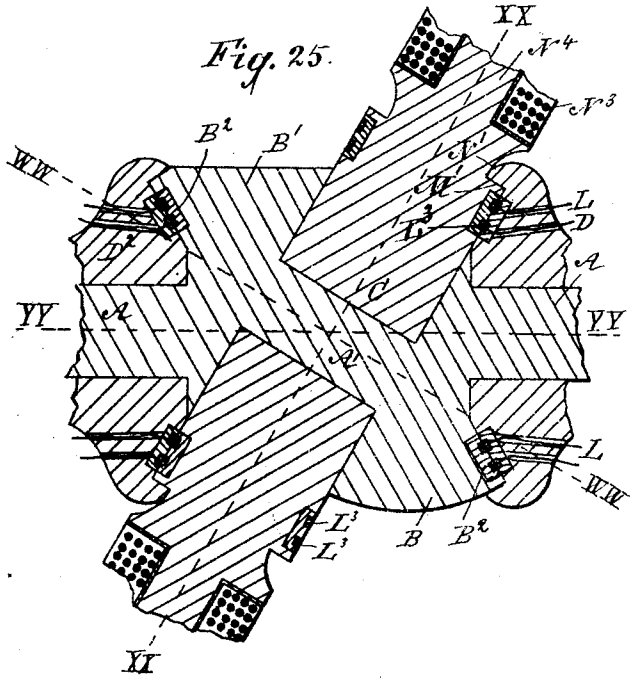
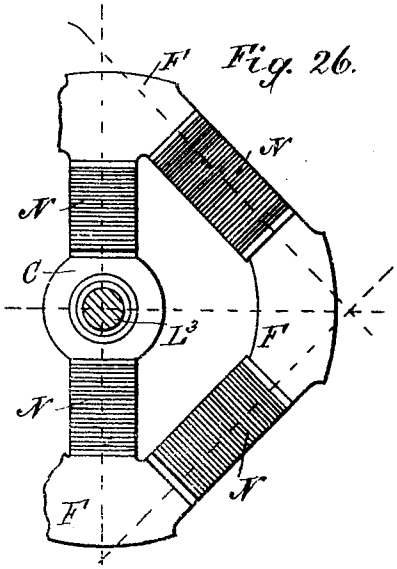


Fig. 26.



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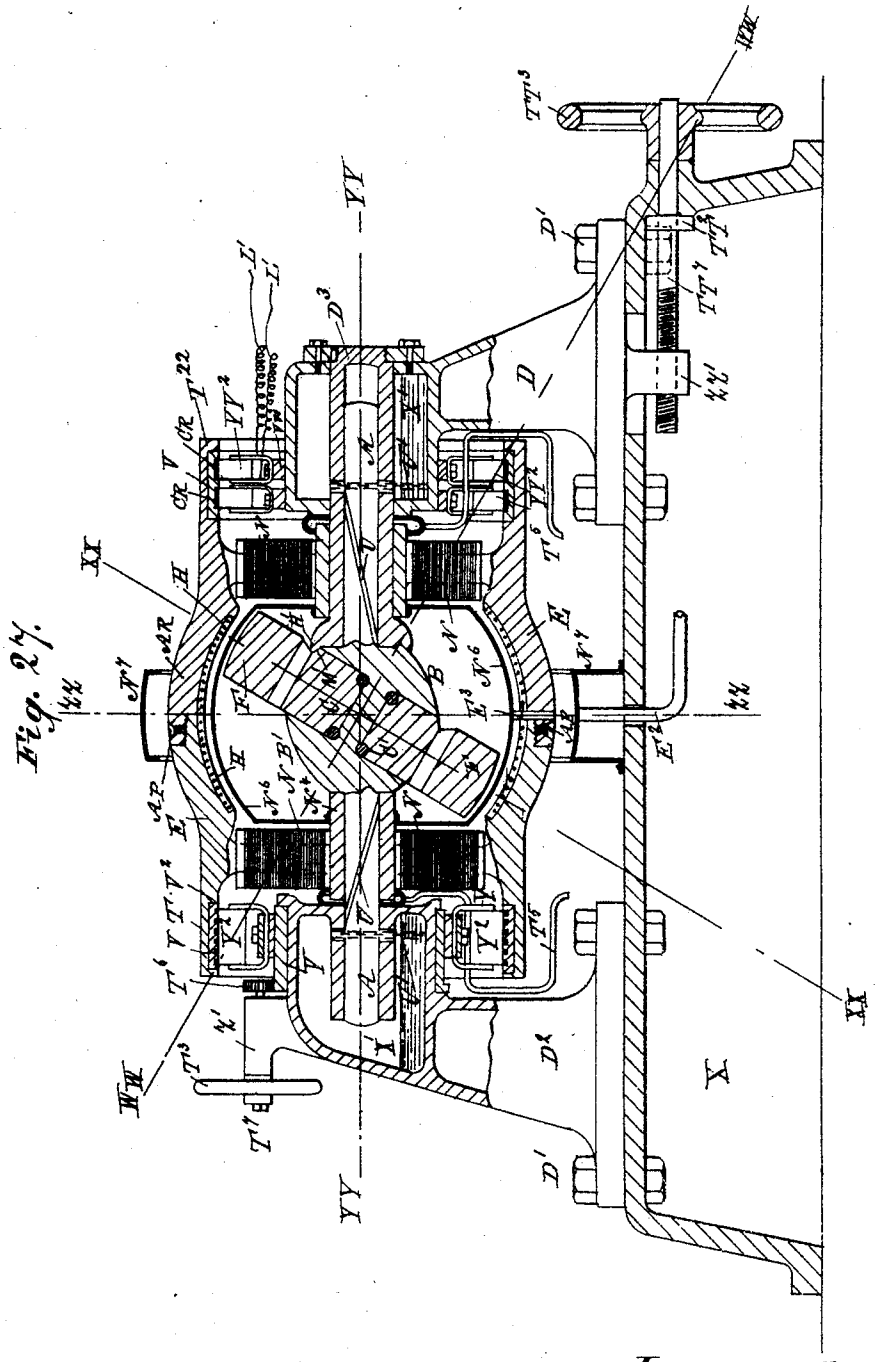
J. MACHAFFIE.

ELECTRIC MOTOR.

No. 500,663. Patented July 4, 1893.

Fig. 24.



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UNITED STATES PATENT OFFICE.

JOHN MACHAFFIE, OF SCHENECTADY, NEW YORK.

ELECTRIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 500,663, dated July 4, 1893.

Application filed October 8, 1891. Serial No. 408,095. (No model.)

To all whom it may concern:

Be it known that I, JOHN MACHAFFIE, a subject of the Queen of Great Britain, and a resident of the city of Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in and Relating to Dynamo-Electric Machines, of which the following is a specification.

This invention relates to spherical armature dynamo electric machines, and it has for its object to so construct such machines, and the parts connected therewith, as to adapt them for the efficient traction or propulsion of any vehicle, vessel or body, as well as for all purposes to which dynamo electric machines, in general, are applied, or are suitable.

The several features of novelty, constituting the invention, are hereinafter pointed out in the claims.

The invention may be put in practice in several ways, and the several parts may be modified or altered, to suit different requirements or circumstances, without departing from the principle of the invention.

In the drawings:—Figure 1 is a longitudinal sectional elevation, showing the invention applied to the axle of a wheeled vehicle. Fig. 2 is an enlarged sectional view of one of the armature coils. Fig. 3 is an enlarged sectional view of four strands of the armature coil, illustrated in Fig. 2, showing the method of binding. Fig. 4 represents a detail sectional view of the commutator. Fig. 5 is a diagram of the electric connections. Fig. 5^a is an enlarged view of Fig. 5, showing the circuits. Fig. 6 is a cross section, through A. A, A, A, of the electromagnets shown in Fig. 1. Fig. 7 is a modified form of the spider of the commutator, shown in Fig. 1. Fig. 8 is a part section of the armature shown in Fig. 1. Fig. 9 is a part section of the framework of the dynamo, showing a modification of that illustrated in Fig. 1. Fig. 10 is a longitudinal sectional elevation of the dynamo, adapted to aquatic service, the pole-pieces being shaped to act as propelling blades. Fig. 11 is a cross section through B. B, B. B, of the electromagnets, shown in Fig. 10. Fig. 12 is a sectional view of the contact surface of Fig. 10. Fig. 13 is a longitudinal sectional elevation of the dynamo, the boss or center being extended and crowned with a hollow semisphere, provided with propelling blades. Fig. 14 is a cross sectional elevation of a marine ship with dynamo at cloven mid-ship bottom. Fig. 15 is a part longitudinal sectional elevation of the same ship. Fig. 16 is a longitudinal sectional elevation of the dynamo, the armature with external radiating propelling blades being the electrical moving part. Fig. 17 is a part sectional longitudinal elevation of a modified form of the dynamo, thrust-block and appurtenances thereof. Fig. 18 is a longitudinal sectional elevation of the dynamo, adapted for general electric or motor purposes. Fig. 19 shows a modification of the coils and electromagnets, shown in Fig. 18. Fig. 20 is a further modification of the coils and electromagnets, shown in Fig. 18. Fig. 21 is a longitudinal sectional elevation of the dynamo, adapted for general service, but more particularly to work as a motor. Fig. 22 is a detail view of the contact surfaces of the commutator, shown in Fig. 21. Fig. 23 shows a modification of the electromagnets' winding, shown in Fig. 21. Fig. 24 is a part longitudinal sectional elevation of the dynamo, the electromagnets being among the moving parts. Fig. 25 shows a modification of the electromagnet electrical contacts, shown in Fig. 24. Fig. 26 shows a modification of the electromagnets, shown in Fig. 24. Fig. 27 is a longitudinal sectional elevation of the dynamo, which may be drive on, or driven from, the periphery of the machine, by any well-known and suitable method.

Referring to Fig. 1:—A is the axle of a vehicle, carried on wheels C. W, and having fitted to, or made in one with it the shoulders B, and B′. The general framework of the car, (which is, or may be, of any ordinary construction,) is not shown. The axle is bent, cranked, or made eccentric, at the part A′. The pole-piece F, which may be a built, (so built for the purpose of erection,) disk of paramagnetic metal, and the boss C, are carried on the axle, as shown. E is the armature body of the machine, and H are armature coils, through which electric current or currents may be passed, (when working as a motor,) as hereinafter set forth. It will be noted that the parts are so constructed, relatively to each other, that the center-line W. W, W. W, of the angled part A′, at its mid-

dle point *i*, intersects the general axis Y. Y, Y Y, of the rotation of said axle A, also the center-line X. X, X. X of the pole-piece F and boss C, and the center-line Z.—Z, Z. Z, of the armature body E. Therefore the intersection point *i* is a relatively stationary point, about which the several moving parts may move in their respective paths, so that there may be a thorough balanced action imparted to said moving parts.

At the ends of the crank portion A′ are the shoulders B, B′, of paramagnetic metal, which are tapered or inclined so as to retain the adjoining parts in correct relative position to one another, and so that the boss C, being placed loosely on said pin or portion A′, is thereby retained in suitable relation to those parts of the general framework, which I have named "thrust-blocks" D, D^2, on one or other of which, at any one instant, the boss C has a greater direct pressure contact on the faces M′, N′, being held thereto by a difference of magnetic intensity in the opposite electromagnets N. In passing from the said pole-piece F to the said armature body E, the "magnetic lines" of force intersect the armature coils H. The boss C is, preferably, as shown, fitted with the double series of anti-friction balls C′, which fit into the fillets of the portion A′ of the axle A, (and are so sunk into the boss C, as to absorb, in rolling action thereon, the friction due to torsional strains. Oblique strain and sliding tendencies, due to the normal impelling action of the pole-piece F, are absorbed in rolling friction on the contacts M′, N′.) The said pole-piece F may be, preferably, built up of two or more parts, in any well-known and suitable manner, to admit of its being placed on the portion A′, and is suitably perforated with a number of holes F′, and provided with grooves F^2 on the periphery, to admit of the passage of oil and air, whenever the pole-piece F impinges against the oil, (shown in hair lines), and air, contained within the oil holder N^6. The oil holder is shown at N^6 and is shaped so as to admit of the normal wabbling action of the pole-piece F, being held oil tight to the thrust-blocks D and D^2, near the parts N′, and by the several oil and air tubes E^2, E^3, and E^6. The tube E^6 is provided with a suitable faucet E^4, for the discharge of waste oil. The tube E^3 is for fresh oil supply, and the tubes E^2 for air ingress and egress, during normal action, with consequent cooling effects.

The armature body E is made in three parts, secured together, so as to insure the necessary spheroidal form, and to retain the armature coils H, with their suitable insulation, binding, and casings K, in position, and also to admit of the termini L′ of the coils H, being suitably led out to form connections, (hereinafter specified,) with the commutator C. T, (hereinafter specified.) The armature body E is shown as having fitted to, or made in one with it, the electromagnets N, which may be of any well-known and suitable construction, number, and arrangement, for magnetic purposes. They are shown arranged radially in this figure, and as projecting out from the thrust-blocks D, D^2, to the armature body E. The armature has also fitted to, or made in one piece with it, the cover C. C. C, having a stuffing box O and gland R. The armature body E is also provided with suitable lugs E^7, which are secured to some suitable and convenient permanent part E^9 of the vehicle, by means of the bolts E^8.

The device C. T. is what I term the "commutator," and it consists of a cylinder T, which is made, preferably, in one with the armature E, and may be provided with a suitable drain E^{12}, for the outlet of any oil which may escape from the holder N^6.

In the cylinder T is embedded, in a suitable insulation V, the commutator rings T. R, one of which is operated by means of a rack, and wheel or pinion T′, which is turned by the spindle T^7. The spindle T^3 has its bearing in the end cover C. C, and is turned by bevel wheel T^2 on the spindle T^4, mounted on a bracket Z′, and connected to an operating handle. With this arrangement, the ring T, R′, (see Fig. 4,) may be easily turned about the axis Y, Y, Y, Y, of the axle A, into the proper relative position to the other rings, so as to effect instantaneous stoppage, start, or reversal, of this dynamo electric machine.

The commutator C. T. has a suitable hub or center Y, grooved at one end or edge to throw off any waste oil into the oil guard N^8, attached to the thrust-block D^2. The groove is not shown on the drawings. Springs Y′ are also connected to the commutator, and bolts or pins V′, suitably insulated as at V^2 and V^3. The springs Y′ carry on their tips, in suitable bearings, the pivots of the conducting rolls, Y^2, which, as the axle A revolves, pass over the inner circumference of the rings T. R, thereby effecting the necessary transpositions of the electric current or currents from one ring to another, and thus effect the alternating changes in the direction of the currents passed through the said armature coils H.

Fig. 2, shows one of the armature coils H, of Fig. 1, on a larger scale, each convolution being suitably insulated and bound together, and the whole suitably incased in the oil-tight casing K, when found necessary. In Fig. 3 the method of binding the said convolutions is shown clearly. J is the binder, which may be of any well known and suitable kind and material, being crossed between and brought tightly over and under each said convolution, as indicated, thus interlacing them. The rings T. R^5 and T. R^4, (Fig. 4), merely afford contact bearings, being complete rings suitably insulated from each other, and without any electric connections. The rings T. R′, T. R^3, T. R^2 are each divided into two parts, insulated each from each, the bearing contacts of T. R′ and T. R^2, being half the length of the same of T. R^3; but all having the same radius, and placed as shown,

and suitably connected by combined bolts and line-pieces L′, to the armature coils H, (Fig. 1), and to the external circuit or circuits, so that, when one of the rolls Y^2, (Fig. 1), may roll in contact, say at section D. D. D, (Fig. 4), closing say the positive current or currents between that section of the ring T. R^2, and the corresponding section of T. R^3, the other roll will be simultaneously closing the negative current or currents between the section A. A. A, and the corresponding section of T. R^3; and so on, closing section B. B. B. simultaneously with section C. C. C, section D. D. D. simultaneously with section A. A. A, and section C. C. C. simultaneously with section B. B. B, as the rolls aforesaid perform their circular paths, thereby alternately opening and closing the said sections, D. D. D; A. A. A; C. C. C; and B. B. B; of the said rings T. R′, T. R^5, T. R^3, T. R^4 and T. R^2, in order to maintain a continuous current or currents in the external circuit or circuits, and alternating current or currents in the internal circuit or circuits, in cases where this difference between the said currents of the said circuits is expedient. It is evident that said rings T. R′, T. R^2, T. R^3, may be suitably divided, and a suitable number of rolls Y^2, (Fig. 1), employed, to effect the proper transpositions, for any suitable number of armature coils, which may be suitable, as the case may be.

Fig. 5 is a diagram of the electric connections of the dynamo in general. The following explanations will render this diagram in Fig. 5, plain to those skilled in the art:—H represents the armature coils, and H′ the helices, (of which there may be any convenient number,) of the electromagnets. C. T. represents the commutator, and E. C. the external circuit of either the generated or derived current or currents, the crosses thereon indicating electric current sources, or lamps. It will be noticed that the arrow heads plainly show alternating currents in the armature coils H, and the general internal circuits, passing in and out through the respective quarters of the said commutator C. T, and a constant current through the general external circuit E. C; and it is evident that suitable connections to and from the said rings T. R′, T. R^2, T. R^3, and T. R^4, (Fig. 4,) may be made to suit any number of armature coils H. (Fig. 1,) which may be adopted: and moreover, that in any case where alternating current or currents may be preferable in both the external and internal circuits, (Fig. 5,) the said commutator may not be used. E. S. is the source of electricity.

The action of the machine is as follows, reference being made to the enlarged diagram Fig. 5^a which will be well understood by electricians, and on which E S shows the source of electricity, which may be a dynamo, storage batteries, &c.: The lines A x represent the wire connections, H, H′, the armature coils T R′, T R^2, T R^3, T R^4, T R^5, the commutator rings, and H^2 the magnet coils. The ring T R^3 is made in two parts, with a space between them, as shown, and one part A—x of the external circuit wire is connected to the one part, while the other part of the circuit wire, A—x—x, is connected to the other part. E—L are lamps. Presuming that the machine Fig. 1, is acting as a motor, then the object aimed at is to impart, at suitable times, simultaneous transient and opposite impulses to the parts of the volume of disk F, under the influence of the magnet fields within the coils H, H′ so that, as a result of these impulses in combination with the controlling effects of the rolling contacts M′, N′, such an oscillatory-reciprocative and revolutionary action will be imparted to the disk F that, consequently, as long as the conditions be maintained, disk F forces crank A′ and shaft A round and propels the vehicle. The magnet and armature windings may be either "series" or "shunt," but, presuming that they are wound in "series" let it be supposed that the rollers Y^2 of the commutator are in contact with the divisions A′, D′ respectively, of the ring T R^2 and also with the portions of the ring T R^3 the rings T R^4 and T R^5 being inactive and merely supports, then the electric current from the external circuit A—x will pass from the lower part of ring T R^3, through the roller Y^2 in contact with it, to the division D′ of ring T R^2 and from thence, by wire A—x' to the branch wires A—x^2 and A—x^3 and would be divided, one current passing to armature winding H, and the other to the armature winding H′ (see arrows Fig. 5^a). The current, passing through the armature windings H, and H′, would convert said windings, for the time being into solenoids, and, as a result, the disk F would be impelled. The coils H, H′ are wound spirally, so that the portions of the disk F, which come under the respective combined control of the coils H, H′ and the magnetic fields induced in the immediate vicinity of suitable portions of the coils, H, H′, are impelled in opposite directions across the said induced and directed fields, *i. e.*, the upper part of said disk F is impelled to the left hand, while the lower part is, at the same time, impelled to the right hand. From the coils H, H′ (while the rollers Y^2 are still passing over the divisions D′ and A′ of the ring T R^2), the electric current passes by the wires A—x^4, A—x^5, respectively, to the connection A—x^6 where the divided current is again united and passes by the division A′ of the ring TR^2 and the roller Y^2 in contact therewith, to the upper portion of the ring TR^3 and out of the commutator, through the connections A—x^7 to the "series" windings H^2 of the magnets N, thereby producing in the latter magnetic fluxes. After passing through the windings of the magnets N the derived electric current completes its circuit by the external wire A—x—x back to the other terminal of the wire A—x. By a well-known law of magnetic circuit, these induced

magnetic fluxes in the magnets N will assume a path of least resistance to complete their circuits round the windings H^2 of the magnets, therefore, cover C, C, C and rolls Y^2 being of diamagnetic material, the "magnetic lines" must (see Fig. 1) travel through the provided paramagnetic circuits, *i. e.*, through the armature E, disk F, shaft A, and blocks D, D^2 cutting the coils H, H′ in their respective paths. But, as the coils H, H′ are solenoids, when the magnetic lines cut through them, by a well known law of motor action, the disk F, being the only part free to move, will be impelled to roll on the contacts M′, N′ thus causing, since the disk is mounted on crank A′, shaft A to revolve about its axis, through ninety degrees. At this juncture, let it be supposed that the disk F has been impelled over the opposite side to that shown at Fig. 1, then it is evident that the disk must be impelled in an opposite direction, that is, back again in order to force it out of position and, at the same time, complete another ninety degrees of a revolution. This is done by reversing the currents in the armature coils, H, H′. The reversal is effected by the rolls Y^2, which, during the movement of the disk F and shaft A, have now traveled round until they cease to be in contact with the divisions D′, A′ of the ring T R^2 but have run into contact with the divisions B, C, of the ring T R′. As a consequence, the electric current from the line wire A—x, now passes from the lower division of the ring TR^3, through the roll Y^2 for the time being in contact therewith, to the part C of the ring T R′ and from thence, by the connection A—x^8, into the branches A—x^9 and A—x^{10} and so to the armature coils H, H′. The current as indicated by the arrows, now passes in a reverse direction, through the coils, the circuit being completed through the wires A—x^{11} and A—x^{12} connection A—x^{13}, section B of ring T R′, the roll Y^2 in contact therewith, the upper part of ring T R^3, connection A—x^7, coils H^2 of magnets N and external circuit A—x—x. As a result of this reversal of the current, the impulses of the coils H, H′, act on the disk F, in an opposite direction, and, as a consequence, turn it and the shaft through other ninety degrees, when again, by the movements of the rolls Y^2 the currents are reversed, and so on, the currents being reversed at every ninety degrees of the revolution of the shaft. As will be seen, since the rolls Y^2 are mounted on the shaft A, the action is continuous and automatic so long as the supply of electricity is maintained.

In Fig. 5, the reversed or alternate currents are plainly indicated by the arrows.

The cross section shown in Fig. 6, is through A. A, A. A, (Fig. 1,) of the electromagnets N, and shows the electromagnet core N^4 insulated from and surrounded by the helix N^3, which may be insulated or covered in any well-known and suitable manner. N^2 represents the covering.

Fig. 7 shows a modified form of spider for the commutator C. T. (Fig. 1), and may be used in lieu of the spider there shown with the rolls Y^2, in any case where suitable, or where brushes Y^2, (Fig. 7,) of any well-known and suitable type and material, may be preferable to rolls Y^2, (Fig. 1.) It will be noticed that the springs Y′, (Fig. 7,) in the sockets or arms Y^3, keep a constant initial outward pressure on the brushes Y^2, to keep them in contact positions, when the centrifugal force, due to revolution, may be small or *nil*. With this arrangement, as portrayed in the aforedescribed figures, though with special reference to Fig. 1, if suitable electric current or currents be, as hereinbefore specified, conducted through the armature coils H, then, by the well-known principle of action of so called "electric motors," the disk pole-piece F, with its boss C, being the only part free to move under the conditions, and having suitable contacts at its boss C, at any one instant, with either one or other of the thrust-blocks D or D^2, at the surfaces M′, N′, is impelled to move as nearly at right angles to the said armature coils H, opposite, or in the vicinity of, each electromagnet N, as the rolling action of the said boss C on the said contact surfaces M′, N′, will permit, which said impelling action is caused to be repeated in suitable, successive order, by the commutator C. T, alternately changing the direction of the said electric current or currents passed through the said armature coils H, so as to cause the said pole-piece F to wabble, with the intersection point *i* as center. The result of the construction is that the movement is equivalent to that which can be effected by any well-known form of gearing, thus effecting in this case, or in any other case, by the means shown in Fig. 1, a so called "gearing down" effect, from the angular velocity of the pole-piece F about the point *i*, to the angular velocity of the axle A about its axis Y. Y, Y. Y, without the intervention of so called "gearing." It will be noted that if, in any case, said contacts M′, N′, on the said boss C, may be preferably less in diameter than the corresponding contacts M′, N′, of either one of the said thrust-blocks, a so called "gearing up" effect would thereby be effected.

In order to reverse the dynamo, the operating ring, say T. R′, (Figs. 1 and 4), of the commutator, may be turned, by means of the wheels T^2 (Fig. 1), and spindle T^3, through one hundred and eighty degrees or any other suitable angular quantity, thereby reversing the order of sections D. D. D, C. C. C, A. A. A, B. B. B, (Fig. 4), and in order to maintain a stoppage of the dynamo, the same ring, say T. R′, may be turned, by the same means, through ninety degrees, or any other suitable angular quantity, thereby destroying the alternating order of the transpositions through the divisions D. D. D, A. A. A, C. C. C, B. B. B. In order to reverse these operations, the said ring T R′ may be either turned the reverse way, or still farther in the same direction,

until the said sections D. D. D, A. A. A, C. C. C, B. B. B, may have the necessary relative order to produce the desired results.

It will be noticed that if an oil or lubricant be used, which is a non-conductor of electricity at the voltage at which this dynamo may be worked, then the oil-holder N^6 (Fig. 1) may be omitted, when the whole machine becomes simultaneously an oil holder; and it will be noticed that, in any case whatever, the contact surfaces M′, N′, at and on one or other of the said thrust-blocks, may have different diameters from the similar surfaces at and on the other thrust-block, with their corresponding surfaces M′, N′, of the boss or center C, thus effecting a difference between forward and reverse velocities, in any case where preferable, as, for instance, to return energy to the general circuit or circuits, when a car or other vehicle, may be descending a grade; and, moreover the said electromagnets N, may be substituted by permanent magnets, if preferable. If the aforesaid difference of magnetic intensity or intensities, between opposite electromagnets N, (Fig. 1), may not afford sufficient pressure on the contacts M′, N′, to maintain the necessary rolling action thereon at all points of revolution of shaft A, then the modified form of the armature body E, shown in Fig. 8, may be used, where an intermediate section E^{12} is threaded to extensions E^{10} by right and left threads to the main sections of the armature body E, and the sections may be drawn together by turning the section E^{12} through teeth W^4 operated by a worm W^3 on the spindle T^4. There is thus afforded a means of varying the contact pressure on the contacts M′, N′, so that an instantaneous stop, or start, may be effected, independently of any electrical means, thus rendering it unnecessary to interfere with the continuous action of the electric current or currents, except when a reverse action may be desired.

In Fig. 9 is partly shown a modified form for attaining the same object. The lever T^{14} is attached at T^{13}, to suitable operating devices and is pinned, at T^{12}, to a loose collar or ring Z, on the ring T^{15}, around the axle A, and, by a link Z′, is connected to the thrust-block D by means of a pin T^{10}. Further, it will be noticed that in Fig. 9, the armature E is made or built up of a suitable number of parts, consisting of the sections E, with flanges E^{19}, shown above the dotted lines, and held together by the bolts or pins E^{20}. The oil-holder N^6 is made of jointed sections, one of the joints being shown at N^7, for the purpose of affording access to the internal parts.

Fig. 10 represents the dynamo adapted for propulsion in water, (as, for instance, at the stern, or in the "dead wood" of a marine ship.) The spindle T^3, which is operated by any suitable means, operates the cylinder T, (which contains all the rings T. R, rigidly embedded in suitable insulation V,) by an external rack T. O, into which gears the spur pinion T′ on the spindle T^7, which is turned by the bevel wheels T^2, the said spindles T^3 and T^7 having their respective bearings on the bracket Z^2, which may be fitted to, or made one with, the rigidly fixed containing cylinder Z^3, all the other parts of the said current transposer C. T. being similar to those shown in Fig. 1. The pole-pieces F may be similar in their helical formed surfaces to the blades of a screw-propeller, or they may be made specially wide for purposes of propulsion toward and at the outer tips, where they may be suitably curved to present sufficient surfaces to form suitable magnetic fields with the armature body E, made in sections E, E′ and E^2, secured by screws A. P. Armature body E is provided with a suitable guard N^5, to protect the insulated electric connections L′, passing through glands L^2. The thrust-blocks D and D^2 have strengthening ribbed flanges D^4, and pins or bolts D′, for securing said blocks to the frame X. The thrust-block D has a stuffing box O, and the gland R, to prevent leakage of water round the shaft A. The oil hole and groove W, in the frame and block D, are for the purpose of distributing oil, from the pipe X′ to the channel U, and over the bearing of the shaft A. The oil is transmitted, through the channel U, to the several bearings within the boss C, which is spheroidal in contour; the internal rolling surfaces M′, N′, on the boss C, are less in diameter than the corresponding surfaces M′, N′, on the thrust-block D. The said boss C is also provided with the external rolling contact surfaces M^2, N^2. By this arrangement, motion of the pole-pieces or blades F, in a reverse direction to that of the shaft A is effected, and the said blades F are caused to constantly revolve into mechanically undisturbed water or air, as the case may be, simultaneously with their oscillatory-reciprocative-feathering propelling action. This rotation of the shaft is in a direction, according as the said shaft A may be moved longitudinally in one direction or the opposite, by the solenoid S, which is provided with a suitable spool T^{30}, having on it a cogged segment T^8, and a helical thread T^5, fitting into a corresponding groove in the rigidly fixed cylinder T^9, in which, at a sliding fit, there is the piston G, of some suitable paramagnetic metal, and rigidly attached to the shaft A, so that, through the rotation of pinion T^6, which gears with said cogged segment T^8, the solenoid S will occupy a position at one side or other, or midway in relation to the piston G, and thus, by magnetic impulse, will move the said shaft A longitudinally, or retaining it in a mid-way position, thereby engaging, or retaining in a mid-position, the contacts M′, N′, and M^2, N^2, of the boss C, thus effecting the aforesaid forward and reverse, or a cessation of propulsion, at will.

Fig. 11 is a section, through B. B, B. B, of the electro-magnets N, in Fig. 10, the core N^4, helix N^3, and water proof and tight casing N^2, being all of a suitable oval or elliptical section, in order that the said electromagnets N

(Fig. 10), may pass through water or air, as the case may be, with a minimum retardation to the desired propulsion.

Fig. 12 is a Mercator's projection of the internal surface of the cylinder T (Fig. 10), showing the rings T. R′, T. R⁵, T. R³, T. R⁴, T. R² (Fig. 12), embedded in the insulating material. This figure differs only from Fig. 4 in that the cylinder T, with its parts, must be bodily operated.

In Fig. 13, the armature E, with its attachments, is stationary, the guard or casing N⁵ being sufficiently large to prevent circulation of water through the said armature E. The object of having the casing at one end only is to prevent water along with floating particles rushing through the machine and tending to clog it up and impede the working. In this figure the extended boss C² presents the outer rolling contacts M², N², to the outer thrust block D², the boss C, (which is provided with actuating anti-friction balls C′, which may be inserted by the hole, plugged by the plug O′,) presenting the inner rolling contacts M′, N′, to the inner thrust block D. The boss C carries the hollow semisphere E, E with its blades F A. R is an armature ring, which retains the armature coils H in their respective positions. In this case, the cylinder T is provided with a drain hole T⁵ and is rigidly fixed, by bolts T¹¹, to the general framework X. In this view, the spool T¹⁰, with solenoid S, is mounted on a rigidly fixed cylinder T⁹. The shaft at A can, as shown, be operated by steam, hydraulic or pneumatic pressure on piston G, as well as by the action of the solenoid S.

Figs. 14 and 15 represent a case where a dynamo is applied to the suitably divided, or recessed or cloven, mid-ship bottom of a merchant marine ship, the commutator C. T. being inside the vessel, and connected to the shaft A by means of a shaft or spindle A², and suitable bevel wheels A³, which are suitably incased, (see dotted lines Fig. 15) to prevent obstruction to their normal action. A⁴ is a stuffing box and gland, to prevent leakage.

In Fig. 16, the armature is the moving part, having the propelling blades F, rolling contacts M², N², and boss or center C, and has accommodation for the box-nut C², which is screwed internally over the extremity A′ of the shaft A, retaining actuating balls C′, and with suitable hole for the insertion of the cable L, which makes the electrical connections with the coils H, and passes to the swivel L⁵, through the central hole U of the shaft A, which is provided with a suitable stuffing gland L⁴, to keep back oil and water. The commutator C. T. is similar to that shown at Figs. 1 and 15, except that it has a bracket N², to support the swivel L⁵. The casing T³¹ has a spring S′, which presses against the hub Y of the commutator C. T, thereby keeping a longitudinal strain on shaft A, to effect the necessary contacts M′, N′, while the said solenoid S, (through which some suitable electric current may be passed), excites a magnetic impulse on said hub Y, in an opposite direction to said spring S′, thereby effecting an automatic regulation, similarly and for the same purpose as solenoid S in Fig. 13.

Fig. 17 shows a modified form of thrust-block D. Y is a cylinder. The channel S P may admit some suitable fluid pressure to act on piston G′, which may be fitted to or made in one with the thrust-block D so that when thrust of propulsion comes on the said thrust-block D, said fluid pressure on said piston G′ will yield to said thrust, admitting of sufficient longitudinal movement of said thrust-block D, (before stop ring D R comes in contact with block D D,) to transmit a sufficient similar movement, through any well known and suitable system of devices Q Q′ to regulate the source or sources of power, by any well known and suitable means, whether such source or sources may be mechanical or electrical, this system of regulation being particularly useful, as for instance in heavy seas, or any varying load. O O are stuffing boxes. R. R′, stuffing glands. Z (Figs. 13 and 17) is a slide valve, operated by rod Q Q. D. C. drain cocks.

Fig. 18. shows the dynamo adapted for general purposes, as a dynamo or motor, having the electromagnets N at one end and the commutator C T at the other end of the armature body E, which is provided with the external helix N³ to assist or augment the magnetic circuit or circuits through said armature body E which may be further provided with suitable feet E⁷ secured by bolts E⁸. It differs from Fig. 1 in having teeth or cogs on the contact surface M′ of the thrust-block D, meshing into corresponding teeth or cogs on the corresponding surface M′ of the boss or center C and further in having a solenoid S (through which the electric current, or any suitable part thereof passes) and spring S′ similarly to Fig. 16 so arranged that the mechanical and magnetic actions are directly on the hub Z⁶ of the belt pulley B P which is rigidly keyed to shaft A thereby effecting the automatic regulation similarly as in Fig. 16. The shaft A² is attached rigidly to the extremity A′ of the shaft A thereby retaining boss C with pole-pieces F in suitable relation to the cogged contacts M′ and the rolling contacts N′. In any case where preferable, the said toothed contacts at M′ may be plain rolling contacts in which case, (as shown dotted) said shaft A² may have fitted to it or made in one with it, the suitable collar Z² operated by the lever T T⁵, which has its fulcrum at T T² and operated at the end T T³ thereby rendering it unnecessary to manipulate the commutator.

Fig. 19 shows a modification of Fig. 18 N N being additional electromagnets and H H being additional coil placed on the pole piece F, the currents from or to which pole piece F may be conducted by the wires L′.

Fig. 20 shows a further modification of Fig. 18, having the coils H H on the pole piece F,

in an extended casing K K and the electromagnets N clad by the shroud D^3 and covered so as to act on the extended portion of the said coil H H and having an additional helix N^3 on the thrust-block D thus utilizing thrust-block D as another electromagnet.

In Fig. 21 is shown the machine specially adapted as an electric motor for general work, the thrust blocks D and D^2 being utilized as electromagnets, similarly as in Fig. 20, and the armature body E, is provided with air-holes E^2 and oil-holes E^3 and E^6 and the covered commutator cylinder T which has a hole E^{12} to accommodate the drain pipe T^6. The commutator C T is similar to that shown in Fig. 10 but in Fig. 22 is shown a Mercator's projection of the transposing rings T R′, T R^2, T R^3, T R^4, T R^5, which may be adopted. It will be noted that the said rings, though different in shape from what has been previously referred to herein still the same electric effects are insured, the bent portions TR^5 acting for bearings for the said rolls in the places 1 and 2 and rings or portions TR^3 in the other two places 3 and 4 as said rolls pass over spaces between the divisions D D D, C C C, A A A, B B B.

In Fig. 23 is shown a modification of the electromagnets N in Fig. 21 the helix N^3 being wound internally to the armature body E and externally on the thrust-block D thus intensifying the so called "magnetic circuit" through said armature body E and thrust-blocks D and D^2 with consequent increase of field intensity.

Fig. 24 shows the electromagnets N mounted on the common boss or center C and tipped with the pole-pieces F the electric current being supplied to the helices of the said electromagnets by means of the rolling contacts L^3 rolling in pairs each pair being insulated from one another, and connected by wires L to the electric source or sources and in this case the said armature body E will have a suitable oblate-spheroidal form, to suit the paths of the said pole-pieces F.

Fig. 25 shows another method of supplying the electric current to the electro magnets N; L^3 being the suitable metal contacts, and B^2 the insulations embedded in the shoulders B, B′, of the shaft A and in the thrust-blocks D, D^2, conveniently near the rolling contacts M′, N′.

Fig. 26 shows in part another method of arranging the electromagnets shown in Fig. 24, two being radial, and four tangential, (Fig. 26) passing their "magnetic lines" in suitable directions, as is well known to the art, through four pole-pieces F.

In Fig. 27 the armature E, cylinder T, current collector cylinder T^{22}, the electromagnets N, pole-pieces F and shaft A, each with their respective devices, are all driving parts while the thrust-blocks D, D^2, are stationary with the bed-plate X, the block D being adjusted longitudinally by means of the hand wheel T T^3 to effect the rolling contacts M′, N′, also to effect a start, stop, or variation as required mechanically. The commutator rolls Y^3 are operated on the block D^2 by means of the hand wheel T^3. Oil chambers X′ are provided in the thrust-blocks and the chains U′ lifting the oil therefrom, and passing it on through the helical grooves U in the surface of the shaft A, to lubricate internal bearings. It will be noted that if preferable, the pillow-block D^2 may be the longitudinally adjustble one.

Although I have shown on my drawings, by way of example, convenient methods of carrying out my invention in practice, I do not limit myself to the exact arrangement or arrangements of parts thereon shown, as the arrangements may be manifestly slightly altered, as is evidently compatible with the versatility of the invention, to suit different requirements; and it is to be understood that it may be used efficiently and advantageously for all purposes to which dynamo electric machines in general may be applied, or are suitable.

Having now fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a dynamo electric machine, a main rotating shaft arranged in a straight line, and pole-piece projections F carried by said shaft and extending from opposite sides thereof at an angle less than a right angle, combined with an armature and magnets, substantially as described.

2. In a dynamo-electric machine, a main rotating shaft, a boss arranged centrally thereon and pole-piece projections F extending from said boss at an angle less than a right angle to the line of the shaft and from opposite sides thereof, combined with an armature and magnets, substantially as described.

3. In a dynamo electric machine, a main rotating shaft arranged in a straight line, and disk pole piece F carried on said shaft and inclined thereto at an angle less than a right angle, combined with an armature and magnets, substantially as described.

4. In a dynamo electric machine, a main rotating shaft, a boss arranged centrally thereon and disk pole piece F extending from said boss at an angle less than a right angle to the line of the shaft combined with an armature and magnets, substantially as described.

5. In a dynamo electric machine a main shaft, a pole piece extending at an angle from the shaft less than a right angle, a hollow shell carried by said pole piece and external blades carried thereby, substantially as described.

6. In a dynamo electric machine, a rotating shaft, inclined shoulders projecting therefrom and pole pieces fitted between said shoulders, substantially as described.

7. In dynamo electric machines, the combination with a bent, cranked, or eccentric shaft or axle, of a boss or center fitted on said shaft or axle, a pole-piece made in one with or

fitted on said boss or center, and of a thrust-block, substantially as hereinbefore set forth.

8. In dynamo electric machines, the combination with a bent, cranked, or eccentric shaft or axle, of a boss or center fitted on said shaft or axle, a pole-piece made in one with or fitted on said boss, and of thrust-blocks with contact or bearing faces between said blocks and said boss, substantially as hereinbefore set forth.

9. The combination with the bent, cranked, or eccentric shaft or axle A, of the boss C, pole piece F, thrust-blocks D, D^2, magnets N, and inclosing armature E, substantially as hereinbefore set forth.

10. The combination with the shaft or axle A, of the boss C, pole-piece F, thrust-blocks D, D^2, magnets N, armature E, and oil casing N^6, fitted within said armature, substantially as hereinbefore set forth.

11. The combination with the shaft or axle A, of the boss C, the inclined pole-piece F, thrust-blocks D, D^2, the side magnets N, armature E, and coils H, H on the circumference of the pole piece, substantially as hereinbefore set forth.

12. The combination with the shaft or axle A of rolls Y^2 carried on said shaft by means of springs Y', transposing rings T R and means for operating one or more of said rings, substantially as hereinbefore set forth.

13. In a dynamo electric machine, the combination with the main shaft, boss with pole pieces thereon, the armature, contact surfaces M', N', M^2, N^2, and means for varying the degree of contact between said surfaces, substantially as hereinbefore set forth.

14. The combination with the shaft A, of a movable thrust-block surrounding said shaft and regulating devices connected to said movable thrust-block for regulating the source or sources of power, substantially as and for the purpose hereinbefore set forth.

15. The combination with the shaft A, of an extended thrust-block surrounding said shaft, and a piston G made in one with or secured to the thrust-block, said piston being inclosed in a cylinder containing fluid pressure, substantially as and for the purpose hereinbefore set forth.

16. In dynamo electric machines, the combination with a bent, cranked, or eccentric shaft or axle, of an inclosing armature, made in two or more parts, and carried on said axle, and of a device for drawing the parts of said armature together or for thrusting them apart, substantially as hereinbefore set forth.

17. The combination with the bent, cranked, or eccentric shaft or axle A, of a thrust-block fitted on said shaft or axle, of a boss C, contacts M', N', between said boss and thrust-block and teeth or cogs on the boss and thrust-block, which mesh into each other, substantially as hereinbefore set forth.

18. The combination with the bent, cranked, or eccentric shaft or axle A, of a pole-piece fitted on said shaft or axle, an inclosing or partially inclosing armature and electromagnets fitted around said shaft or axle, substantially as hereinbefore set forth.

19. The combination with the bent, cranked, or eccentric shaft or axle A, of a boss fitted thereto, one or more magnets fitted to said boss and one or more pole-pieces surmounting said magnets, substantially as hereinbefore set forth.

20. The combination with the bent, cranked, or eccentric shaft or axle A, of a boss fitted thereon, one or more magnets fitted to said boss, one or more pole-pieces fitted to said magnets and electrical contacts L^3, substantially as hereinbefore set forth.

In witness whereof I hereunto set my hand in presence of two witnesses.

JOHN MACHAFFIE.

Witnesses:

JOHN B. HAGADORN,

LEVI T. CLUTE.