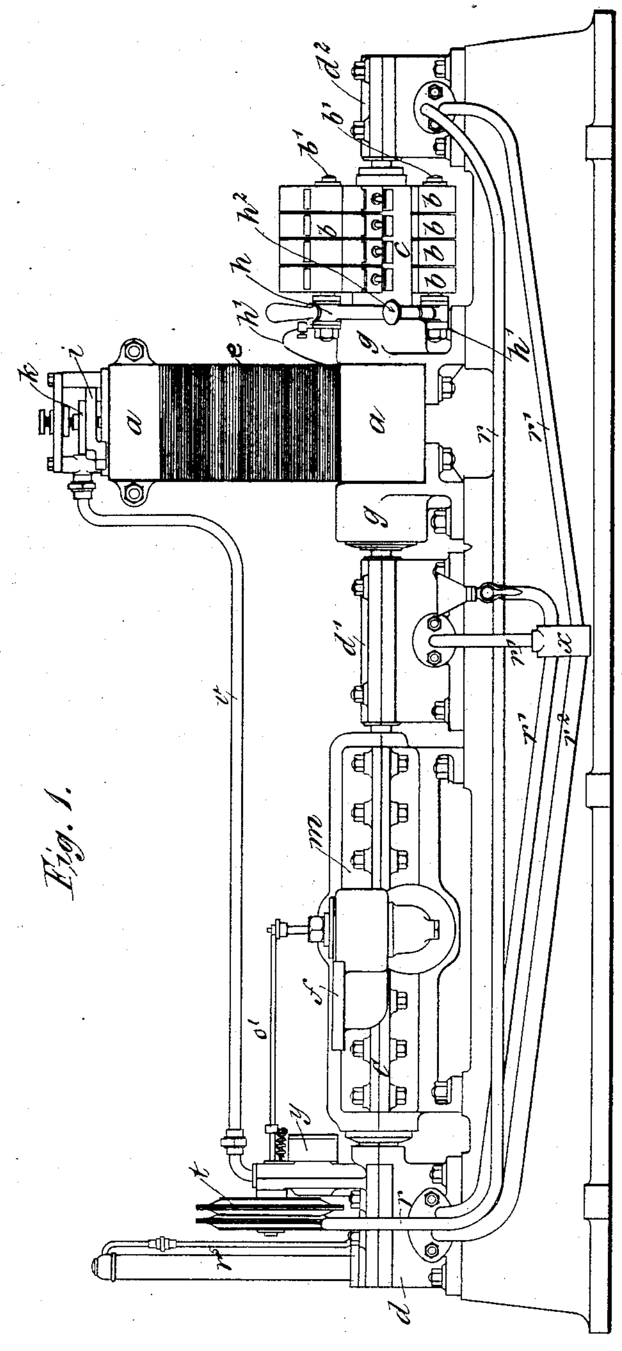
(No Model.) 9 Sheets—Sheet 1.

C. A. PARSONS.

DYNAMO ELECTRIC MACHINE.

No. 344,542. Patented June 29, 1886.



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(No Model.) 9 Sheets—Sheet 2.

C. A. PARSONS.

DYNAMO ELECTRIC MACHINE.

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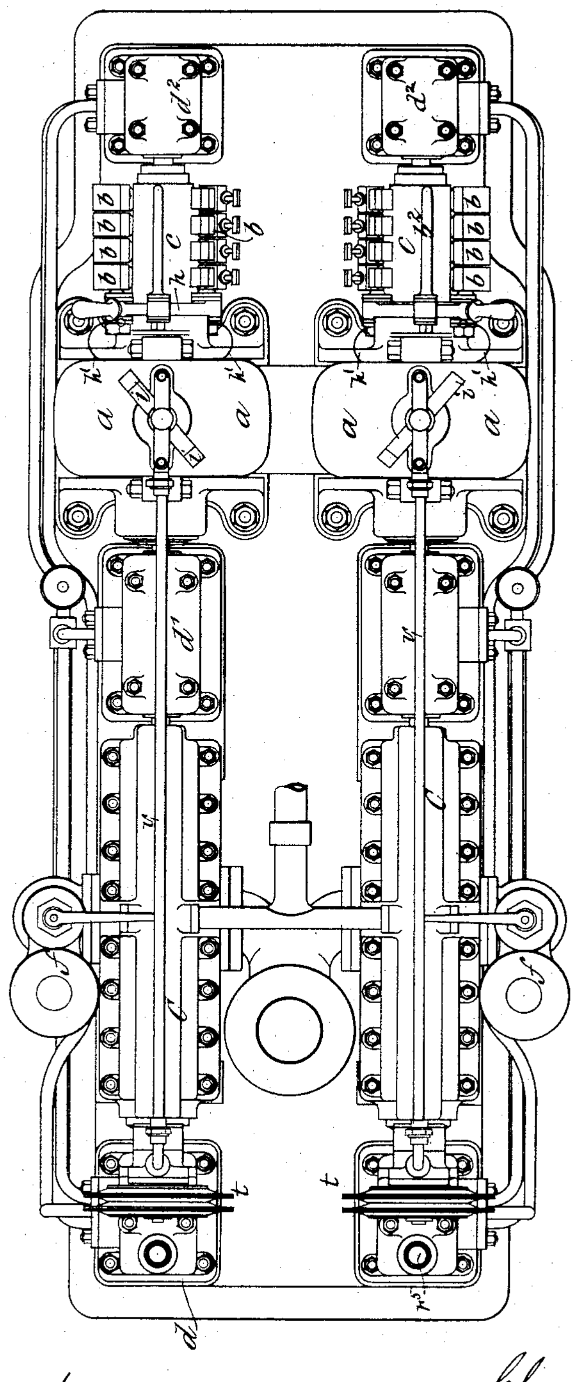
Fig. 2.



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(No Model.) 9 Sheets—Sheet 3.

C. A. PARSONS.

DYNAMO ELECTRIC MACHINE.

No. 344,542. Patented June 29, 1886.

Fig. 3.

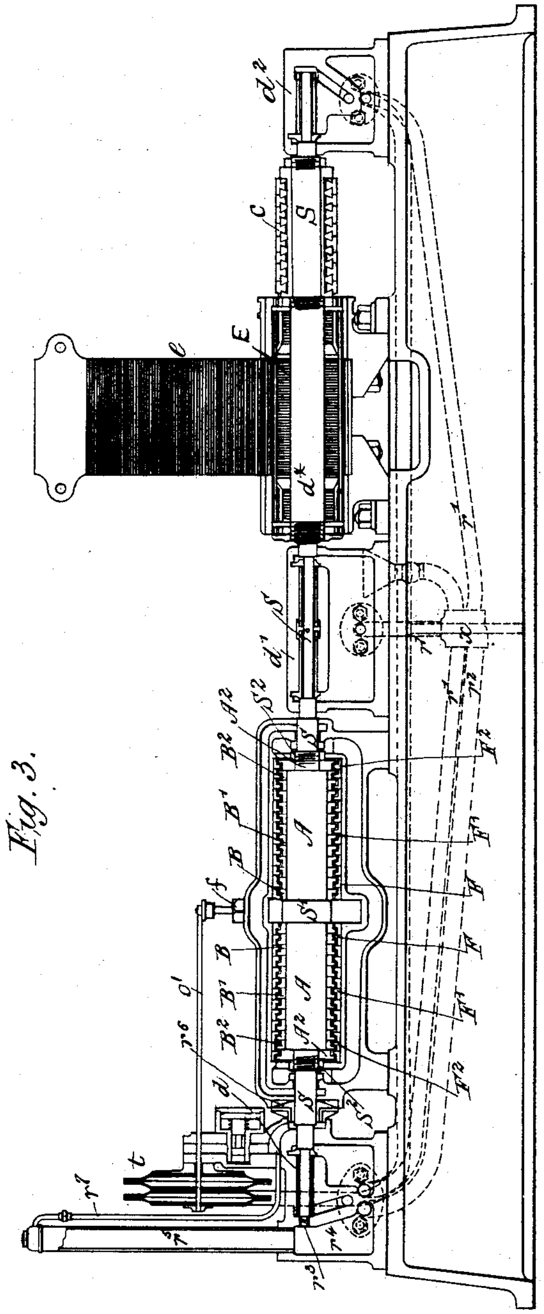

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Fig. 4.

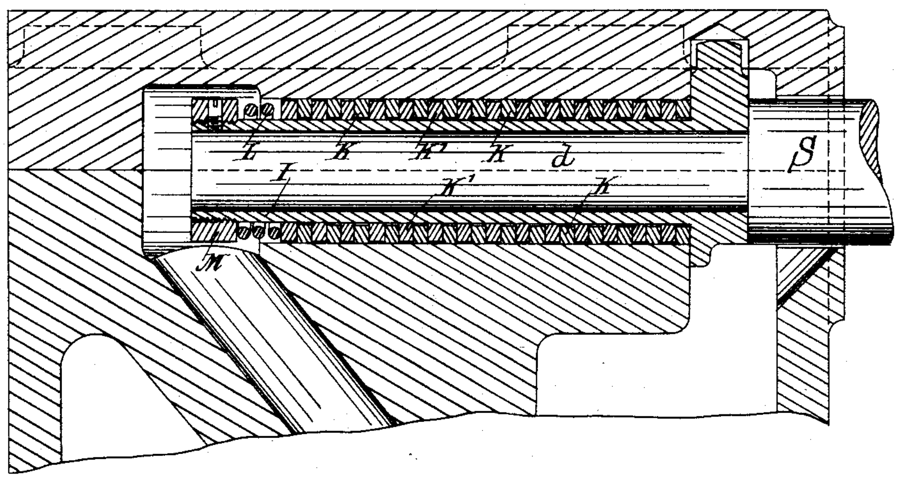
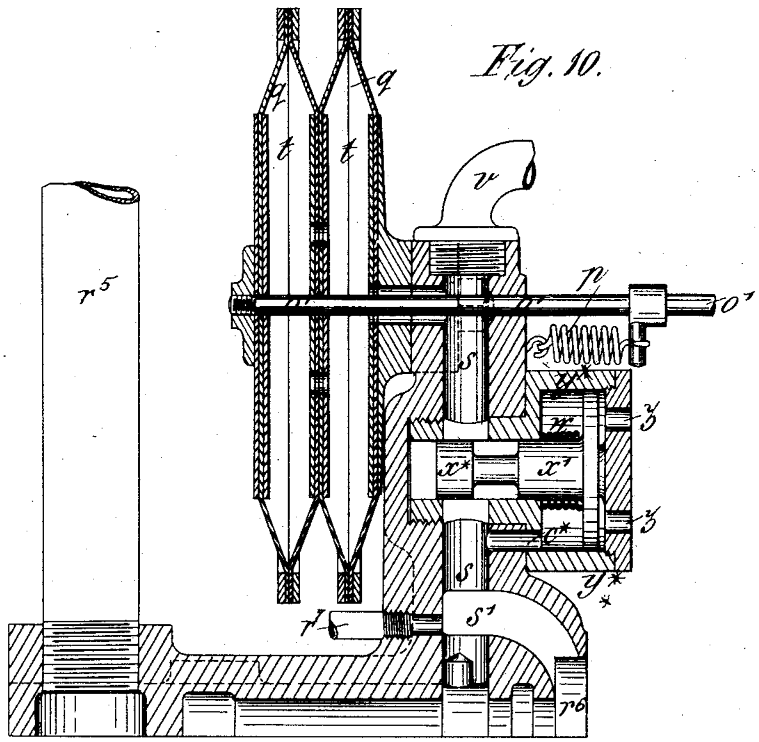


Fig. 10.



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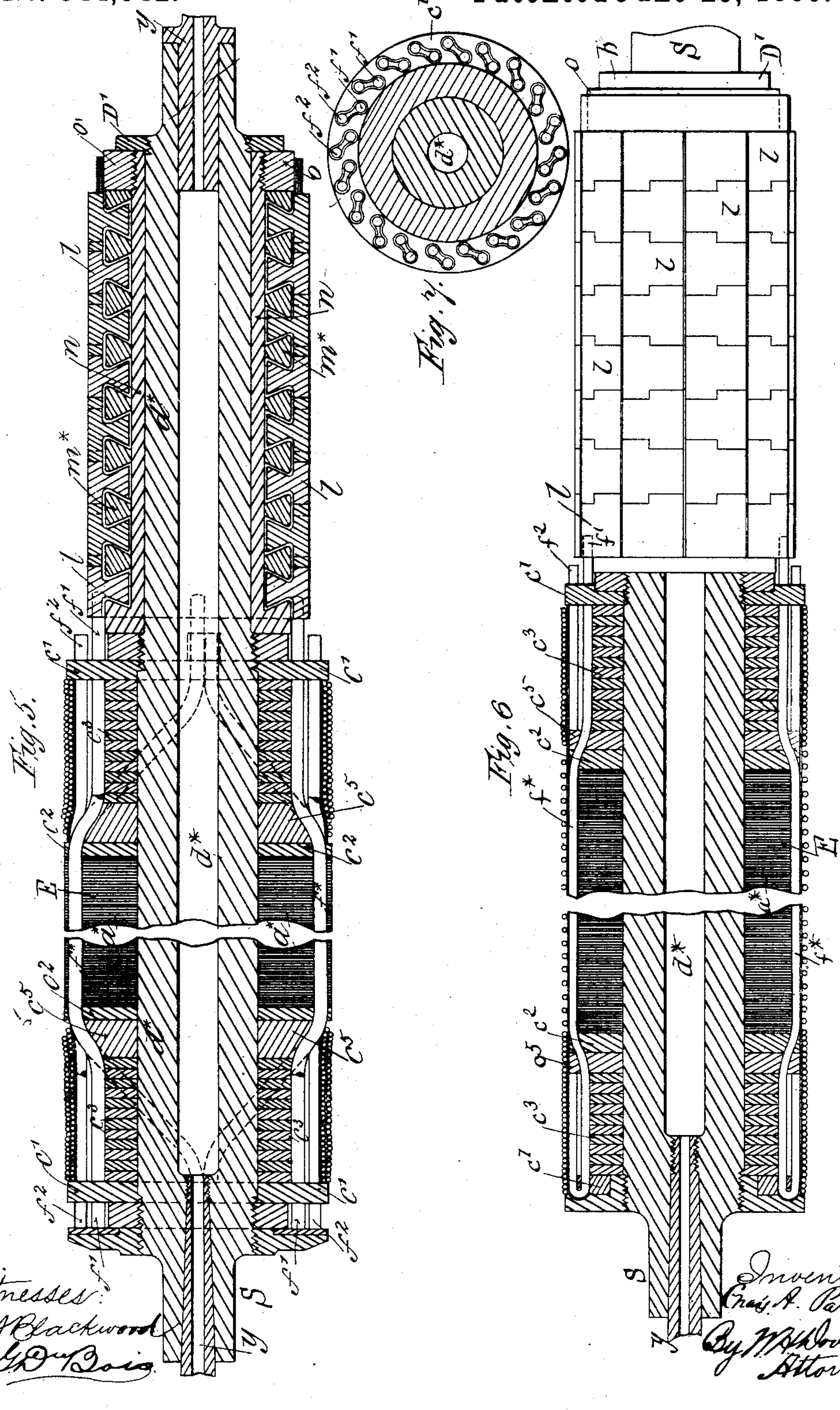
9 Sheets—Sheet 5.

C. A. PARSONS.

DYNAMO ELECTRIC MACHINE.

No. 344,542. **Patented June 29, 1886.**



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(No Model.) 9 Sheets—Sheet 6.

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DYNAMO ELECTRIC MACHINE.

No. 344,542. Patented June 29, 1886.

Fig. 8.

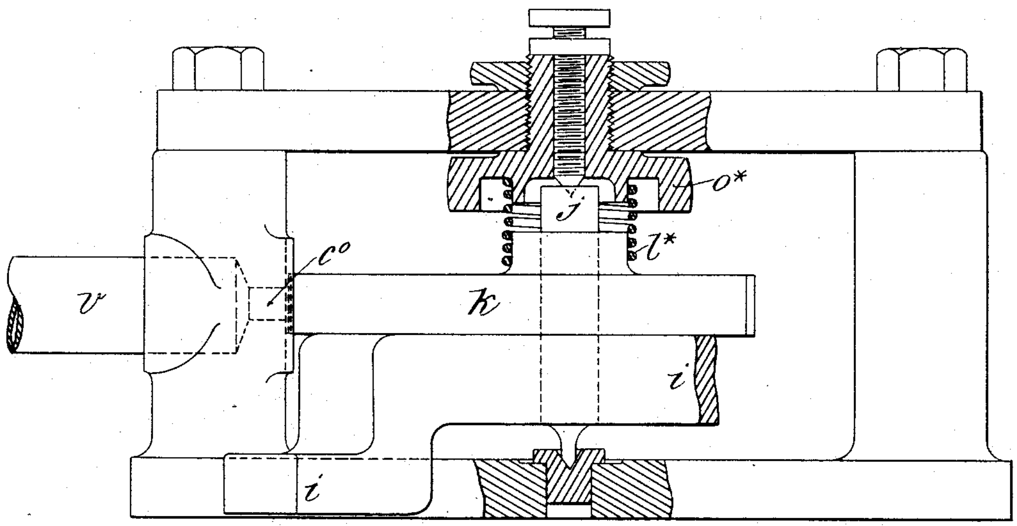
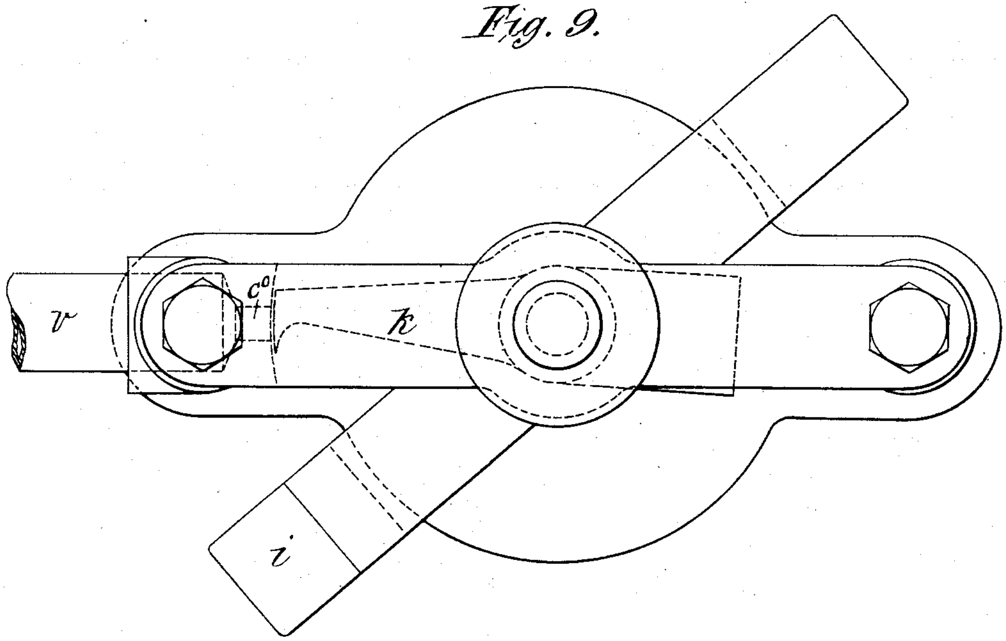


Fig. 9.



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DYNAMO ELECTRIC MACHINE.

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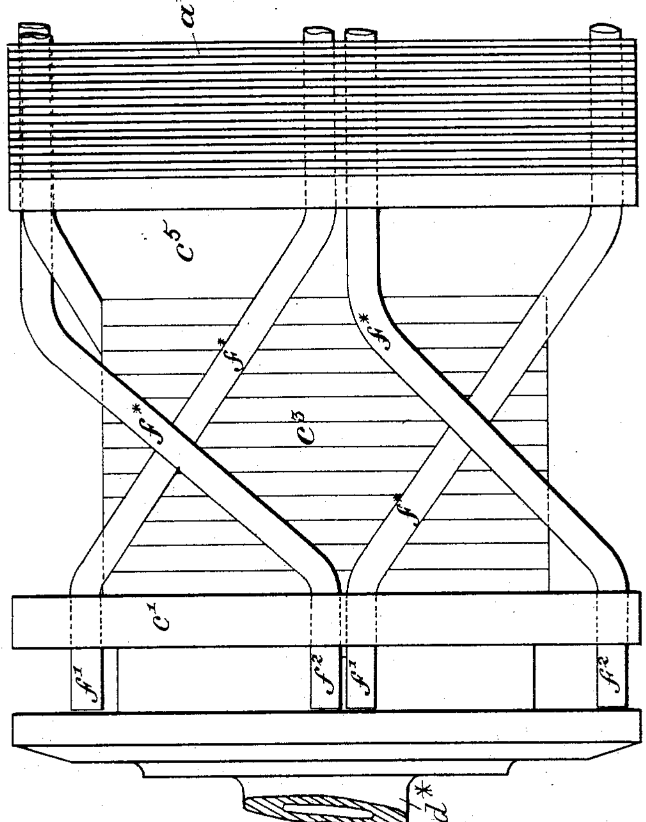

Fig. 12.

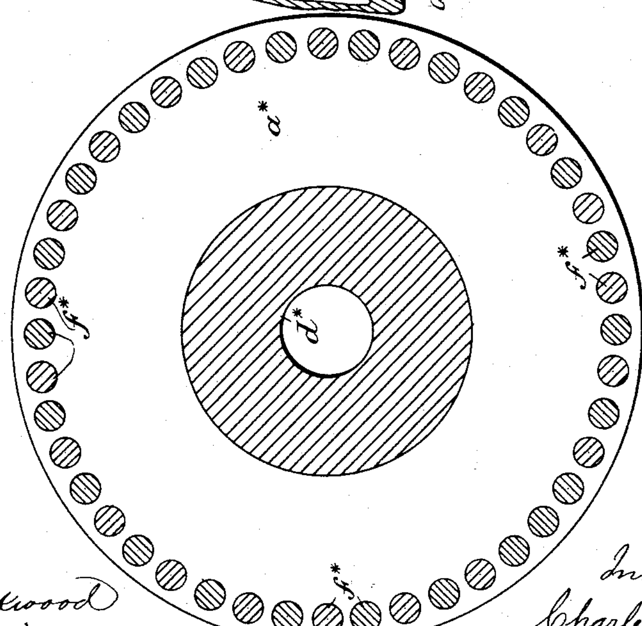

Fig. 11.

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(No Model.) 9 Sheets—Sheet 8.

C. A. PARSONS.

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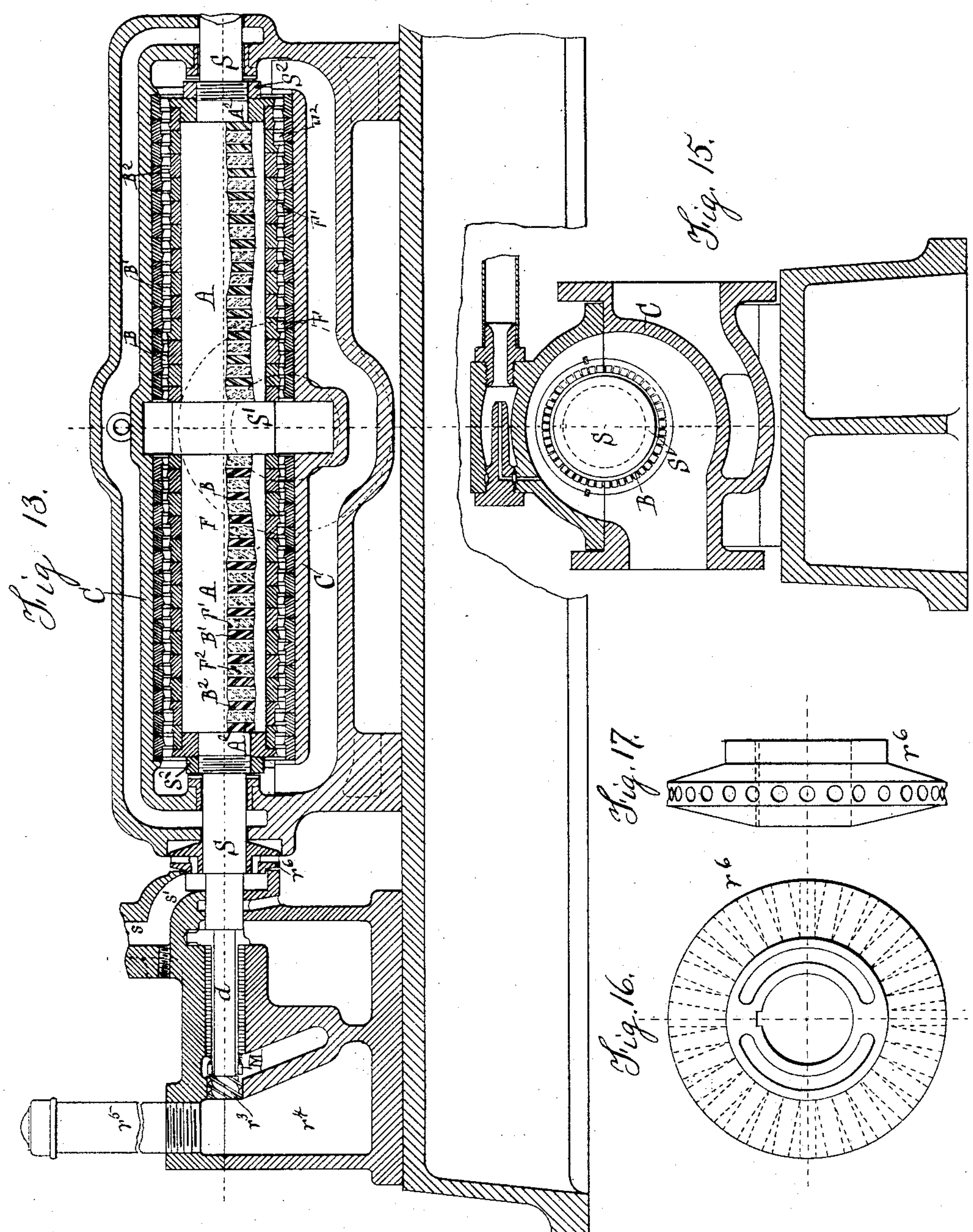

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(No Model.) 9 Sheets—Sheet 9.

C. A. PARSONS.

DYNAMO ELECTRIC MACHINE.

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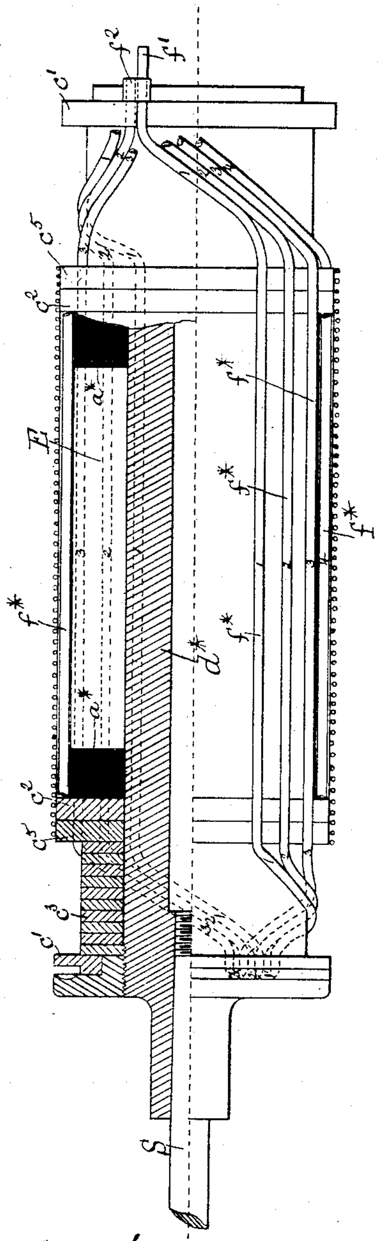
Fig. 14.



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UNITED STATES PATENT OFFICE.

CHARLES ALGERNON PARSONS, OF GATESHEAD-ON-TYNE, ENGLAND.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 344,542, dated June 29, 1886.

Application filed December 15, 1884. Serial No. 150,406. (No model.) Patented in England April 23, 1884, No. 6,734, and November 7, 1884, No. 14,723; in Germany November 29, 1884, No. 34,230; in France December 1, 1884, No. 165,694; in Belgium December 1, 1884, No. 67,069; in Italy December 31, 1884, No. 47, and in Canada August 24, 1885, No. 22,286.

To all whom it may concern:

Be it known that I, CHARLES ALGERNON PARSONS, a subject of the Queen of Great Britain and Ireland, residing at Gateshead-on-Tyne, Kingdom of Great Britain and Ireland, have invented a new or Improved Combined Machine for Generating Electricity, of which the following is a specification.

My invention, illustrated in the annexed drawings, is designed to produce an electric generator which may be driven at a very high rate of speed, several or many times as fast as such machines are now driven, the object being to obtain a large current or a high electro-motive force, or both, from a small machine, and also to obtain greater steadiness in the current and an increased efficiency.

In the accompanying drawings, Figures 1 and 2 show in elevation and plan a double apparatus according to my invention, each half comprising an electric generator and a motor. Fig. 3 is a vertical longitudinal section of one apparatus. Fig. 4 is a section to an enlarged scale through one of the bearings of the central shaft. Fig. 5 is a longitudinal section through the armature and commutator of the generator. Fig. 6 is a similar view showing a modified method of arranging the conductors. Fig. 7 is an end view of the same, partly in section. Figs. 8, 9, and 10 show a device for regulating the speed of the motor according to the requirements of the electric circuit. Fig. 11 is a cross-section of the armature shown in Fig. 5, and Fig. 12 is an elevation of one end of the armature, illustrating the method of coupling up the conductors, both figures being drawn to an enlarged scale. Fig. 13 is a central longitudinal section of the motor. Fig. 14 is a side view, partly in longitudinal section, of the rotating armature, showing the arrangement of the electric conductors. Fig. 15 is a central vertical cross-section of the motor; and Figs. 16 and 17 are side and edge views, respectively, of the regulating-fan.

In a generator according to my invention, a very small portion of the energy of the motor is wasted in overcoming the resistance of the armature and field-magnets, and at the same time there is a very great and hitherto unattainable economy in construction. This result is obtained by rotating the armature at an exceedingly high speed by the device of mounting it upon the same shaft as a motor which is capable of running at several or many (say from ten to twenty-five) thousand revolutions per minute.

Hitherto, in order to obtain the required electro-motive force for a generator for electric lighting, it has been requisite to surround it with a very considerable number of convolutions of conductor, and to cause it to move in an intense magnetic field. At the same time, when it was intended that the current should be used for incandescent electric lighting, it was necessary that the resistance of the armature should be small. These conditions necessitated an armature of large diameter moving in an extended field, with the consequence that much electrical energy was expended in exciting the field-magnets, and that the resistance of the armature was not so low as could be desired, while the size and weight of the machine became serious. These defects could be obviated by increasing the speed of the dynamo; but it required the use of pulleys, belting, and other forms of gearing, which by their size, weight, and expense more than counterbalanced any apparent gain that they offered; and at very high speeds, such as I employ, even these devices would fail, as it is well known that at a certain velocity belts attain so much momentum that their grip on the pulley becomes uncertain and steady driving cannot be obtained by them. This is clearly shown by the fact that few dynamos are now driven more than one thousand revolutions per minute, and that makers who once advocated eighteen hundred and two thousand revolutions have now ceased to put forward such speeds, partly owing to the difficulties that were found and partly to the accidents that befell the generators from the effects of the centrifugal force.

For many purposes—particularly for ship and train lighting—the use of direct-acting high-speed engines has become very popular; but hitherto these motors have not been able to run more than one thousand revolutions per minute, and consequently no great economy has been effected in the size of the generators; but by using a motor of the kind herein described, in combination with a generator according to my invention, a great saving is effected, for as the magnetic field is small it will be proportionately intense, while as the armature need have but few convolutions, its internal resistance will be much less than usual. No additional space is occupied, as would be the case if gearing were interposed between the motor and the dynamo, perfectly-steady driving is obtained at all speeds, and a velocity is attained which is not remotely possible by any other system heretofore adopted in practice. In order to attain this high velocity I use, in connection with the generator, the rotary motor described in Letters Patent No. 328,710, granted to me October 20, 1885, which is the only motor known to me which is capable of the great velocity required. The rotating shaft of this motor is extended to form the rotating armature of the generator.

In order to supply a lubricant properly, which will be necessary where such high speed is attained, I adopt substantially the same lubricating mechanism as that shown in the Letters Patent just referred to, and in Letters Patent No. 328,711, granted to me October 20, 1885.

I use in the dynamo-machine an armature of the drum or Siemens type. I form the core of disks or washers of iron insulated from each other, but in contact with the shaft, in order that the heat which they carry from the conductors may readily be communicated to the shaft. At each end of this iron core there are insulating washers, and beyond them a number of brass washers of smaller diameter. The conductors are laid in holes or channels bored or formed in the body of the iron core, and when they emerge from that are carried spirally round the brass washers alternately to right and left in two layers, and fixed in a disk of insulating material in such a way that the conductors which require to be connected come out side by side, and can be easily coupled together. The object of the brass washers is to form a solid body, upon which the conductors can be coiled spirally, so as to carry them from one side of the armature to the other at the end. If this body were made of iron, it would have the effect of distorting the lines of force, which proceed from the field-magnets, and of diverting them from the direct path between the poles and the iron core of the armature. It is not necessary that the washers should be made of brass; but as they must not be of iron brass is the most preferable of the materials yet found.

Although the conductors are coupled to a single ring, as hereinafter described, this ring is of non-conducting material, and the conductors themselves being insulated, it is perfectly easy to join the conductors in pairs at that end, and thus form a continuous circuit. At the extremity of the armature at which the commutator occurs the end of each convolution is connected to a segment of the commutator. In some cases the conductor is laid on the outside of the core, and is bound in place by wire. At the end remote from the commutator the conductor is bent and pressed back through the outer ring of holes in the non-conducting washer.

The commutator is formed of several rings of segments, retained in position around a central bush by interlocking steel rings. The steel rings are insulated from the segments, and each row of segments is insulated from the adjacent rows. Where the ends of the segments touch each other they are stepped to secure good contact.

To prevent the machine becoming unduly heated by the intense currents which are developed, I introduce lubricating-fluid—such as oil—into the interior of the armature or into a casing into which the heat developed in the armature flows, and I maintain a circulation of such fluid and carry off the heat, which may be dissipated in any convenient way.

It is often advantageous to form the commutator complete in itself, so that it can be removed bodily for returning or when worn out. To this end I attach the copper strips with suitable insulation to a metal cylinder, which can be slipped on and off the shaft of the generator. This commutator can likewise be cooled by causing the lubricant to pass down the shaft, and thereby abstract the heat by conduction from the shaft and the metal cylinder.

I regulate the speed of the motor by means of a valve operated by a piston or diaphragm, from one side of which air is exhausted by a pump or fan driven by the motor. Air is admitted to the same side of the piston or diaphragm through an inlet which is controlled by a valve, plug, or shield, the position of which is regulated by an apparatus actuated by the current produced by the dynamo. The current may operate by means of a solenoid or magnet or other suitable appliance; but I prefer to avail myself for this purpose of the attractive force of the field-magnets of the dynamo. When the magnets are shunt-wound and the iron is far from saturation, the intensity of the magnetization will vary as the difference of electro-motive force between the terminals of the machine, and when they are series-wound it will vary as the current. Thus a self-regulating machine, either for constant electro-motive force or constant current, will be produced. To this end a bar or needle of soft iron is mounted upon a spindle or pivot in such a way that the polarity of the field-magnets tends to rotate it in opposition to the influence of an adjustable spring. The spindle carries a valve or shield, which covers, to a greater or less extent, the inlet of the air-pipe leading to the diaphragm or piston. When the intensity of magnetization of the field-magnet increases the size of the air-inlet is decreased, and vice versa. The motion of the diaphragm, due to the reduction of the pressure on one side of it, is communicated to a valve which regulates the supply of actuating-fluid to the engine. Should the circuit become ruptured or some accident happen to the dynamo, the intensity of the field-magnets would decrease instantly, with the result of admitting actuating-fluid in dangerous quantity to the engine. To avoid this, the passage from the fan to the diaphragm is normally contracted by a piston-valve. This valve is connected to a piston in a cylinder, one end of which communicates with the atmosphere and the other with the pump. This piston is normally maintained in position against the air-pressure by a spring; but should the speed of the pump be greatly increased the piston is drawn forward, and, carrying with it the piston-valve, it leaves an unobstructed passage from the pump to the diaphragm, and thus the full effect of the pump is brought to bear to control the motor.

In Figs. 1 and 2, *a a* are the field-magnets, which are excited by the current flowing in the coils *e e*. The armature E is not visible in Figs. 1 and 2, but is to be seen in Fig. 3. It is mounted upon a shaft, S, which runs through the three bearings $d\ d'\ d^2$. Upon the same shaft, which may be in one piece, or two or more pieces coupled together, the moving portion of the motor *m* is carried. *g g* are guards of non-magnetic metal, which protect the armature and also carry the magnets. *h* is the brush-holder. *b b b* are the brushes, carried on the rods *b'*, attached to but insulated from the holder *h* and pressing on the commutator *c*. By preference these brushes are made of fine brass wire. The electric current produced is delivered by the brushes to the couplings or wires *h' h'*. The holder *h* is so arranged as to be free to rotate in a groove on one of the guards *g*, and is clamped thereon by the screw h^2.

The motor, which is shown in detail in Figs. 3, 13, and 15, is the same as described in Letters Patent No. 328,710, to which reference is made for a detailed description.

In the drawings accompanying this specification, A A are the enlargements on the center shaft, S, which constitute the inner rotating cylinder. B B' B^2 are the sets of blades thereon.

C is the outer stationary casing or cylinder, carrying the inwardly-projecting blades F F' F^2.

S' is the central projection, which divides the rotating cylinder into two parts.

A^2 are screw-threaded portions of the shaft, on which fit nuts S^2, which secure the rings of blades on the cylinder A. The bearings of the dynamo and its motor have a certain amount of elasticity or play combined with a frictional resistance to their motion, and thus the moving part will be enabled to rotate around the center of gravity instead of the geometrical center, if the two be nearly coincident, and the vibration will be damped or modified. To this end they are constructed as in Patent No. 328,710, and as shown in Fig. 4 of the accompanying drawings.

I is a light bush, outside of which are placed metal rings or washers K K'. The alternate washers K are slightly larger than the washers K', so that the alternate washers K fit the casing but not the bush, and the washers K' fit the central bush but not the casing. L is a spiral spring, and M is a nut. By these the rings or washers K K' are pressed tightly together. Thus the bush is capable of a slight lateral movement, but this movement is resisted and controlled by the rings or washers and their mutual friction. The amount of liberty given to the rings or washers may be, say, one hundredth part of an inch diametrically; but it may be more or less, according to circumstances, as may be found desirable in practice.

The lubrication of the bearings and the cooling of the armature and commutator are carried out by means of a screw-pump, r^3, at the end of the central axis, and of the pipes $r\ r'\ r^2$, Fig. 1. The oil from the reservoir r^4 is forced by the pump through the bearing *d*, and the pipe *r* to the bearing d^2. Some of the oil goes to lubricate the bearings, but the greater part flows through the hollow spindle of the armature, Figs. 5 and 6, cooling the armature and commutator, and then lubricating the bearing *d'*. The oil, after performing its office, returns by the pipes $r'\ r'\ r'$ to the central junction-piece, *x*, from which it is again drawn through the pipe r^2 to the reservoir r^4. The raising of the oil is not effected by the suction of the screw-pump, but by a fan, r^6, also mounted on the central axis, which is connected by a tube, r^7, to the stand-pipe r^5, and constantly maintains a partial vacuum therein. The power of the fan is not sufficient to draw the lubricant over the head of the stand-pipe.

Fig. 5 is a longitudinal section of an armature suitable for use in a generator revolving at a high rate of speed. Upon a hollow shaft, d^*, there are arranged a series of tightly-fitting iron disks or washers, $a^*\ a^*$, insulated from each other, preferably by paper. At each end of the series of iron washers is a washer or disk, c^2, of insulating material. Beyond each of the washers c^2 is a second insulating-washer, c^3, and after these there comes another series of metal washers, c^4, preferably of brass, and insulated from each other, the arrangement being concluded at each end by an insulating-washer, *c'*, forced up by a nut. The part of the core beyond the iron washers is made of non-magnetic metal, to prevent it from distorting the lines of force between the field-magnets and the armature.

The iron washers, which form the core of the armature are pierced at equal angular distances with holes or channels, in which the conductors $f^* f^*$ are placed. Each conductor is laid in separately, and is coupled to the corresponding one at the other side of the armature in the following way: Every alternate conductor is bent down along a groove in the washer c^5, and is then carried round the cylinder at an angle of about forty-five degrees with the axis, as shown in dotted lines, and is finally threaded through a hole in the outer non-conducting flange or washer, c'. When the one half of the conductors have been thus treated, they are bound round with insulating-tape, and the remaining half are similarly arranged, except that they are bent in the opposite direction. The ends $f' f^2$ are united in couples, and at the commutator end every alternate one of the wires is left projecting and fits into a suitable recess or hole in one of the commutator-segments $l\ l$.

The coupling of the conductors $f' f^2$ is preferably effected by fine wire or copper rings, and is so arranged that when completed the whole of the wires form a continuous circuit, as shown in Fig. 14.

In the drawings there are twenty convolutions, and there are ten segments in the commutator, which are connected to each alternate coil.

$y\ y$ are the hollow spindles of the armature, through which lubricant is caused to flow and cool the shaft d^* and attached parts.

In Fig. 6 the wires are shown differently arranged at the end farthest from the commutator, where, instead of the conductor being divided and coupled to the next, in the manner described above, it is bent and passed back through the outer ring of holes, passing spirally round the smaller portion of the core to the appropriate channel in the iron washers.

To retain the wire in position, I prefer to use piano forte steel wire bound on tightly over suitable insulation.

In order to resist the great centrifugal force the commutator is formed of several rings of gun-metal segments, $l\ l$, retained in position on the bush n by the steel rings $m^* m^*$ and the nut o. The segments are insulated from each other and from the rings $m^* m^*$ preferably by asbestus mill-board.

The regulating apparatus is shown in Figs. 1 and 2, and to a large scale in Figs. 8 and 9. It is mounted upon the top of the field-magnets, by which it is operated, and is connected by the pipe v to the diaphragm t, Figs. 1 and 10. A bar of soft iron, $i\ i$, Figs. 2 and 9, is pivoted on a vertical spindle, $j\ j$, which also carries a finger or pointer, k, ending in a valve or guard which covers more or less the inlet c^0 to the pipe v. The polarity of the magnet tends to place the bar i parallel to the lines of force, and this tendency is resisted by the spring l^*, which is attached at one end to the spindle and at the other to an adjustable bush, o^*, which can be rotated and fixed, as desired, to vary the tension of the spring. When the magnets are shunt-wound and the iron is far from saturation, the intensity of the magnetization will vary as the electro-motive force at the terminals, and when they are series-wound it will vary as the current. Thus a self-regulating machine either for constant electro-motive force or constant current will be produced. The pipe v connects the air-inlet on the magnetic regulator with the space inclosed between the flexible diaphragms $t\ t$, Fig. 10. These diaphragms are stiffened by metal disks in the usual way, and the outer one is mounted on a spindle, o', which is impelled outward by the spiral spring p. The space q between the diaphragms is in connection by the passages $s\ s'$ with the exhaust-fan r^6, which raises the lubricant, and every movement of the diaphragms, consequent on the variations of pressure due to the varying speed of the motor which drives the fan, is transmitted by the spindle o' to the valve f, Figs. 1 and 2, which governs the supply of actuating-fluid to the motor.

So far the arrangement shown in Fig. 10 is similar to that already described in Patent No. 328,710, mentioned above.

In case the regulator should cease to act efficiently, either from accident to itself or to the dynamo or to the external circuit, excessive speed of the motor is prevented by the action of the piston x^*. This is normally kept in the position shown in the drawings by the spring $w\ w$, and in that attitude it partially closes the passage s between the diaphragm and the fan. The rear end of the piston is enlarged at x', and stands in a cylinder, y^*. One end of this cylinder is exposed to the atmosphere through the holes $z\ z$, and the other to the suction of fan through the hole c^*. Should the fan attain a dangerous velocity, the reduction of pressure in the cylinder y^* causes the piston x^* to be forced forward against the opposition of the spring, which is adjusted to permit of this, and a clear passage is left between the pump and the diaphragms $t\ t$. The diaphragms are then exhausted and the supply-valve to the motor closed and this independently of the magnetic regulator.

What I claim is—

1. A compound machine for the generation of electricity, comprising a turbine motor, an electric generator, and a lubricating-pump, all mounted on a common rotating shaft, said shaft in the portion of its length wherein it serves to carry the armature of the electric generator being made hollow, and bearings in which said shaft turns, in combination with a chamber which holds the lubricating-fluid and passages or conduits connecting said chamber with the several bearings and with the hollow shaft of the armature, the whole being so combined and arranged that by the action of the pump when the machine is at work the lubricant is supplied to the bearings and caused to

circulate as a cooling-medium through the hollow shaft of the armature, substantially as set forth.

2. The combination, with an electric generator and a motor, of an apparatus regulating the speed of the motor in such a way that the generator produces a constant current or a constant electro-motive force, and comprising a needle, bar, or armature subject to and actuated by the influence of the field-magnets, a valve, a cock or shield connected to the said needle, bar, or armature, and serving to vary the size of an air-inlet, a diaphragm connected to the throttle or regulating valve of the motor, a fan to exhaust air from one side of the diaphragm, and an inlet to admit air thereto, the whole substantially as described, and for the purposes specified.

3. The combination, with an electric generator and a motor, of an apparatus for regulating the speed of the motor, and comprising a needle, bar, or armature subject to and actuated by the influence of the field-magnets, a valve, cock, or shield connected to the said needle, bar, or armature, and serving to vary the size of an air-inlet, a diaphragm connected to the throttle or regulating valve of the motor, a fan to exhaust air from one side of the diaphragm, an inlet to admit air thereto, and a valve and piston to increase the exhaustive effect of the fan upon the diaphragm in case of accident, substantially as described, and for the purposes specified.

4. In the rotating armature of an electric generator, a rotating shaft having a longitudinal central passage therein, and iron disks or washers constituting the core of the armature, secured to said shaft, in combination with lubricant-feeding devices which communicate through the bearings of said shaft to the central passage therein, substantially as set forth, whereby the same fluid which lubricates the bearings also serves to carry off the heat from the armature.

5. In the commutator of an electric generator, a central rotating shaft and a removable cylindrical sleeve or bush which is slipped over said shaft, in combination with dovetailed rings carried by said sleeve, two or more sets of segments held between said rings and insulated therefrom, and a locking-nut, which secures said rings and segments upon said sleeve, substantially as set forth.

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