

No. 611,006.

Patented Sept. 20, 1898.

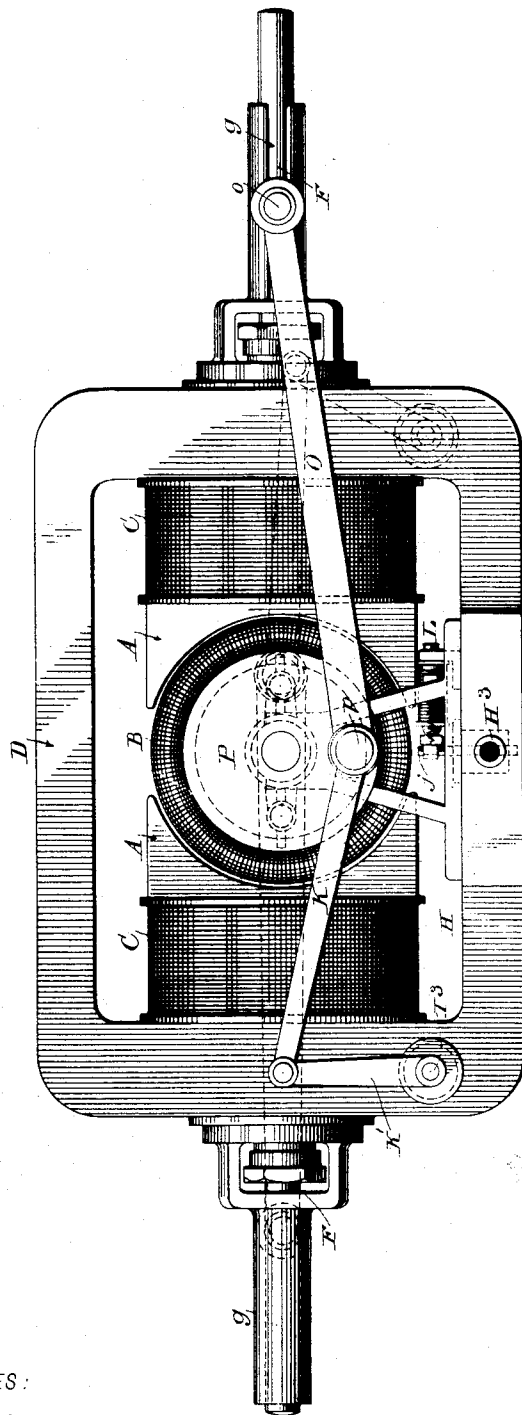
M. L. WHITFIELD.
COMBINED GENERATOR AND STEAM ENGINE.

(Application filed Nov. 16, 1897.)

(No Model.)

5 Sheets—Sheet 1.

Fig. 1.



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5 Sheets—Sheet 3.

Fig. 3.
section on line 3-3, fig. 2.

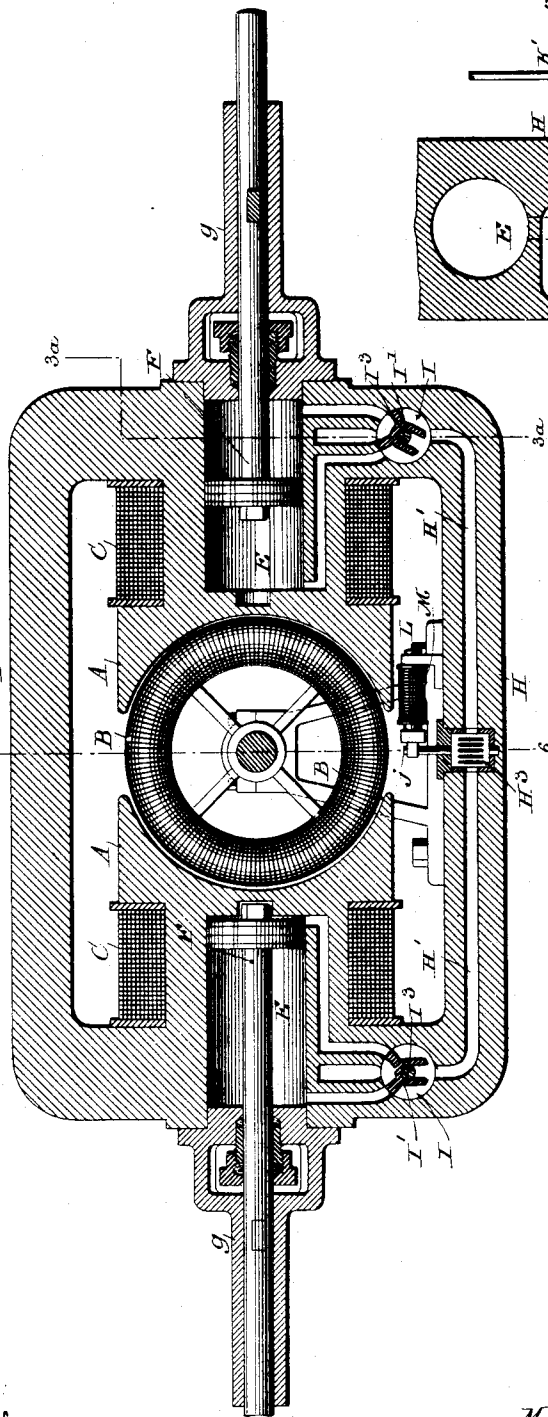
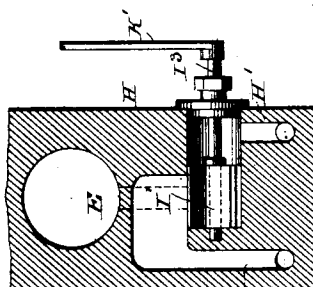


Fig. 3a.
on line 3a-3a, fig. 3.



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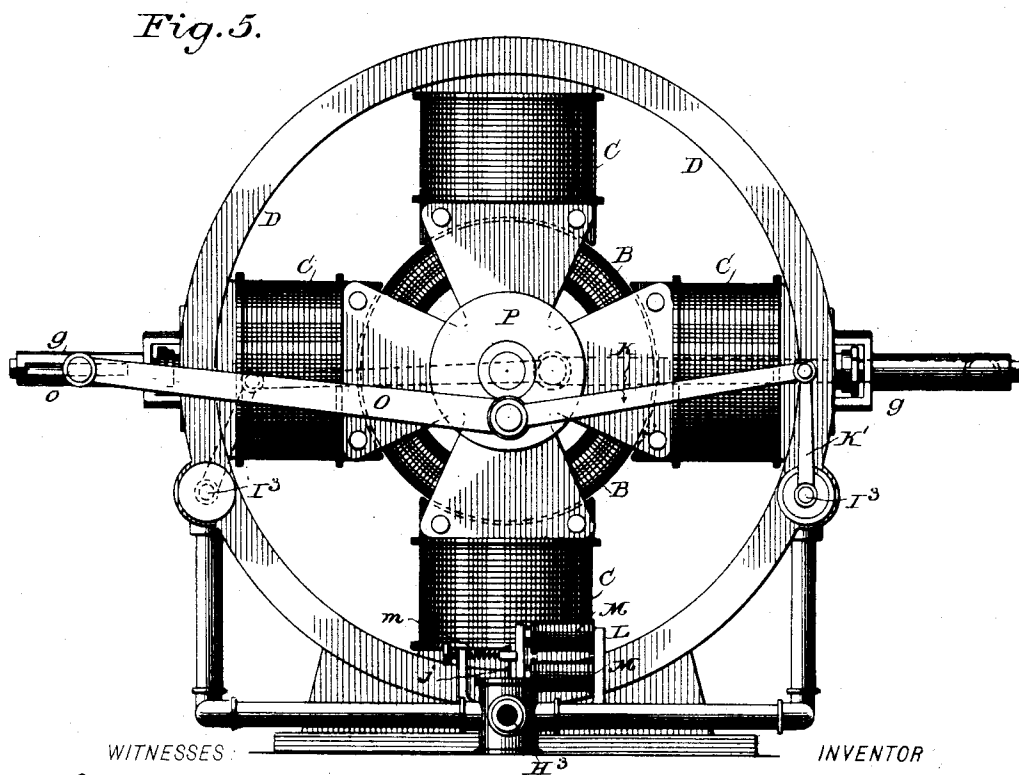
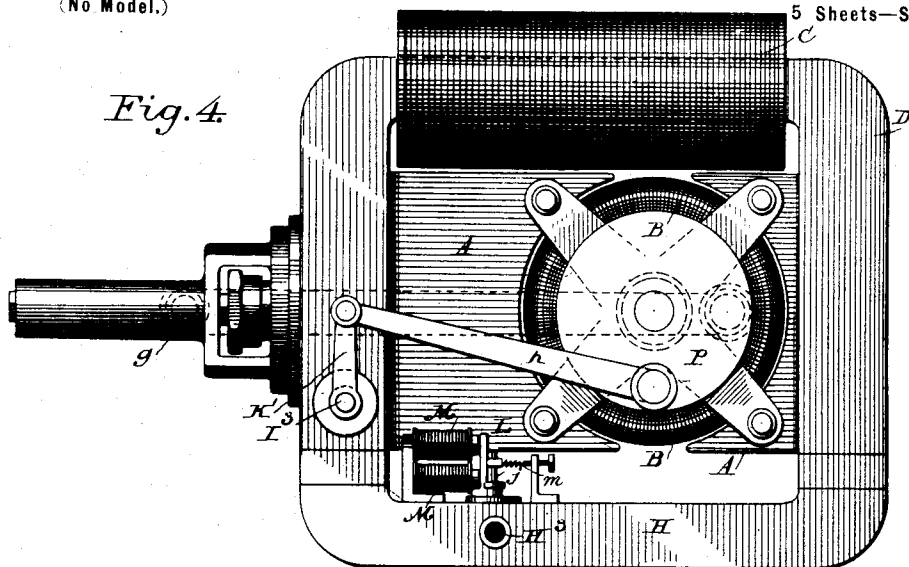
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5 Sheets—Sheet 4.



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5 Sheets—Sheet 5.

Fig. 6.

on line 6 6 of fig 3.

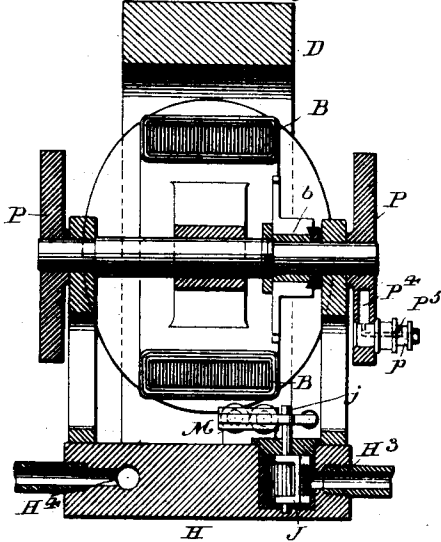


Fig. 7.

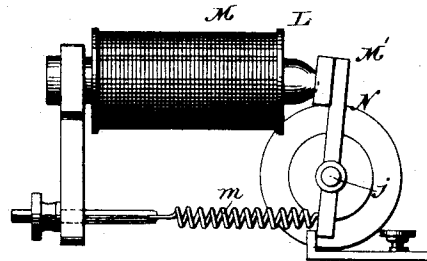


Fig. 8.

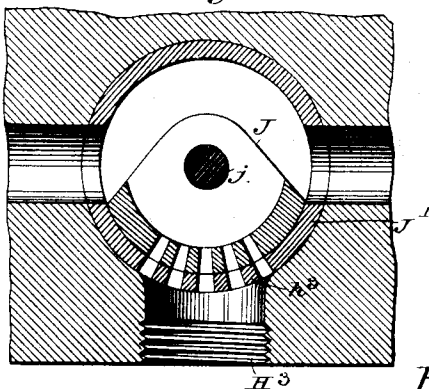


Fig. 9.

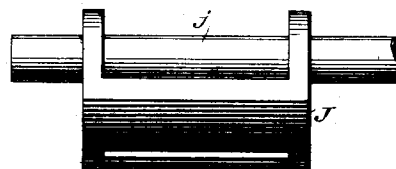


Fig. 10.

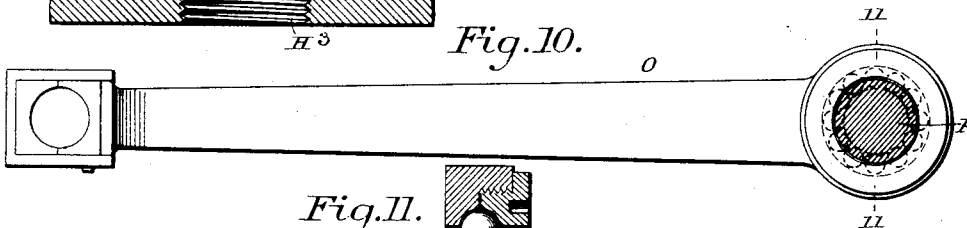
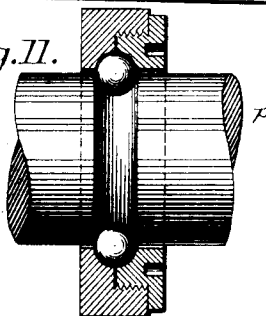


Fig. 11.



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UNITED STATES PATENT OFFICE.

MARCY L. WHITFIELD, OF MEMPHIS, TENNESSEE, ASSIGNOR TO THE AMERICAN DYNAMO ENGINE AND MOTOR LAMP COMPANY, OF TENNESSEE.

COMBINED GENERATOR AND STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 611,006, dated September 20, 1898.

Application filed November 16, 1897. Serial No. 658,681. (No model.)

To all whom it may concern:

Be it known that I, MARCY L. WHITFIELD, a citizen of the United States, residing at Memphis, in the county of Shelby and State of Tennessee, have invented certain new and useful Improvements in Electric Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The object of my invention is to devise a machine which will combine within itself the mechanism for producing or consuming electrical energy and for consuming or producing the expansive energy of steam, air, &c. I aim, in other words, to produce an engine which will be adapted to utilize both electric and expansive energy, both directly as a producer and indirectly as a consumer, and in which either character of energy may be produced or consumed independently of the other. When my engine is used to consume expansive energy and produce electric energy, it takes the form of a combined engine and dynamo. When used to consume electric energy and produce expansive energy, it is a combined electric motor and pump. As, however, my engine may be used to produce or consume electric energy independently of its consumption or production of expansive energy, it finds its fitting designation in neither of the terms before mentioned. It may be properly called an "electric" engine.

Economy of space and power are both obtained by my construction. My electric engine is capable of use in many places where existing power producers or users are either inadequate or impossible to employ.

In accomplishing the object of my invention I have constructed a dynamo-electric engine in which one or more of the field-magnets are interiorly hollowed, so as to form what I term "piston-chambers." Within the chambers thus formed reciprocate pistons which may be and preferably are connected by suitable mechanism to the armature of the dynamo-electric machine, so that movement of one will cause corresponding movement of the other.

I wish to call attention to the fundamental difference between the function of the piston-chamber which I employ and that of the piston chamber or cylinder used in steam-engine construction. In steam-engine construction the design of the cylinder is controlled by the object to make it sufficiently strong to allow the production of the desired amount of expansive energy with the use of the least quantity of metal, and the metal is solely and simply a confining agent for the expansive power. In my construction the design of the field-magnet is controlled by the amount of electric energy which it is to produce or the number of magnetic lines which it is to contain, and the use of the field-magnet to inclose the hollowed-out portion which forms the walls of the piston-chamber is incidental and subservient to its use as a magnetic agent. Arising from this difference in the purpose and function of the metal forming the field-magnet are the facts that the position of the piston-chamber within the field-magnet need not be confined to the central portion illustrated in the drawings of this specification, nor need the proportions of the piston-chamber relative to the field-magnet be those commonly used in steam-engine construction.

When steam is conveyed to the piston-chamber through suitable valve connections provided and the expansive engine becomes a steam-engine, reciprocation of the piston results in a corresponding movement of the armature and the dynamo-electric machine becomes a producer of electric energy. If, on the contrary, the dynamo-electric machine is supplied with electrical energy and used as a motor, reciprocation of the piston follows corresponding rotation of the armature and the steam-engine is converted into a pump. The power produced by the reciprocation of the piston may also be added to that produced by the action of the armature as a motor to effect concentration of power.

My invention is fully illustrated in the drawings which accompany and form a part of this specification, in which the same reference-letters refer to the same or corresponding parts, and in which—

Figure 1 is a side elevation of my electric

machine. Fig. 2 is a top plan view of the same. Fig. 3 is a central section on the line 3 3, Fig. 2. Fig. 3^a is a detail cross-section of the yoke containing the steam-passages on the line 3^a 3^a, Fig. 3. Fig. 4 is a view of a modified construction. Fig. 5 is a view of another modified form of construction. Fig. 6 is a section on line 6 6, Fig. 3. Fig. 7 is an enlarged detail of the mechanism for actuating the throttling-valve. Figs. 8 and 9 are views of a novel form of throttling-valve for governing the speed of the engine. Fig. 10 is a detail view of the driving-rod employed to transmit power from the piston to the armature. Fig. 11 is a detail of the crank-and-rod connection, showing the ball-bearing. Fig. 12 is a detail view of the commutator and magnetic brush controller.

In the construction of my electric engine considerations of economy in the production of power, of the utilization of the greatest possible proportion of the power produced, and of the avoidance of unduly heating the coils used for energizing the field-magnets of the dynamo-electric machine have caused me to adopt several types, each being fitted for special conditions. Of these I shall describe three of the most prominent types of construction—namely, a bipolar type of generator both fields of which are interiorly hollowed so as to confine piston-chambers, a bipolar type of generator only one field of which is formed so as to constitute a piston-chamber, and a multipolar type of generator two fields of which are specially formed so as to inclose piston-chambers. Other types may be devised and successfully operated, but I confine myself to the illustration of the three mentioned, as they are fairly representative of all.

Referring to Figs. 1, 2, 3, and 6 to 11, inclusive, A represents the pole-pieces of my dynamo-electric machine; B, the armature thereof; C, the energizing-coils, and D the magnetic yoke connecting the two pole-pieces. The cross-section of the yoke D, as well as of the poles A, is determined by the amount of electrical energy to be utilized in any special machine, and should be amply sufficient to carry the lines of force.

The special feature of my machine consists in the use which I make of the field-magnets or poles of my dynamo. These field magnets not only perform their ordinary function of producing a magnetic field, but are so formed as to constitute the piston-chambers, within which reciprocate pistons, by the action of which the power necessary to effect the revolution of the armature is generated. For this purpose they are hollowed interiorly to form the cylinders E. For this purpose also valve-chambers I are formed integrally or otherwise closely connected to the field-magnets at the extreme rear or guide end of the same, space being afforded between such valve-chambers and the pole-pieces A for the magnet-coils C. Within the valve-chambers I

are stationed the valves I', which alternately connect the ends of the cylinders with the supply-pipe H' and exhaust-pipe H², respectively. Both the supply and exhaust pipes are cast within a yoke H, which connects the two pole-pieces and serves also in this type of the electric engine to carry a portion of the lines of force produced by the energizing-coils. Within the yoke H is also cast the main steam-inlet port H³ and the main steam-discharge port H⁴. Great simplicity and strength of construction are hereby attained.

The valve J used to control admission of steam is of novel construction and is shown in Figs. 8 and 9. The desirability of a special type of valve for this purpose arises from the fact that in an engine of this type the ordinary forms of governors to regulate the speed of rotation of the armature are not suitable, and I have devised a new form of valve and a novel governor acting in connection with the valve to control the movement of the same to effect the control of the engine ordinarily obtained by centrifugal or other types of governors. The valve J is a throttling-valve and controls the amount of steam entering the steam-chests. It is arc-shaped and fits closely within its casing J'. The central portion of the valve, or that which is normally in front of the main inlet-pipe H³, is longitudinally slotted. The mouth of the steam-inlet pipe is also partially closed at this point by a series of bars h³. The parts are so proportioned that when the bars of the valve J register in position with the bars h³ the passages of the valve and of the inlet-pipe also register and ingress of steam is permitted. It requires, however, but a slight axial turn of the valve to cause the valve-bars to close the passage between the inlet-bars h³, when steam is entirely cut off. The diameters of the valve-casing J' and of the valve are so chosen that the total area of the opening permitted when the valve is opened is equal to that of the inlet-pipe or to the sum of the cross-sections of the two branch inlet-pipes. Thus free passage of steam is secured, and at the same time a very delicate control is effected over the amount of steam introduced.

The mechanism for controlling the valve J must of necessity be very delicate and responsive in its action in order to properly and automatically control the electrical output. To control the position of the valve, I make use of a magnetic valve-controller L. This consists of magnets M, mounted upon a suitable base, which act upon an armature M', which is in the form of a lever, keyed to the valve-stem j and normally held distant from the magnetic pole-pieces by the spiral spring m. The magnets M are energized by the current produced by the rotation of the armature. The strength of the current energizing the governor is thus directly dependent upon the speed of rotation of the armature, and effective control is provided over the amount of steam admitted to the piston-chambers.

This control may be made as delicate as required by properly proportioning the length of the armature-lever N.

It may be here stated that the electric valve-controller is only used when the machine is used as a combined steam-engine and dynamo. When the engine is used as a motor and pump, the electric governor is disconnected. The power produced by the reciprocation of the piston F is conveyed to the armature-shaft by the driving-rods O. The driving-rods O are connected to the piston-rods by the wrist-pins *o*, which slide in slots formed in the guides *g*, and are connected to the armature-shaft by the wrist-pins *p*, formed on the disks P, which are keyed to the armature-shaft. To the crank-pins *p* are also attached valve-rods K, which extend across the dynamo toward the opposite piston-chamber. As the driving-rods are quartered with respect to each other, proper action of the valve is thus secured. Suitable reduction in the movement of the valves relative to that of the crank-disks P is effected by proportioning the lengths of the levers K', by means of which the valve-rods are connected to the stems I³ on which the valves are mounted.

I make provision for oiling the driving and valve rods by oil-wells P⁴, formed within the disks P and connected to the wrist-pins *p*, upon which the driving and valve rods are mounted, by channels P⁵. The centrifugal action caused by the rotation of the disks P will serve to properly feed the oil to the bearings.

The armature B which I use may be of any desired construction, as also the commutator *b* used in connection therewith; but the form of controller I use to graduate and determine the pressure with which the carbons press against the commutator-surface is novel, and is shown in Fig. 12. To secure the best effects from a commutator, the brush used should press against the same with a pressure corresponding to the amount of current carried by the armature, increasing as the current strength increases and decreasing as the current strength falls. The friction generated by the contact of the brush with the commutator-surfaces is thus reduced as low as possible consistent with the best electric action.

In my construction the brushes *b'* are carried upon angled levers *b*², which are pivoted centrally to the magnetic brush-controller *b*³. This brush-controller is pivoted to the poles at either end and conforms in general contour to the shape of the face of the same. The central portion *b*⁴ of the controller is of non-magnetic material, such as brass, but the tips *b*⁵ are made of steel, so as to be magnetically attracted by the pole-pieces when current is passing through the energizing-coils of the dynamo or motor. The strength of the magnetic attraction varies with the variation in current strength of the energizing-current and is directly proportional to the amount of

current strength. As the pressure with which the brushes bear against the commutator is greater or less in accordance with the position in which the magnetic brush-controller *b*³ is held, and it will be seen that a perfect regulation is here secured, brass is employed for the central section of the brush-controller in order to secure a more perfect action of the same.

The operation of my electric engine is as follows: When steam is used in the piston-chambers of the engine and the engine is used as a combined engine and dynamo, steam is admitted through the steam-inlet pipe H³, passes into the piston-chambers, causing reciprocation of the pistons F, and is discharged through the discharge-port H⁴. As the steam inlet and discharge conduits between the ports H³ and H⁴ are formed within the engine itself, leakage of steam is avoided and a very strong construction secured. The reciprocatory movement of the pistons F produces by reason of the connecting mechanism rotation of the armature B and consequent generation of current. The speed of rotation of the armature is determined by the amount of steam admitted to the steam-chests or valve-chambers I, and this in turn is governed by the position of the arc-shaped throttling-valve J. The arc-shaped throttling-valve J is governed as to its position by the action of the magnets M through which the main current passes, so that a close regulation in the speed of rotation of the armature is secured.

When the electric engine is used as a combined motor and pump, the operation above stated is reversed. The reciprocation of the pistons is in this case the result and not the cause of the rotation of the armature, but otherwise the action of the engine is substantially the same.

In Figs. 4 and 5 I have shown views of two modified forms of construction.

In Fig. 4 a bipolar type of generator is shown with only one field hollowed to constitute a piston-chamber. In this case the energizing-coil C is wound upon the yoke connecting the pole-pieces for the double reason of securing economy in copper on account of the increased size of the pole-piece necessary because of the hollowing of its interior and of avoiding undue heating of the coil. It is necessary in this instance to magnetically insulate the yoke H, in which are formed the steam inlet and discharge conduits.

In Fig. 5 a multipolar type of generator is shown with only two of the pole-pieces hollowed to constitute piston-chambers. The pole-pieces thus hollowed are oppositely situated, and the engine corresponds to the type of engine shown in Fig. 1, with the exception that two additional pole-pieces are employed. In all instances I prefer to make the pole piece or pieces of a relatively large mass with respect to the piston-chamber formed therein, particularly when the device is used as an

electric generator operated by steam, in order that the heat may be properly radiated without affecting the insulated wire of the field-magnets.

- 5 Other types of construction may be employed than those I have shown and other forms of valves, valve-fittings, &c. I do not
10 and do not affect the real character of my invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. A field-magnet or pole-piece having its
15 interior hollowed so as to constitute a piston-chamber, and having valve-passages formed within said field-magnet or pole-piece, in combination with a piston and suitable valve
20 mechanism, substantially as described.

2. A field-magnet or pole-piece of relatively
20 large mass having its interior hollowed so as to constitute a relatively small piston-chamber, whereby the heat produced by steam
25 within said chamber will be radiated by said pole-piece, and an armature rotatable with respect to said pole-piece, in combination with a piston, suitable valve mechanism, and
30 connections between said piston and armature, substantially as described.

3. The combination with an armature, of a
30 field-magnet hollowed so as to constitute a piston-chamber, and having valve-passages formed within said field-magnet or pole-piece, a piston within said piston-chamber, valves
35 and valve mechanism for controlling ingress and egress to said piston-chamber, and mechanism for connecting said piston to said armature, whereby movement of one will cause
40 corresponding movement of the other, substantially as described.

4. The combination with an armature, of
45 field-magnets hollowed so as to constitute piston-chambers having valve-passages also formed within the same, a yoke holding said field-magnets in line with each other on
50 opposite sides of said armature and also completing the magnetic circuit through said field-magnets, pistons within said piston-chambers, valve mechanisms for controlling
55 ingress to and egress from said piston-chambers, and mechanism for connecting said pistons to said armature and thereby rotating
60 said armature, substantially as described.

5. The combination with an armature, an
55 armature-shaft, disks on both ends thereof, and field-magnets hollowed so as to constitute piston-chambers having valve-passages also formed within the same, of a frame adapted
60 to hold said field-magnets in line with each other on opposite sides of said armature and also to complete the magnetic circuit through said field-magnets, pistons within said piston-chambers, valve mechanisms for controlling
65 ingress to and egress from said piston-chambers, and driving-rods connecting said pistons and said disks, said driving-rods being on opposite sides of said field-magnets and

being quartered with relation to each other, substantially as described.

6. The combination with an armature, of
70 field-magnets hollowed so as to constitute piston-chambers having valve-passages also formed within the same, a frame holding said field-magnets in line with each other on
75 opposite sides of said armature and also completing the magnetic circuit through said field-magnets, pistons within said piston-chambers, valve mechanisms for controlling
80 ingress to and egress from said piston-chambers, mechanism for connecting said pistons to said armature and thereby rotating said armature, and means operated by each piston-chamber for operating the valve mechanism
85 of the opposite piston-chamber, substantially as described.

7. The combination with an armature, an
90 armature-shaft, disks on both ends thereof, and field-magnets hollowed so as to constitute piston-chambers having valve-passages formed within the same, of a frame adapted to hold said field-magnets in line with each
95 other on opposite sides of said armature and also to complete the magnetic circuit through said field-magnets, pistons within said piston-chambers, valve mechanism for controlling ingress to and egress from said piston-chambers, driving-rods connecting said pistons and said disks, and valve-rods connecting the valve mechanism of each piston-chamber with the driving-rod of the opposite piston-chamber, substantially as described. 100

8. The combination with an armature, pole-pieces hollowed so as to constitute piston-chambers having valve-passages also formed within the same, and a frame adapted to hold
105 said pole-pieces in line with each other on opposite sides of said armature, of pistons within said piston-chambers, valve mechanism for controlling ingress to and egress from said piston-chambers, mechanism for connecting
110 said pistons to said armature whereby movement of the one will cause corresponding movement of the other, a magnetic yoke connecting said pole-pieces, and an energizing-coil wound thereon, substantially as described. 115

9. The combination with an armature, two pole-pieces, each of said pole-pieces being
120 interiorly hollowed so as to constitute a piston-chamber, and being formed with valve-passages, a yoke connecting said pole-pieces, said yoke having formed therein ingress and egress conduits, and valve mechanism for controlling ingress to and egress from said piston-chamber, of a piston within said piston-chamber, and mechanism connecting
125 said piston and said armature whereby movement of the one will result in corresponding movement of the other, substantially as described. 130

10. The combination with an armature, pole-pieces, and a commutator, of commutator-brushes, magnetic fittings pivoted to said pole-pieces and adapted to change position

relative thereto with variations of magnetic attraction of said pole-pieces, and mechanism connecting said brushes with said fittings, whereby the pressure with which the brushes
5 bear against the commutator is dependent upon the magnetic attraction of said pole-pieces, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

MARCY L. WHITFIELD.

Witnesses:

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S. G. HOPKINS.