(No Model.) 2 Sheets—Sheet 1.

T. H. HICKS.

OSCILLATING RECIPROCATING TRIPOLAR ELECTRIC MOTOR.

No. 568,947. Patented Oct. 6, 1896.

Fig. 1.

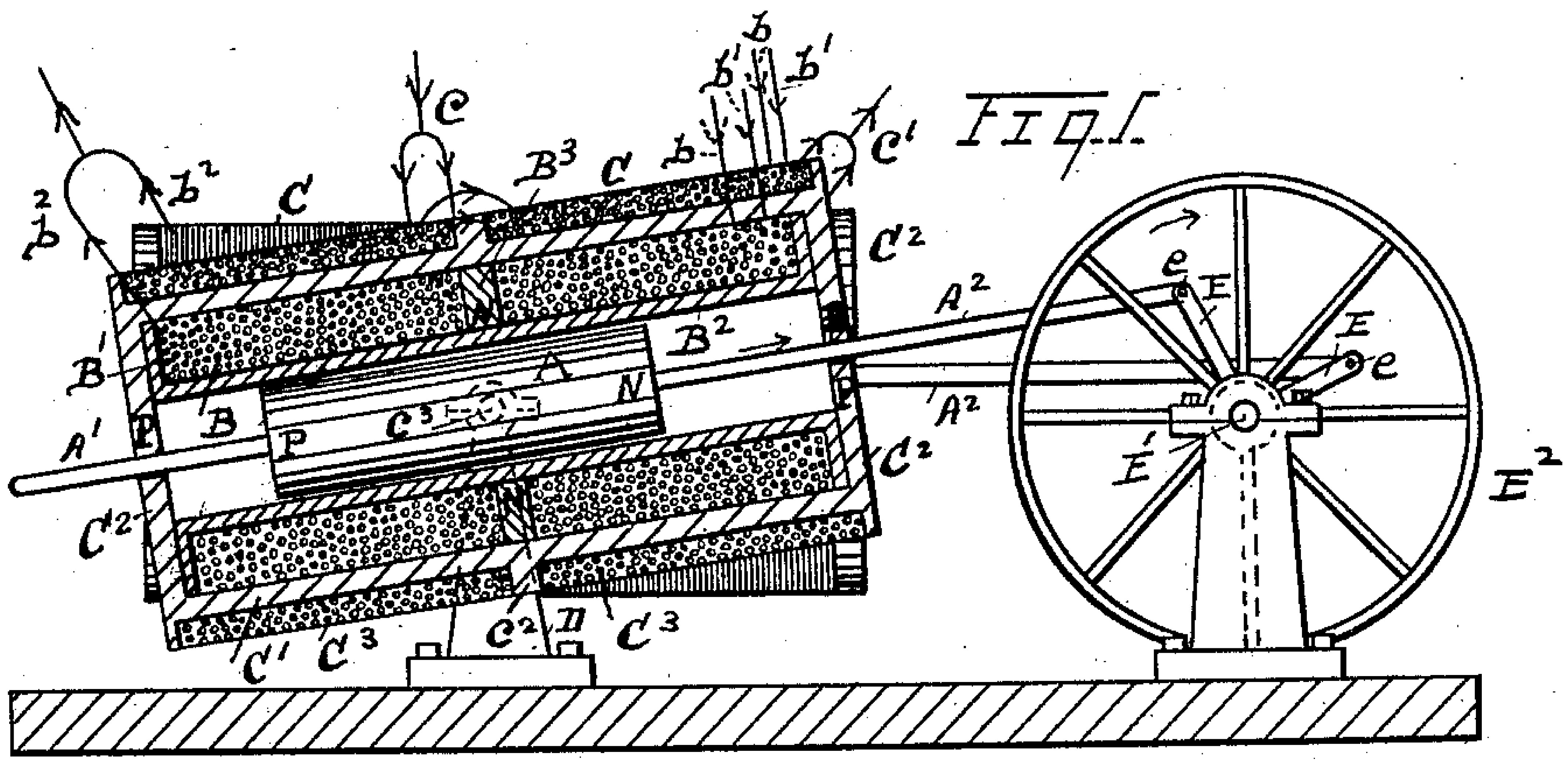


Fig. 2.

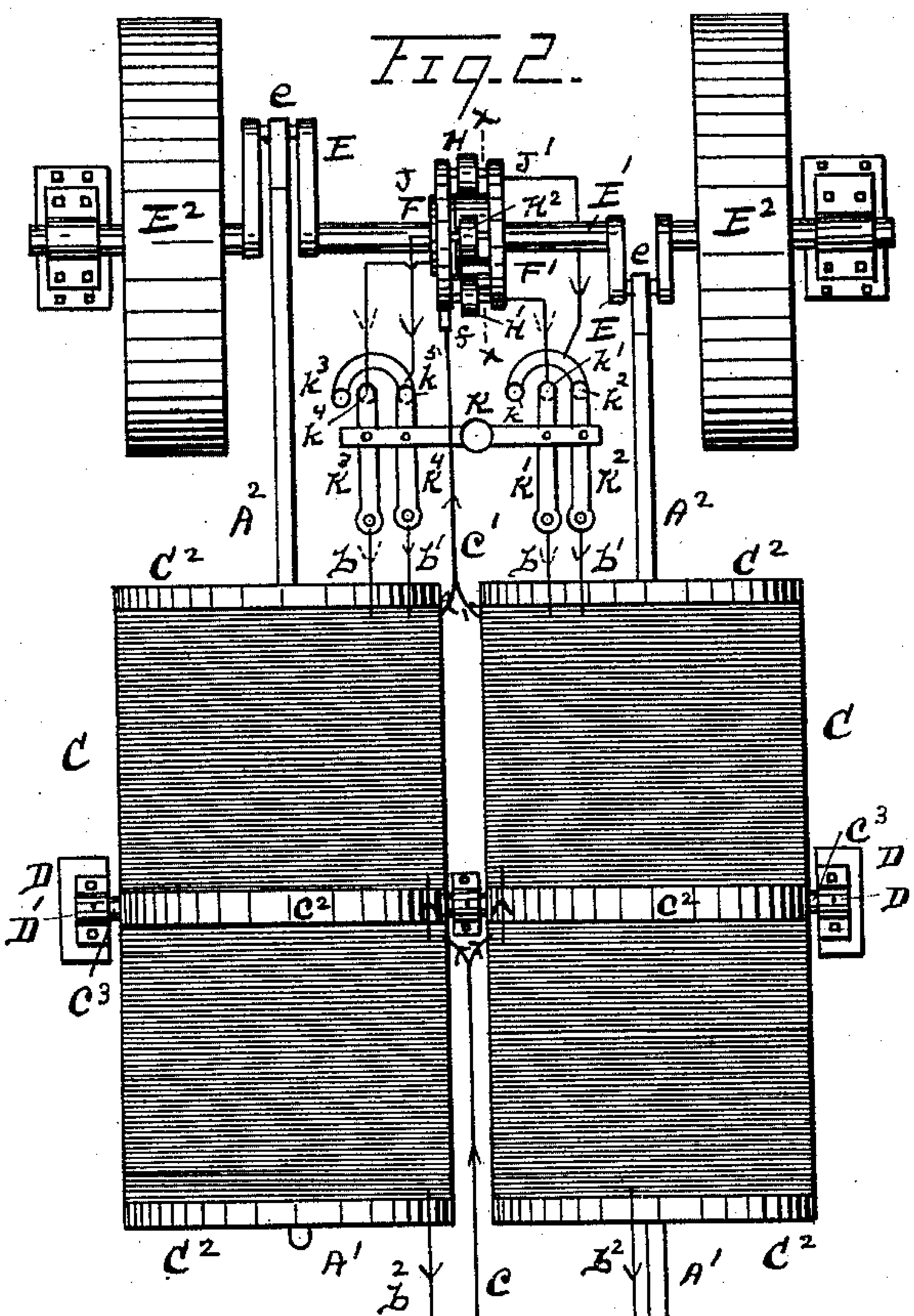
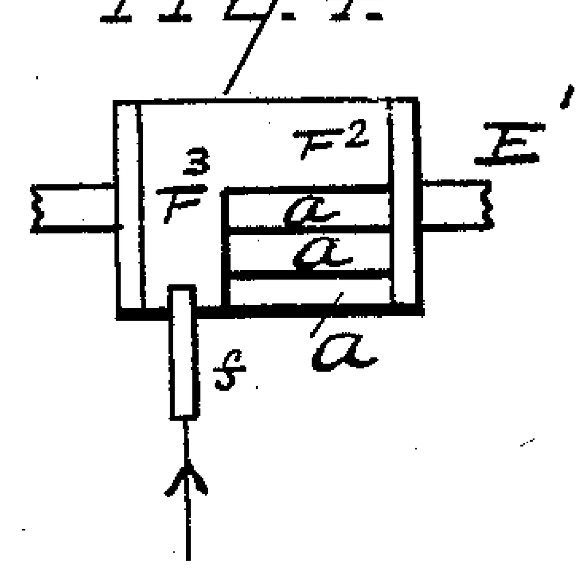


Fig. 4.



Witnesses
John Schuman.
Bertha Orth.

Inventor
Thomas H. Hicks

By Attorney
Newell S. Wright.

(No Model.) 2 Sheets—Sheet 2.

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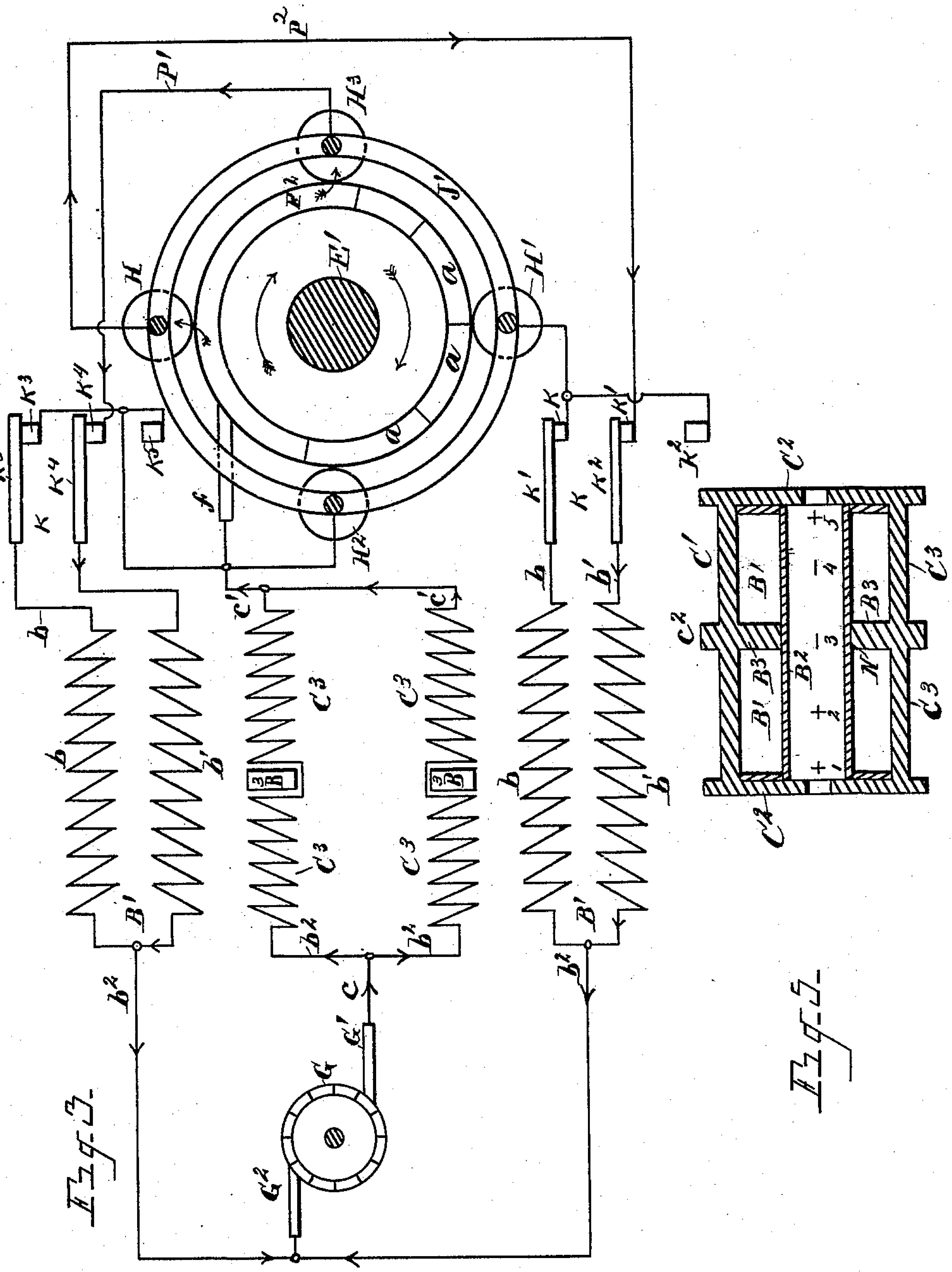

WITNESSES

Otto B. Baenziger.

Mary A. Martin.

INVENTOR

Thomas H. Hicks

By his Attorney

Newell S. Wright

UNITED STATES PATENT OFFICE.

THOMAS H. HICKS, OF DETROIT, MICHIGAN.

OSCILLATING RECIPROCATING TRIPOLAR ELECTRIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 568,947, dated October 6, 1896.

Application filed December 19, 1892. Serial No. 455,564. (No model.)

To all whom it may concern:

Be it known that I, THOMAS H. HICKS, a subject of the Queen of Great Britain, residing at Detroit, county of Wayne, State of Michigan, have invented a certain new and useful Improvement in Oscillatory Reciprocating Tripolar Electric Motors; and I 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, reference being had to the accompanying drawings, which form a part of this specification.

This invention relates to new and useful improvements in reciprocating electric motors. The device, however, embodying my improvements I denominate an "oscillatory reciprocating tripolar electric motor" to distinguish it from other forms of construction belonging to the same class of electric motors.

The nature of my invention may be clearly understood by reference to the following specification and annexed drawings, in which—

Figure 1 is a vertical longitudinal section showing the interior construction of a tripolar-magnet solenoid and showing other parts in side elevation. Fig. 2 is a plan view showing more clearly how I combine two of my solenoid-magnets to operate in one motor. Fig. 3 is a diagram showing all of the circuits and their connections with each other, the arrow-heads indicating the comparative directions of currents when the motor-commutating device is in the position of its rotation indicated in this figure. The solenoid and magnet windings are not shown in this figure to be wound one upon the other; but this I do simply to show the circuits more clearly. Fig. 4 is a side elevation of the commutator I use to shift the current at the proper moment for the two solenoid-magnets. Fig. 5 is a longitudinal sectional view of the magnetic and non-magnetic cores of the magnet and solenoid. The plus and minus signs shown in this figure indicate the number and relative positions of the magnetic poles of both the magnet and solenoid when the piston A is in the position of its phase. (Shown in Fig. 1 in the solenoid-magnet, that is seen in section.)

In the drawings like letters of reference indicate like parts.

I describe my invention as follows:

Looking first at Fig. 5, in which I show the framework of my "tripolar magnet and solenoid," the same being shown complete, but in section, in Fig. 1, B^2 is a non-magnetic tubular shell which is inclosed by an outer magnetic drum consisting of a cylinder C', ends C^2 C^2, and an annular pole-piece B^3, the latter dividing the outer part of the solenoid-core into two parts. From the pole-piece B^3 extends outward an annular extension c^2, having journals c^3 attached thereto, which oscillate in journal-bearings D', the latter being a part of the supporting-frame D, as may be seen in Fig. 2.

In Fig. 1 I show the tubular shell B^2 and drum C' (illustrated in Fig. 5) wound with bobbins of wire, (marked B' and C^3, respectively.) The solenoid-bobbin consists of two circuits b and b', which are either wound in reverse directions to each other or connected to produce similar results, the two windings being only alternately used, one to draw the piston A in one direction and the other to draw it in an opposite direction. The drum or annular magnet-core C' is only wound with one circuit, C^3; but the winding is reversed in its direction at the annular pole-piece B^3, so as to produce consequent or like poles in the pole-piece B^3 and opposite but like poles in the ends C^2 C^2 of the drum; but I wish it to be understood that I could reverse the order and wind the tubular shell B^2 with only one circuit and the magnet-drum C' with two circuits, but the latter method would produce flashing from the discharge of the iron core when the current became changed from one circuit to the other, whereas in the former case the tubular shell acts as a discharging-circuit. These three circuits of the combined solenoid and magnet are shown more clearly in diagram in Fig. 3, where it will be noticed that the circuits b and b' of the two solenoid-magnets shown in Figs. 1 and 2 terminate at one end in conductors b^2, leading from the generator G, terminating at the other end in switches K' K^2 and K^3 K^4, respectively, the bobbin C^3 terminating at one end in the other lead, c, from the generator and at the other end in the conductor c', which is in electrical circuit with the commutator-brush f.

The two pairs of switches referred to are shown mechanically joined together in Fig. 2. This I do so as to reverse the direction of motion in the two solenoid-pistons at the same time. Each pair of switches has three contact-points, (marked, respectively, $k\ k'\ k^2$ and $k^3\ k^4\ k^5$.) k and k^2 are joined together, and $k^3\ k^5$ are similarly joined together. When the switches are shifted, therefore, the two solenoid-circuits b and b' exchange places with each other, and the direction of motion will thereby be reversed. Each solenoid has a reciprocating piston A, having non-magnetic arms A′ and A^2 for supporting the piston in position for free action. The arms have bearings in the ends C^2 of the magnet. The arms A^2 of the two pistons form piston-rod connection with the cranks E, they being joined to permit the rotation of the wheel E^2 at e.

The commutator or current-shifting device is shown in Figs. 2, 3, and 4. It consists of a continuous metal ring F^3, having a brush f, through which the current is supplied, and a semicircular segment F^2, joined to the ring, as in Fig. 4, and insulated segments $a\ a\ a\ a$, which are only used to make an even surface for the brushes or rollers H H′ and $H^2\ H^3$. The commutator thus constructed is mounted upon the shaft E′ so as to rotate therewith, and by having two pairs of sliding or rolling contacts H H′ and $H^2\ H^3$ I am thereby enabled to operate two reciprocating pistons by the one commutator, and by having two circuits in either the solenoid or the magnet acting in combination with the two sets of said sliding contacts and the two sets of switches I am further enabled to reverse the direction of rotation without stopping the motor, and short-circuiting the current is also effectually avoided. This part of the construction and combination therefore forms an essential part of my invention.

Each annular tripolar-magnet solenoid is constructed so as to oscillate independently, each being journaled from its center. In this way I can dispense with the usual bed-plate. By constructing a motor thus, having two solenoids, and connecting them to cranks of the shaft, so that one piston will always be in advance of the other, as may be seen in Figs. 1 and 2, I can thereby start the motor from any position of the piston without having what is known as a "dead-center" to overcome. This constitutes another important feature of my invention. The combined magnet and solenoid produce five magnet-poles, two being produced by the solenoid in its piston A, (marked P and N,) and three being produced by the magnet, one in the annular pole-piece and one in each end C^2. The relative nature and location of these five magnetic poles I illustrate in Fig. 5 by crosses and dashes, (marked 1, 2, 3, 4, and 5.) The poles 2 and 4 are in the ends of the piston, 3 being in the annular pole-piece B^3 and 1 and 5 in the magnet ends $C^2\ C^2$. By such an arrangement of magnetic poles there will be two attracting and two repelling forces throughout the full stroke of the piston in either direction of its motion, as I will explain in the following manner: Suppose the piston to be advancing in the direction forward, as indicated by the arrow. One point of attraction would then be between the end of the piston (marked N) and the approaching end of the magnet C^2, a second point of attraction being between the opposite end of the piston (marked P) and the annular pole-piece B^3, the repelling-points being between the end of the piston (marked N) and the annular pole-piece B^3 and between the end C^2 of the magnet and the receding end P of the piston, the said poles of course being arranged as indicated in Fig. 5 and the position of the piston being taken as in Fig. 1. The arrangement of these magnetic poles as specified and indicated therefore forms another essential feature of my invention, for such can only be accomplished by the combination of a magnet and a solenoid, as aforesaid. In this way I not only gain the advantage of attraction and repulsion referred to, but I am also thereby enabled to keep up an equal power throughout the whole stroke of the piston, which will be readily understood by noticing that as the distances increase between the repelling-poles the distances decrease proportionately between the attracting-poles. The length of the stroke therefore can be very much greater than in any other form of reciprocating motors.

The outer case of iron in my solenoid-magnet is made an independent magnet by a separate helix, which produces like magnetic poles in the center and ends of the drum. The construction I show is therefore unlike all others, and is new in every essential feature which I have mentioned.

I will now describe the direction of the flow of current through the two solenoids, magnets, and commutator during one complete rotation of the drive-wheel E^2, and for this purpose I desire attention principally to Fig. 3, which fully represents all of the practical features now to be explained.

Starting from the generator G the current flows from the brush G′ to the conductors $b^2\ b^2$. From here the current divides through the helices $C^3\ C^3$ of the two tripolar magnets and reaches the commutator-ring F^3 and segment F^2 through the conductors $c'\ c'$ and brush f. The roller-brushes H and H^3 are shown on the commutator semicircular segment F^2, the other two rollers H′ and H^2 being shown cut out of circuit by the insulated segments a. The current therefore can only flow through the roller-brushes H and H^3 and through their respective conductors P′ and P^2, which terminate, respectively, in the switch-contacts, (marked k' and k^4.) From here the current flows through one circuit b' of each solenoid, the currents from said circuits b' then returning to the generator G through the conductors b^2 and brush G^2. The circuits for the flow of current I have thus described may also be clearly traced by the arrow-heads. During the flow of current as described the solenoid-piston is supposed to have moved forward to the end of its stroke, and at the same time the commutator is supposed to have made one-half of a revolution. This would throw the roller-brushes H and H^3, through which the current has been flowing, out of circuit, and at the same time throw the roller-brushes H' and H^2 in circuit. This will cut the solenoid-circuits b' b' out and throw the other solenoid-windings b b in circuit, and they being wound in a reverse direction to the windings b' b', the magnetic poles in the piston would therefore become reversed, and this would cause the piston to reverse its motion until the commutator completes one rotation. The current is not changed from one circuit to the other in the two solenoids at the same instant, there being a quarter of a revolution of the fly-wheel difference, which may be seen by reference to the position of the rollers H H^3 or H' H^2. If the current were changed in the circuits of both solenoids at the same time, I would only need two roller-brushes for the two solenoids. Using four brushes on one rotating commutator in this way forms a very essential feature of my invention, for I am thereby enabled to prevent a dead-center when starting the motor, and the power is also more steady.

By the term "solenoid" I include the piston A, the hollow core B^2, and the helix of wire B'. The term "tripolar magnet" means a magnet having three magnetic poles, two of like or consequent poles being in one pole-piece and two of opposite but of like polarities to each other being in two separate pole-pieces.

What I claim, therefore, as my invention is—

1. In a reciprocating electric motor, the combination of a solenoid-core, wound with two conductors b and b', a piston, A; the two conductors being alternately traversed by a current of electricity; the current when flowing through the conductor b causing the piston to move in one direction in the axis of said core, and when flowing through the conductor b' causing the piston to move in an opposite direction, substantially as described.

2. In a reciprocating electric motor, the combination of a solenoid with a tripolar magnet, substantially as described.

3. In a reciprocating electric motor, the combination of a solenoid with a magnet; the solenoid and magnet having a separate helix, substantially as described.

4. In a reciprocating electric motor, the combination of a solenoid with a magnet, each having their respective helix; said magnet surrounding the solenoid, substantially as described.

5. In a reciprocating electric motor, the combination of a solenoid and a magnet; said solenoid and magnet being journaled in bearings so as to oscillate together, substantially as described.

6. In a reciprocating electric motor, the combination of a magnet and a solenoid; said magnet having an annular pole-piece, B^3, surrounding the solenoid, substantially as described.

7. In a reciprocating electric motor, the combination of a solenoid and a magnet; the magnet-poles being located intermediate and at the ends of the solenoid, substantially as described.

8. In a reciprocating electric motor, the combination of a solenoid and a magnet; the solenoid-helix having two circuits, and the magnet having only one circuit wound in two reverse directions, thereby producing a consequent pole-magnet, substantially as described.

9. In a reciprocating electric motor, the combination of a solenoid with a magnet; the conductors of the helices of the solenoid and magnet being joined together in linear series, substantially as described.

10. In a reciprocating electric motor, a rotating commutator, consisting of a metallic ring F^3, and a metallic semicircular segment, F^2, and three contact-brushes; one of said brushes being in sliding contact with said ring, and the other two brushes being alternately in sliding contact with said semicircular segment; the brushes in sliding contact with the semicircular segment being used to produce the reciprocating motions of the motor, substantially as described.

11. In a reciprocating electric motor, the combination of two solenoids with a rotating commutator; the pistons of the two solenoids rotating the commutator and the commutator controlling the movements of the solenoid-pistons, substantially as described.

12. In a reciprocating electric motor, the combination of a commutator with a solenoid; the solenoid having two electrical circuits b, b'; the commutator shifting the current alternately from one of said circuits to the other; one circuit being used to move the piston of the solenoid in one direction and the other circuit being used to move the piston in an opposite direction; the commutator being rotated by the piston, substantially as described.

13. In a reciprocating electric motor, the combination of a solenoid, a commutator, and a pair of switches; the solenoid having two electrical circuits; the commutator shifting the current alternately from one of the circuits to the other; the two switches being respectively arranged in the two solenoid-circuits, said switches serving to reverse the direction of the piston of the solenoid, substantially as described.

14. In a reciprocating electric motor, the combination of two solenoids, two pairs of switches K', K^2, K^3, K^4, and a commutator;

each solenoid having two circuits b and b', the commutator shifting the current alternately from one circuit to the other of each solenoid, thereby operating four circuits; the two pairs of switches being used to reverse the movements of the pistons of the two solenoids simultaneously, substantially as described.

15. In a reciprocating electric motor, the combination of two tripolar magnets and their respective solenoids, two pairs of switches K', K^2, K^3, K^4, and a rotating commutator; the solenoids and magnets each having their respective helices and reciprocating pistons; the commutator being used to shift the current for producing reciprocating motions of the two pistons, and the switches for reversing the direction of rotation of the motor, substantially as described.

16. In an electric motor, the combination with two solenoid-helices, each having their respective pistons, of two magnets, two pairs of switches, a drive-wheel, and a rotating commutator; each solenoid being provided with circuits, b, b', each magnet having three magnetic poles; the commutator shifting the current in the two solenoid-circuits for producing automatic reciprocating motions of the two pistons, the switches being used to reverse the direction of rotation of the drive-wheel; the pistons having each oscillating and reciprocating motions, substantially as described.

17. The combination of the herein-described tripolar magnet and solenoid, substantially as set forth.

18. In an electric motor, the combination of two tripolar magnets and solenoids herein described and substantially as set forth.

In testimony whereof I sign this specification in the presence of two witnesses.

THOMAS H. HICKS.

Witnesses:
N. S. WRIGHT,
JOHN F. MILLER.