(No Model.) 2 Sheets—Sheet 1.

C. J. VAN DEPOELE.

RECIPROCATING ELECTRIC ENGINE SYSTEM.

No. 401,231. Patented Apr. 9, 1889.

Fig. 1.

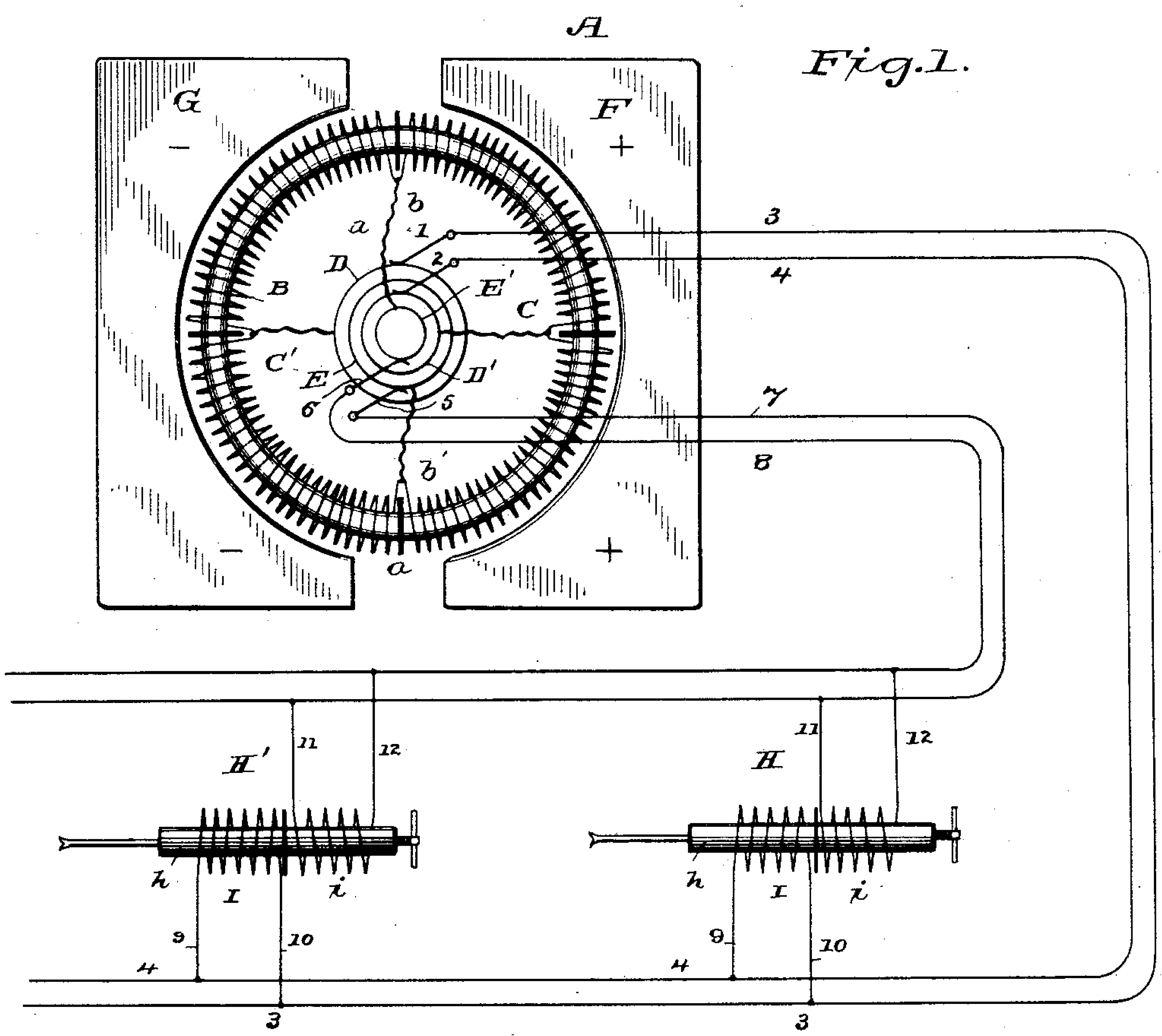


Fig. 2.

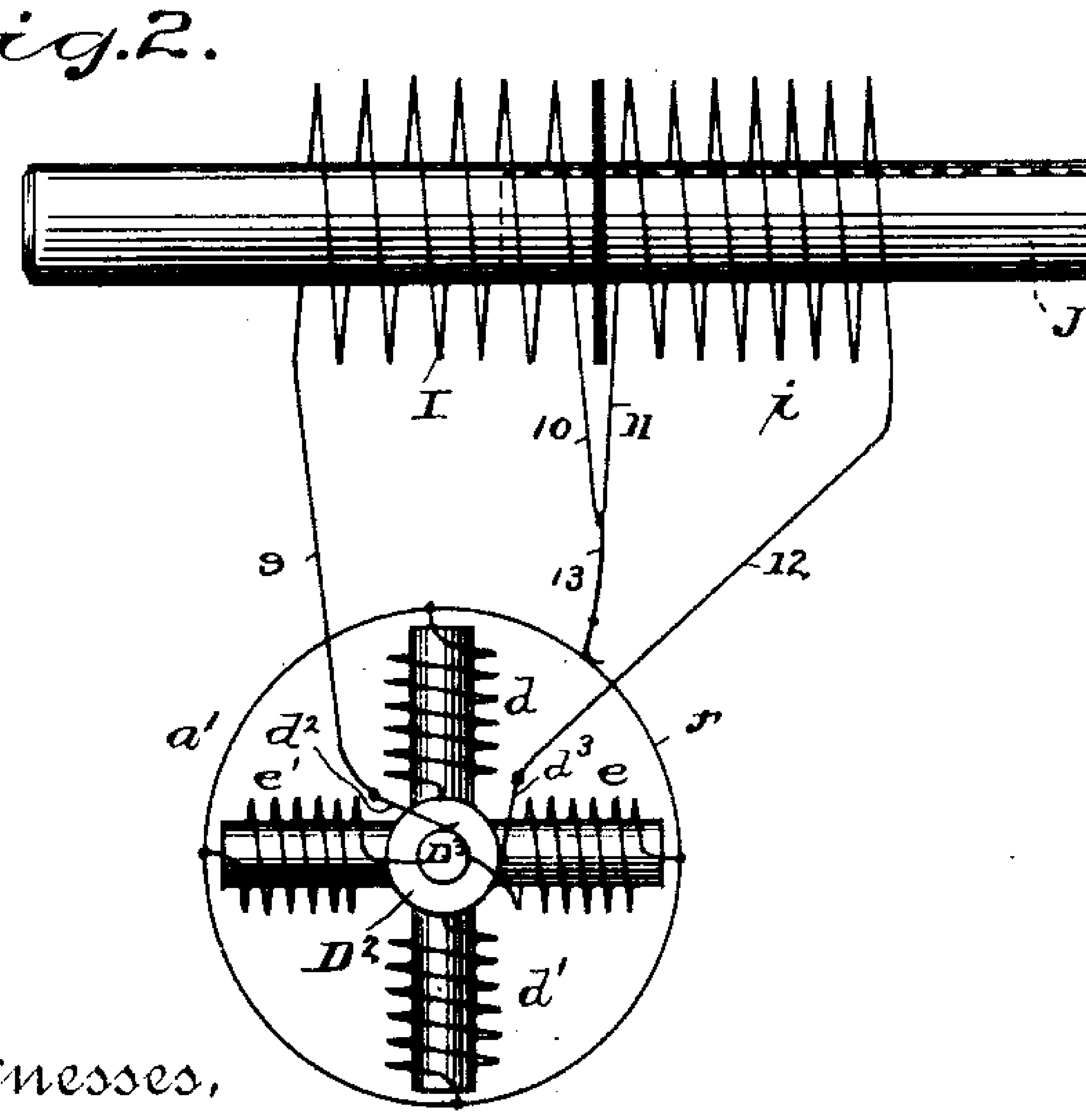
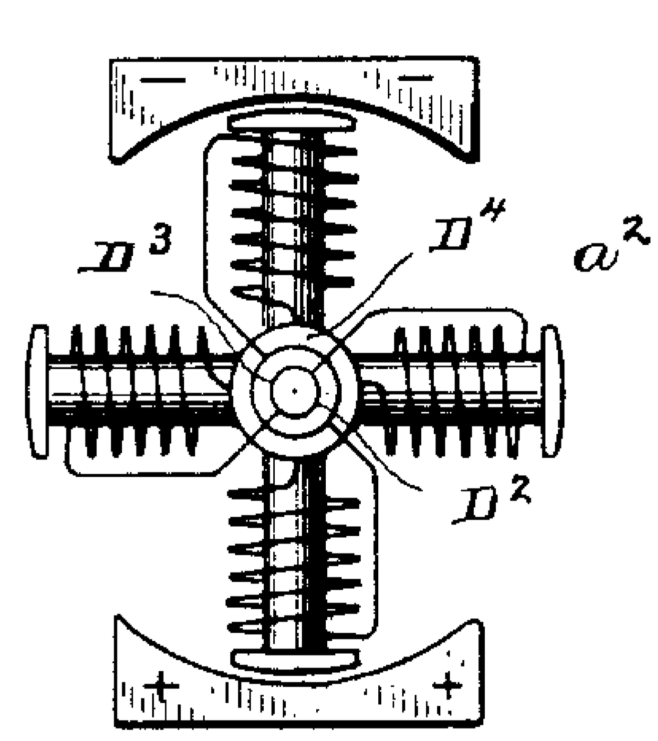


Fig. 3.



Witnesses,

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 4.

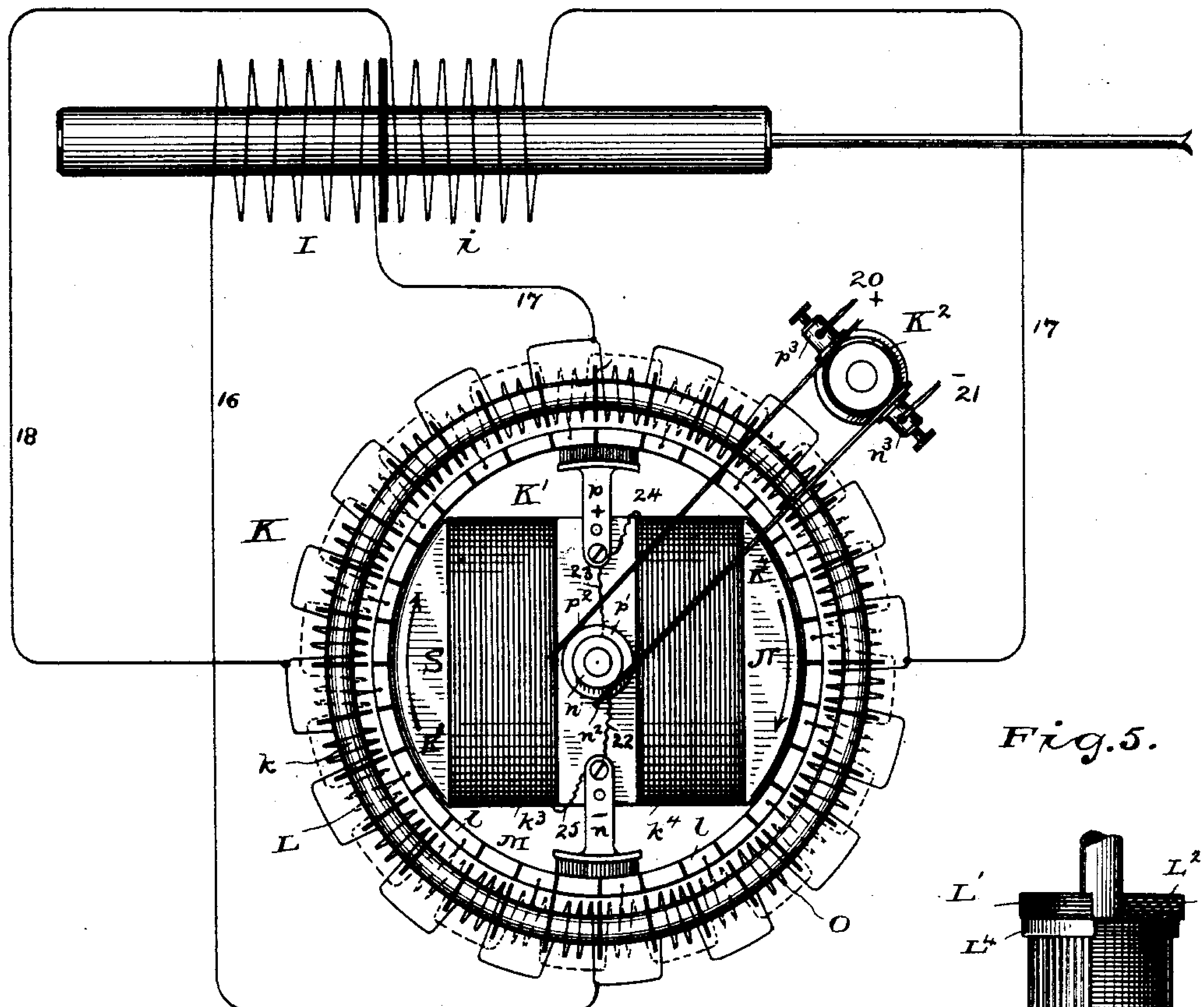


Fig. 5.

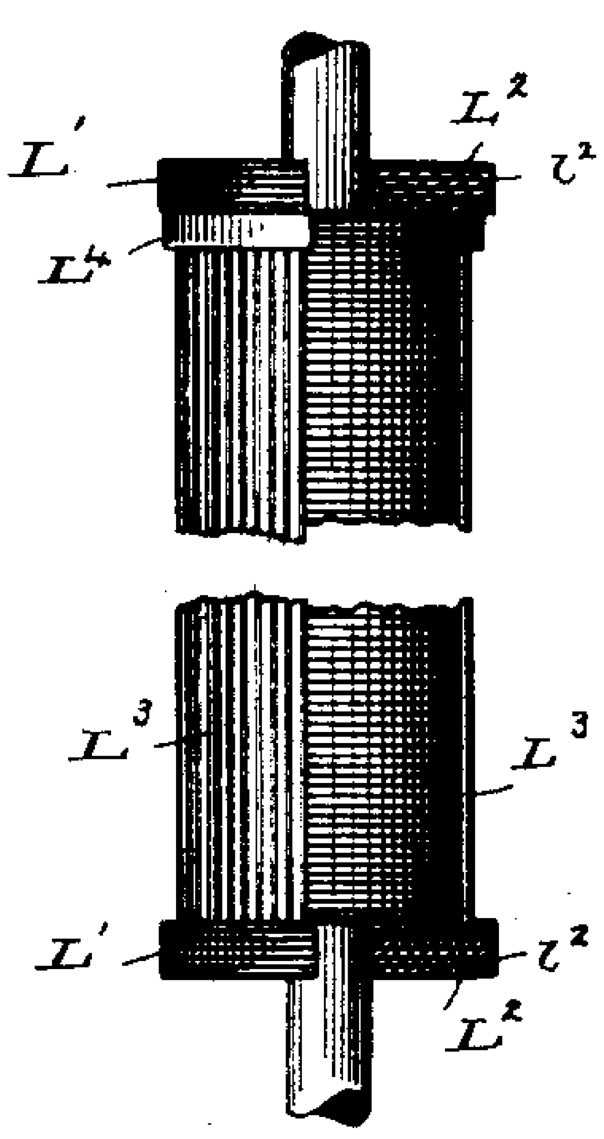
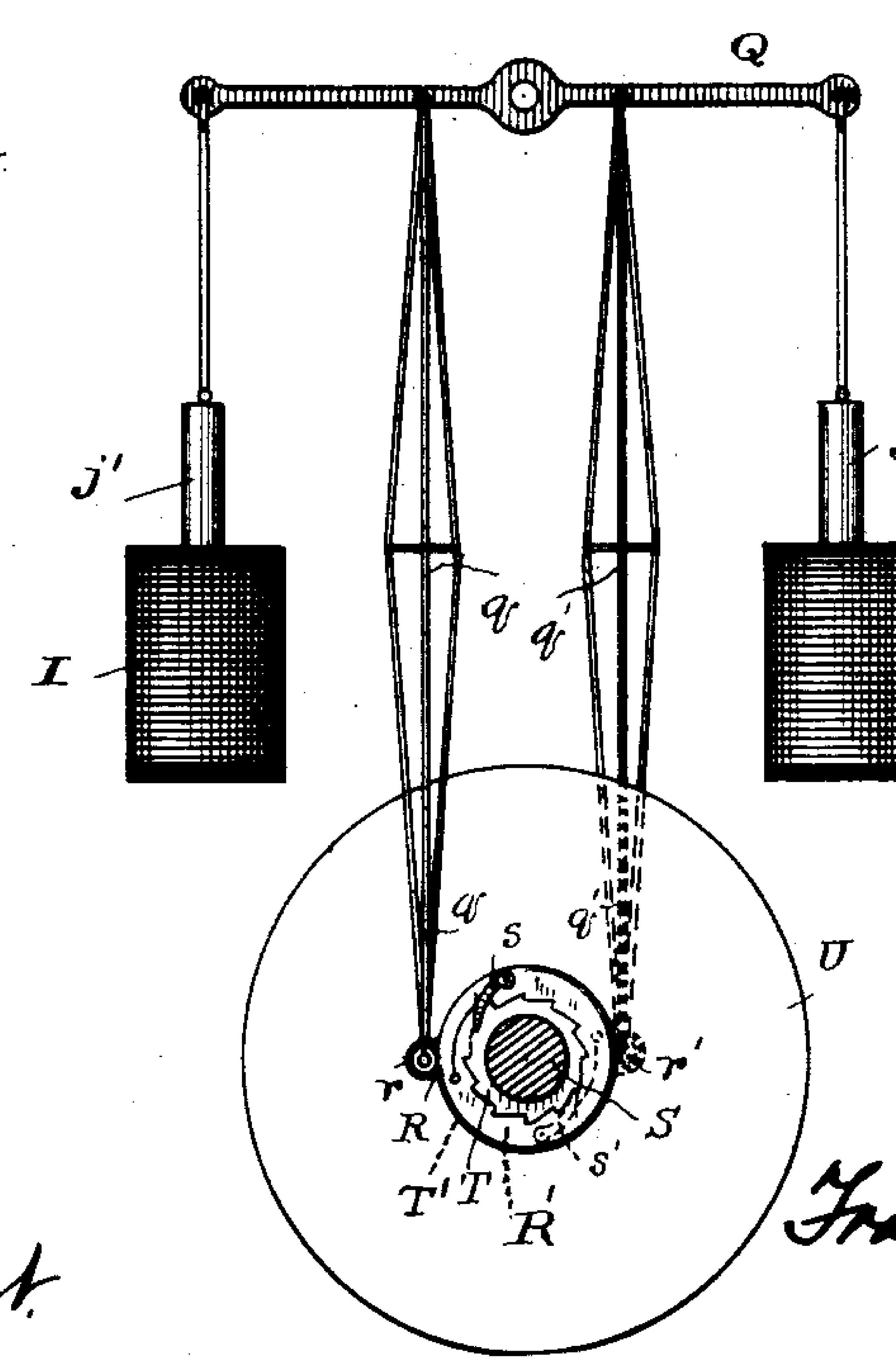


Fig. 5.ᵃ



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UNITED STATES PATENT OFFICE.

CHARLES J. VAN DEPOELE, OF LYNN, MASSACHUSETTS.

RECIPROCATING ELECTRIC-ENGINE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 401,231, dated April 9, 1889.

Application filed January 21, 1889. Serial No. 296,981. (No model.)

To all whom it may concern:

Be it known that I, CHARLES J. VAN DEPOELE, a citizen of the United States, residing at Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Reciprocating Electric-Engine Systems; 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.

My present invention relates to improvements in reciprocating electric engines for the operation of mining-drills and the like and for other purposes where a reciprocating motor is required.

In an application filed September 13, 1888, Serial No. 285,294, an alternate-current reciprocating engine is shown, described, and claimed. As there shown, however, the current is carried along a single circuit and shifted frcm coil to coil to produce reciprocatory motion of the tool-carrying plunger or piston, the circuit-connections being changed at the moment when one current has fallen to zero and before the succeeding phase has become sufficiently developed or attained sufficient force to create a spark.

The present invention comprises means for producing defined current phases of the desired volume and intensity and with only the required rapidity, said currents being transmitted to the motor-coils (producing reciprocation) by separate circuits, so that with a generator adapted to produce defined currents with only the desired rapidity, and circuit-connections for transmitting said currents to the proper working-coils, no circuit breaking, changing, or shifting of any kind whatever occurs. Consequently all danger of setting fire to the gas in fiery mines, as also the wear and tear incident to the use of circuit-breakers in whatever form, is entirely done away with.

The invention relates more to the principles and mode of operation than to any precise details of construction or form.

The accompanying drawings illustrate means for carrying my invention into effect, which will be hereinafter fully described, and referred to in the appended claims.

Figure 1 is a diagrammatic view of a generator, its working-circuits, and reciprocating engines in connection therewith, and embodying my invention. Fig. 2 is also a diagrammatic view showing an engine and a generator embodying a slightly different arrangement of circuit-connections. Fig. 3 is a diagrammatic view of a generator differing somewhat from that shown in Fig. 2. Fig. 4 is a diagrammatic view similar to Fig. 1, but showing another form of current-generating apparatus. Fig. 5 is an elevation, partly in section, showing the coils and exterior envelope of a reciprocating electric engine. Fig. 5ª is a view in elevation of a reciprocating engine arranged to produce rotary motion.

The generator A comprises an armature, *a*, which may be of the Gramme type, as shown. Said armature is provided with a continuous winding, B, which, instead of being divided into a large number of sections connected to corresponding sections of a commutator, is divided into, say, four parts, each one of which is connected, as by wires *b b′* C C′, with separate insulated metallic rings D D′ and E E′. The entire current produced by the armature is therefore brought to the collecting-rings, upon each of which is placed a collecting-brush.

F G are pole-pieces which are suitably magnetized, and in the field of force between them the armature is rotated as in ordinary dynamo-electric generators. The collector-brushes 1 2, which rest upon rings D D′, are connected to separate main-circuit conductors 3 4, which extend to the points where the current is to be used. Similar brushes, 5 6, are connected through working-conductors 7 8, which also extend to the point of current consumption.

Two electro-magnetic rock-drilling engines, H H′, are diagrammatically represented, and shown as in circuit with the working-conductors of the armature *a*. The drilling-engines are provided with two motor-coils or solenoids, I *i*, and said coils are arranged upon the exterior of a suitable protective tube or casing, *h*, within which is placed an iron plunger, J, indicated in dotted lines in Fig. 2, adapted to move freely within said casing and to be reciprocated by the alternate attraction of the coils I *i*. The terminals 9 10 of the coil I are connected to the supply-conductors

3 4, and the terminals 11 12 of the coil *i* are similarly connected to the other supply-conductors, 7 8.

The armature *a* being divided into four parts, two of which are always passing through the field of force, said armature will, when arranged as here shown, produce at each revolution two separate currents having a definite rise and fall. The defined currents so produced, being led off by separate collecting devices through separate circuits, the coils I *i* will alternately receive the entire current strength of the whole armature, under the influence of which they will alternately attract the plunger J to move it back and forth. The coils I *i* are not necessarily of equal size, as here shown. The coil producing the forward or power stroke may be made larger and more effective than the coil producing the rearward movement of the plunger, since the office of the latter is only to retract the plunger for the power-stroke. It follows that the reciprocations of the plunger J are directly in accordance with the number of current phases per minute, and therefore the rate at which the said plunger is operated will depend upon the number of turns made by the generating-armature.

Ordinary electric-lighting alternate-current generators would not answer my present purpose, for the reason that the speed of alternation at which a current can be used for lighting appears to be without limit, and to be commercially efficient must be very rapid—altogether beyond the speed at which a reciprocating engine can be operated. Furthermore, an electric-lighting generator when run at a speed low enough to correspond with the desired piston-speed in the drilling-engine would be too inefficient for practical purposes. With my new generator, however, I am enabled to produce defined currents—that is, currents having a definite rise and fall, as distinguished from the vibratory action of an electric-lighting alternating current, and said generator can be operated at a suitably low speed without departing from its efficiency. It will also be obvious that the generating-armature can be divided into any desired number of sections, each couple of sections being connected to a separate working-circuit. In this manner a very large number of drills with suitable circuit-connections might be operated from a large slowly-moving generating-armature, the coils of which were suitably divided on the principles hereinbefore set forth.

While I have described the generator A as feeding into as many complete circuits as there are separate operative portions of its armature, a number of circuit-wires may be dispensed with by using a separate outgoing wire for each generating portion of the armature and a single return-conductor common to all the circuits. Such an arrangement is indicated in Fig. 2. In said figure the armature *a'* is wound with coils *d d' e e'*, the outer terminals of which are connected to a conductor, *f*, to which the conductors 10 11 of the motor-coils I *i* are connected by wire 13. The inner terminals of the coils *d d'* are both connected to an insulated metal collecting-ring, D^2, and the corresponding terminals of the coils *e e'* to a second collecting-ring, D^3. The outer terminal of the motor-coil I is electrically connected to the ring D^3 by conductor 9 and a suitable collector-brush, d^2, the motor-coil *i* being similarly connected by conductor 12 and brush d^3 with the collector-ring D^2. When rotated in a suitable field of force, the armature *a'* will give defined currents, which, flowing through the rings D^2 D^3 alternately, will pass thence to the motor-coils and actuate the plunger J, returning through conductors 13 and *f*.

As indicated in Fig. 3, an additional collector-ring, D^4, is provided, to which one terminal of each of the armature-coils is connected, the construction and arrangement of the armature a^2 being in other respects similar to the armature *a'*, just described.

As described, the defined currents for actuating electric engines are produced by an armature rotated in a field of force and located at a suitable generating-station, which may be remote from the work. My invention is not, however, limited to this method of operation, since I may also produce similar electric effects by means of an inductional transformer located wherever convenient and supplied with current in the manner best suited to the circumstances—that is to say, the primary circuit of the converter should be wound for currents suitably adapted to be most economically transmitted from the prime generator. The secondary coils of the converter should be gaged to admit currents differing in quality according to the location of the converter with respect to the drilling engine or engines.

As seen in Fig. 4, the converter K comprises an iron core, *k*, primary coils L, divided into sections, each of which is connected to a segment, *l*, of a commutator, M. Secondary coils O are wound upon the core *k* in alternation with the primary coils L.

A rotating device carrying the connection between the supply-conductors and the coils of the primary circuit is provided, being illustrated in the form of an electro-magnet, K', rotatably mounted within the inner circumference of the coils of the converter K. Said inner surface of the converter K is provided with a commutator, M, divided into insulated sections, each one connected to and representing one of the primary coils L. Upon each side of the electro-magnet K', at the neutral point, is placed a commutator-brush, which said brushes *p n* engage and make contact with opposite sections *l* of the commutator M. The rotating magnet K' is provided at its axis with two insulated contact-rings, *p' n'*, against which bear brushes p^2 n^2, which are insulated from each other and secured to a suitable support, K^2, provided with binding-posts p^3 n^3, with which the brushes p^2 n^2 are in electrical connection respectively. To the binding-posts p^3 n^3 are connected the positive and negative supply-conductors 20 21 from a suitable source of continuous current. The insulated rings p' n' are connected by conductors 22 23 to the commutator-brushes carried by the revolving magnet K′, so that as said magnet revolves the supply-current will be conveyed through the commutator-brushes p n and commutator M through the primary coils in succession. The revolving magnet is provided with extended pole-pieces K^3 K^4, and the commutator-brushes are substantially at right angles thereto. The poles in the ring K, being therefore in advance of the pole-pieces of the magnet, will cause it to rotate with a degree of rapidity commensurate with the current flowing in the primary coils of the converter and the relative positions of the adjustable commutator-brushes p n with respect to the polar extensions of the rotating magnet. As shown, the magnet K′ is energized by coils k^3 k^4, connected in derivation between the brushes p n by conductors 24 25. With this arrangement the speed of the magnet K′ will be self-regulating. It will be obvious, however, that the coils of the rotating magnet might be in series with the primary circuit L and the speed of rotation thereof be determined by external regulation.

The coils O of the secondary circuit of the converter K are wound in any desired relation to the primary coils L, and, as here shown, are connected at four equidistant points with the conductors 16 17 18 19, leading to the motor-coils I i. As seen in Fig. 4, the conductors 16 17 are connected to the secondary coils at vertically-opposite points, while the conductors 18 19 are similarly connected at points transversely opposite. As the magnet K′ rotates, the brushes p n are brought successively in contact with the commutator-segments of each coil or division of the primary winding L, continually changing with their movement the position of the poles in the iron core k. As said magnet revolves, carrying with it the commutator-brushes supplying continuous current to the primary coils of the converter, the secondary currents will be generated in the coils O, which will alternately flow through the circuits 16 17 18 19, the said currents rising to the maximum power and falling to zero as the commutator-brushes p n approach and recede from the point at which the currents are led off to the motor-coils. With the brushes p n in the position seen in the drawings, the primary current enters through the commutator-segment opposite to the connection of the conductor 17, and flows thence in multiple arc around the primary coils, issuing at the opposite point through brush n. Under these conditions the current generated in the secondary coils passes out through conductors 16 17 and traverses the motor-coil I, the current in the circuit of the motor-coil i being at zero. With the rotation of the magnet K′ and commutator-brushes these conditions are reversed and secondary current flows through the circuit 18 19 and motor-coil i. Any desired number of reciprocating engines may be arranged in circuit with the conductors 16 17 18 19, although but a single machine is here shown, for convenience of illustration.

In Letters Patent No. 339,897, granted to me March 16, 1886, I have shown, described, and claimed a drilling-engine the coils of which were contained within a magnetic envelope. I find by subdividing the mass of iron on the exterior of the motor-coils improved results are attained. This may be done in a variety of ways—as, for example, by winding thin sheet-iron on the exterior of the coils, a suitable non-magnetic material being placed between each layer, the iron heads being similarly formed. A desirable arrangement is, however, shown in Fig. 5. The heads L′ are formed of disks L^2, of sheet-iron, with a layer of paper, l^2, or equivalent substance, between them. The sides of the coils are inclosed within a series of iron rods, L^3, set close together and held in place by bands L^4 at each end in magnetic contact with the laminated heads; or they may be inserted in annular grooves formed in the heads L′.

In Fig. 5ª is seen an arrangement for converting the reciprocatory movement imparted by the motor-coils I i into rotary motion. As here shown, the motor-coils I i are each provided with a separate iron plunger or core, j j', and said plungers are connected at opposite ends of a pivoted walking-beam, Q, which is arranged to communicate motion to a fly-wheel, R, with which it is connected by pitmen q q', attached to crank-pins r r' on the wheels R R′. The said wheels R R′ are rotatively mounted upon a shaft, S, and each provided with a spring-pawl, s s', arranged to become engaged with ratchets T T′ upon the shaft S to rotate it in the desired direction. As the walking-beam Q is oscillated by the alternate reciprocations of the plungers j j', the pitmen move up and down, and the pawls s s', being arranged, for instance, so that they will engage their ratchets during the downward movement of one pitman and the upward movement of the other and released during the reverse movements thereof, will communicate rotary motion to the shaft S and fly-wheel U. The purpose to which the movement of the fly-wheel U is applied is immaterial.

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

1. An electro-magnetic reciprocating engine system, comprising a generator adapted to produce independent current phases, a reciprocating electro-magnetic engine having two or more motor-coils, and independent circuits extending between the coil or coils and the generator, substantially as described.

2. An electro-magnetic reciprocating en-

gine having two or more sets of motor-coils and a movable core adapted to be reciprocated by the alternate action of said coils thereon, a generator producing two or more independent currents, and separate closed supply-circuits for supplying motive currents to the said motor-coils, substantially as described.

3. In an electro-magnetic reciprocating engine system, a reciprocating engine comprising two or more motor-coils, a generator adapted to produce current of different phases corresponding to the desired speed of reciprocation, and separate circuit-connections between the generator and the said motor-coils for energizing the same in alternation to produce reciprocatory movement of the piston, substantially as described.

4. In a reciprocating electric-engine system, an electric generator for producing defined electric impulses, comprising an armature divided into four or more parts, each connected to a separate insulated collector, a reciprocating electric engine or engines each having a plurality of motor-coils, and separate supply-conductors extending between the separate portions of the generating-armature and connecting the same with the motor-coils of the engine.

5. In a reciprocating electric-engine system, an electric generator for producing defined electric impulses, comprising an armature divided into four or more parts, each connected to a separate insulated collector-ring, a suitable field of force within which said armature may be rotated, a reciprocating electric engine or engines each having a plurality of motor-coils, and separate supply-conductors extending between the separate portions of the generating-armature and connecting the same with the motor-coils of the engine, substantially as described.

6. An electro-magnetic reciprocating engine comprising motor-coils, an iron core adapted to be reciprocated therein, and a magnetic cylinder enveloping the coil or coils, the mass of said cylinder being subdivided, substantially as described.

7. An electro-magnetic reciprocating engine having motor-coils and a movable core adapted to be reciprocated therein, and iron heads at each end of the coil or coils, the mass of the iron in said heads being subdivided, substantially as described.

8. In a reciprocating electric-engine system, an electric generator for producing defined electric impulses, comprising a magnetic core, a primary coil thereon, a secondary in inductive relation to the primary, an electric engine or engines, and separate supply-conductors extending between different portions of the secondary coils of the generator and coil or coils of the electric engine or engines, and means for supplying continuous current to different parts of the primary coils, comprising a rotating circuit-making device and means for adjusting and determining the rate of movement thereof, substantially as described.

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

CHARLES J. VAN DEPOELE.

Witnesses:

E. W. RICE, Jr.,

J. W. GIBBONEY.

Correction in Letters Patent No. 401,231.

It is hereby certified that in Letters Patent No. 401,231, granted April 9, 1889, upon the application of Charles J. Van Depoele, of Lynn, Massachusetts, for an improvement in "Reciprocating Electric-Engine Systems," an error appears in the printed specification requiring the following correction, viz: On page 2, in line 107, the word "admit" should read *emit;* and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 30th day of April, A. D. 1889.

[SEAL.]

CYRUS BUSSEY,
Assistant Secretary of the Interior.

Countersigned:

C. E. MITCHELL,
Commissioner of Patents.