

(No Model.)

3 Sheets—Sheet 1.

W. H. DARLING & L. BOCK, Jr.
ELECTRO MAGNETIC MOTOR.

No. 357,374.

Patented Feb. 8, 1887.

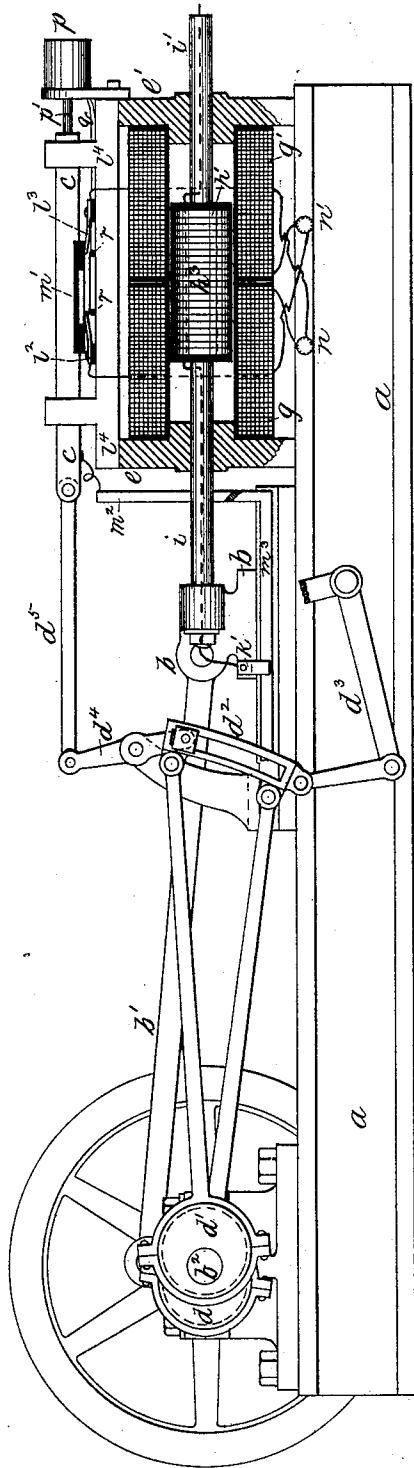


Fig. 1

Witnesses

H. D. Williams
Alfred Stanett

W. H. Darling
L. Bock, Jr.
Inventors
per Alfred Stanett

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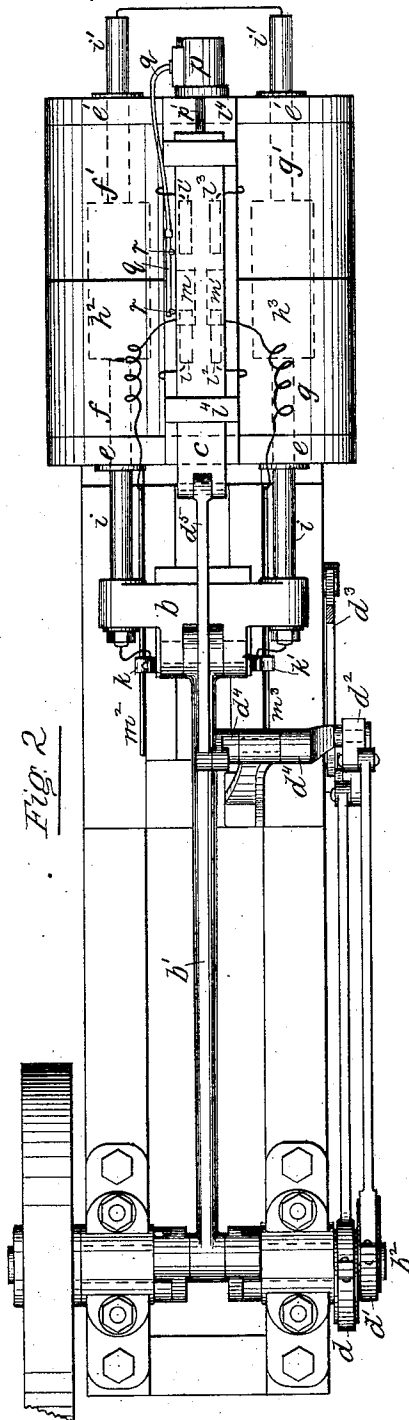


Fig. 2

Witnesses

H. D. Williams
Wm. Stanett

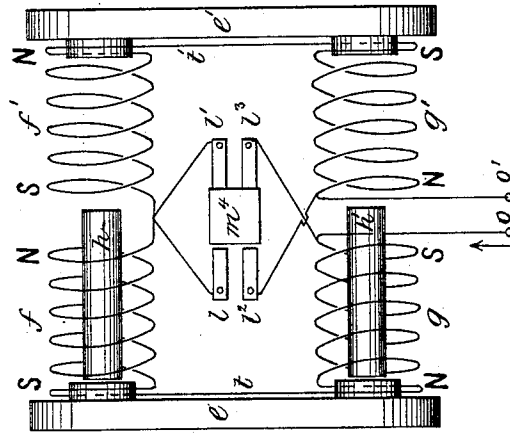


Fig. 4

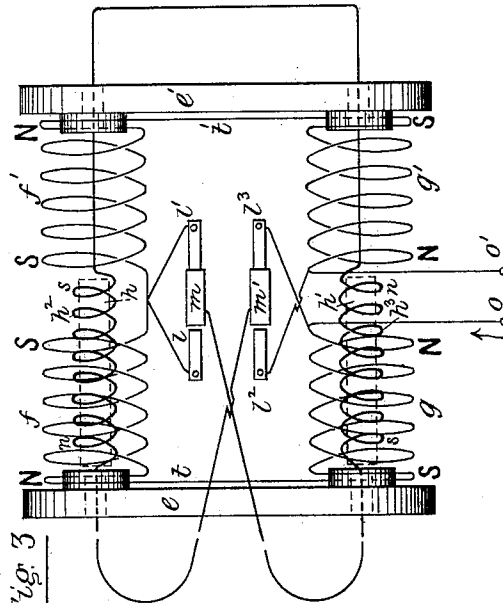


Fig. 3

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L. Bock Jr.
Inventors
per Alfred Throckmoly
att'y.

(No Model.)

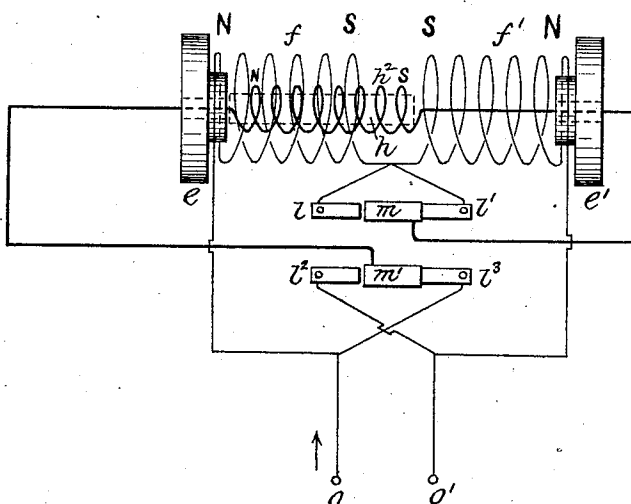
3 Sheets—Sheet 3.

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Fig. 5



Witnesses

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per
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UNITED STATES PATENT OFFICE.

WILLIAM H. DARLING AND LEO BOCK, JR., OF NEW YORK, N. Y., ASSIGN-
ORS OF ONE-THIRD TO GARDNER P. HARRINGTON, OF SAME PLACE.

ELECTRO-MAGNETIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 357,374, dated February 8, 1887.

Application filed August 21, 1886. Serial No. 211,485. (No model.)

To all whom it may concern:

Be it known that we, WILLIAM H. DARLING and LEO BOCK, Jr., both citizens of the United States, and residents of New York, county and State of New York, have invented certain new and useful Improvements in Electro-Magnetic Motors, of which the following is a specification.

This invention relates to that class of reciprocating electro-magnetic motors shown in the United States Letters Patent No. 337,931, granted on March 16, 1886, to William H. Darling, one of the present inventors, and has for its object to improve the electrical efficiency of such motors.

The invention consists of the combination, with double solenoids and reciprocating cores or armatures located therein, of a commutator, whereby the sections of the solenoid are alternately short-circuited or connected in multiple arc with the armatures, thereby allowing the full effect of the mutual inductive action between the active sections and the cores or armatures, and, as the resistance of the armature-circuit is much less than that of the separate sections, thereby virtually short-circuiting the sections in multiple arc with the armature, as the amount of current flowing through said sections is insufficient to appreciably energize them.

The invention also embraces an improved means for preventing the formation of electric arcs between the plates of the commutator, which consists of an air-pump provided with nozzles directed against the edges of the commutator-plates and actuated from the reciprocating part of the commutator.

In the accompanying drawings, forming part of this specification, to which we will now refer to more fully describe the nature and operation of our invention, Figure 1, Sheet 1, is a side elevation of our reciprocating electro-magnetic motor, showing one of the pairs of solenoids in section. Fig. 2, Sheet 2, is a plan view of the same. Fig. 3, Sheet 2, is a diagraphic view of the electrical part of our invention, showing the iron cores wound with wire, thus constituting reciprocating armatures. Fig. 4, Sheet 3, is a similar view, in which the reciprocating parts are simply iron

cores; and Fig. 5, Sheet 3, is a similar view of a modification, in which only one pair of solenoids and one armature are used.

The machine is similar in its general construction to that shown and described in the before-mentioned Letters Patent No. 337,931, comprising a bed-plate, *a*, sliding cross-head *b*, connecting-rod *b'*, crank-shaft *b''*, rotating in bearings in the bed-plate *a*, and slide *c* of the commutator, actuated from the crank-shaft *b''* through the medium of a reversing link-motion, which in these drawings is shown to consist of two eccentrics, *dd'*, link *d''*, controlling and reversing lever *d'''*, lever *d''''*, and rod *d'''''*, by which the lever *d''''* is connected to the slide *c*. This link-motion is similar to that at present used on steam-engines, so it is unnecessary here to enter into a further description of the construction and operation of the same.

Secured to the base-plate *a* are two iron plates, *e e'*, between which are held the two pairs of solenoids, *f f'* and *g g'*. Short pole-pieces on the plates *e e'* extend a short distance within these solenoids.

In the interior of the solenoids *f f' g g'* are located the reciprocating armatures, which in Figs. 1 to 3 are composed of iron cores *h h'*, provided with bobbins *h'' h'''*, of insulated wire, in the usual manner, said iron cores being connected to the cross-head *b* by the hollow rods *i i*, which pass through bearings in the iron plate *e*, and are supported at their other ends by the hollow rods *i' i''*, running in bearings in the plate *e'*. The ends of the bobbins *h'' h'''* pass through these hollow rods *i i'*, those which pass through the rods *i i'* being joined to contact-brushes *k k'*, attached by insulated blocks to the cross-head *b*, and the other ends, which pass through the rods *i' i''*, are joined together.

The commutator consists of two insulated plates, *m m'*, carried by the slide *c*, and four stationary plates, *l l' l'' l'''*, attached by insulated blocks to the bar *l''''*, which is connected to the upper sides of the plates *e* and *e'* and provided with guide-bearings, in which the slide *c* is held. The plates *l l' l'' l'''* are made yielding to insure proper contact. Any form of spring contact-plates may be used for this purpose. The plates *m m'* are respectively connected to the insulated bars *m'' m'''*, secured to the sides

of the guides, in which the cross-head *b* works. The contact-brushes *k k'* bear continually against these bars *m² m³*, thus permanently connecting the plates *m* and *m'* with the bobbins

5 *h² h³* of the armature.

The inner ends of the pair of solenoids *g* and *g'* are respectively joined to the binding-posts

10 *o o'*, forming the terminals of the machine. The inner ends of the solenoids *f* and *f'* are

joined together, and are here also connected to the spring-plates *l l'* of the commutator, the spring-plate *l'* being connected to the terminal binding-post *o'* and the plate *l* to the other terminal binding-post, *o*. The outer ends of

15 the solenoids are connected together—*g* to *f* and *f'* to *g'*—thus arranging in single series all the solenoid-sections.

We will now refer to Fig. 3 to describe the principles of operation, and will here mention

20 that the resistances of the bobbins of the armatures *h² h³* are much less than the resistances of the solenoid-sections *f f' g g'*. Assume that the armatures are at one end of their

25 stroke, as shown at Fig. 3. The commutator-plates *m* and *m'* have then just moved from the plates *l l'* to the plates *l' l*, the eccentrics

30 *d d'* being so set on the crank-shaft as to bring about this result. These eccentrics are also so set as to give the right amount of lead to the

moving commutator-plates, according to the speed, &c., at which the motor is to operate.

The electric current entering the binding-

35 post *o* has two paths, one through the four solenoids and the other through the coils or bobbins *h² h³* of the armatures, and in passing

40 through the solenoids it induces magnetism in the plates *e* and *e'*. Now, as the sections *f* and *g* of the solenoids are in multiple arc with the bobbins *h² h³* of the armatures, a very small

45 proportion of the current passes through these sections *f* and *g*. In fact, they are virtually short-circuited, and the plate *e* becomes substantially demagnetized; but as the whole of the current passes through the sections *f'* and

50 *g'* the plate *e'* becomes strongly magnetized. The letters *N* and *S* at the ends of the sections *f'* and *g'* indicate the magnetic polarity of these parts of the solenoid, and the letters *n*

55 and *s* that of the reciprocating armatures, the reciprocal action between them causing the armatures to be strongly drawn within the solenoids *f'* and *g'*; and this condition or dis-

60 position of the magnetic polarities continues until the armatures arrive at the outer ends of the solenoids *f'* and *g'*. During this movement of the armatures in one direction the plates *m*

65 *m'* have moved forward and back on the plates *l l'*, and they come in contact with the plates *l* and *l'* at the time the armatures complete the stroke, thus reversing the polarity of the armatures, short-circuiting the solenoids *f'* and *g'*, and strongly energizing the solenoids *f* and *g*. The armatures are thereby caused to travel in the opposite direction, the plates *m m'*

moving onto and off from the plates *l l'*, and at the end of the stroke a complete cycle of operations has occurred, the positions of the

various parts being then as shown in Fig. 3.

What little current flows through the sections that are in multiple arc with the armatures 70 will, because of the polarity induced in their iron plates, assist in sending the armature forward to the other and active sections, as the said magnetic polarities of the armatures and end plates are repellant.

The iron plates *e* and *e'* may be omitted and replaced by non-magnetic supports for the solenoids; but it is preferable to use these iron plates, as they re-enforce the solenoids. The bobbins of the armatures may also be omitted, 80 the armatures then consisting of simple iron cores *h h'*, as shown in Fig. 4. In this case a single plate, *m'*, is carried by the slide *c*, which, by alternately connecting the plates *l'* to *l* and *l* to *l'*, shunt or cut out the sections *f* and *g* of 85 the solenoids and sections *f'* and *g'*, respectively. The sections are so arranged that the current in flowing through them induces magnetism, as indicated by the letters *N* and *S*—that is to say, the sections *f* and *f'* and *g* and 90 *g'* constitute continuous solenoids, the adjacent halves of which are alternately energized.

We will now again refer to Figs. 1 and 2 to describe the apparatus we have applied to this form of electro-magnetic motor, adapted to 95 cause a blast or blasts of air to act on the commutator and prevent the formation of arcs. A small double-acting air-pump, *p*, of ordinary construction, is bolted to the end of the bar *l'*, its piston-rod *p'* being secured to the end of 100 the slide *c*. The pipe *q* is provided with nozzles *r r*, so arranged and located as to direct currents of air between the plates *m m'* and the plates *l l' l' l*. These currents of air immediately put out any arcs that may be formed 105 when the moving part of the commutator leaves the fixed parts, thus preventing the destruction of the plates. They also perform other useful functions in keeping the plates of the commutator cool and in removing any 110 dust or dirt, thereby keeping the plates clean and insuring proper electrical contact between them.

The advantage from operating the pump *p* by the slide *c* is that, by reason of the slide 115 having its maximum speed at the center of the stroke, the strongest blast or largest quantity of air is forced through the nozzles by the pump in this position, which is its position when the makes and breaks occur between 120 the commutator-plates.

We have shown and described a motor with two pairs of solenoids and two reciprocating armatures connected to one cross-head. It is evident that the principle embodied in our 125 invention may be applied to a motor having one armature and one pair of solenoids, or to a motor having more than two armatures, said armatures being connected to either one or more cross-heads. When only one pair of 130 solenoids and one armature are used, the circuit-connections will be arranged, as shown at Fig. 5—viz., the ends of the wire *h²*, connected to the plates *m* and *m'* of the commutator, and

the two lower stationary plates, $t^2 t^3$, to the terminals $o' o$, to which are also connected the outer ends of the solenoids f' and f . The operation will be understood by reference to the description of Fig. 3.

Having now described the nature of our invention and ascertained the manner in which it operates, what we claim, and desire to secure by Letters Patent, is—

1. The combination, with a solenoid divided into two sections, or a pair of solenoids, of an armature wound with insulated wire and fitted to reciprocate therein, and a commutator, whereby the coils of the armature are alternately connected in multiple arc with the different sections or solenoids, substantially as set forth.

2. The combination, with a solenoid divided into two sections, or a pair of solenoids, of an armature wound with insulated wire and fitted to reciprocate therein, and a commutator composed of two moving plates forming the terminals of the armature, and four stationary plates, two of which are connected to the adjoining ends of the sections of the solenoid, and one of the other two to each of the terminals of the machine, whereby the coils of the armature are alternately connected, with reversal of polarity, in multiple arc with the different sections of the solenoid, substantially as set forth.

3. In combination, two pairs or sets of solenoids, two iron end plates with pole-pieces projecting in the ends of the solenoids, armatures wound with insulated wire and fitted to reciprocate within the solenoids between the end plates, and a commutator composed of two moving plates forming the terminals of the armature, and four stationary plates, two of which are connected to the adjoining ends of the sections of the solenoid and one of the other two to each of the terminals of the machine, substantially as set forth.

4. In combination, pairs or sets of solenoids arranged parallel to one another, the whole connected up in single series and constructed to induce similar polarities at their adjoining ends, reciprocating armatures located in each pair or set of solenoids, and wound with insulated wire and adapted to be attracted alternately within the solenoids of each pair or set, and a commutator so connected to the solenoids and armature as to induce at the forward end of the armature magnetism of the same sense as that of the adjoining ends of the solenoids, and to place the coils of the armatures alternately in multiple arc with their actuating pairs or sets of solenoids, substantially as set forth.

5. The combination, in an electro-magnetic motor of the reciprocating type, of the solenoids $f f'$ and $g g'$, the armatures $h h^2$ and $h' h^3$, connected to and actuating the cross-head b , the stationary commutator-plates $l l' t^2 t^3$, joined to the solenoids, and the plates $m m'$, joined to the armatures and carried by the slide c , actuated from the crank-shaft b^2 , which, by the connecting-rod b' , receives motion from the cross-head b , substantially as set forth.

6. In combination with a reciprocating electro-magnetic motor having a reciprocating commutator, an air-pump, the piston of which is connected to and actuated by the slide which carries the moving parts of the commutator, substantially as and for the purpose set forth.

In testimony whereof we have hereunto set our hands, at New York, county and State of New York, this 18th day of August, 1886.

WILLIAM H. DARLING.
LEO BOCK, JR.

Witnesses:

ALFRED SHEDLOCK,
H. D. WILLIAMS.