No. 630,448. Patented Aug. 8, 1899.

M. S. CONLY.

ELECTROMAGNETIC RECIPROCATING ENGINE.

(Application filed Aug. 9, 1898.)

(No Model.)

Fig. 1.

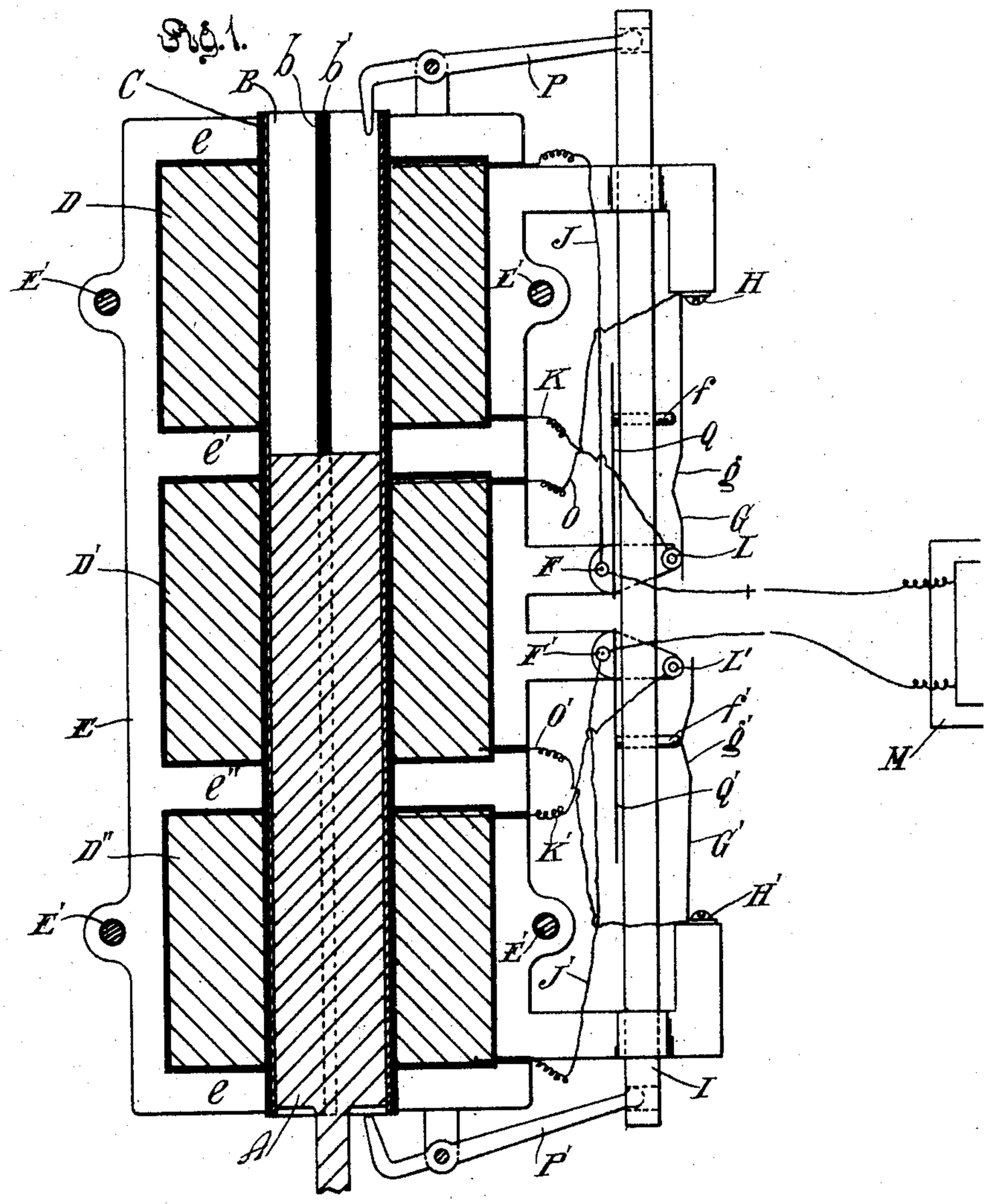
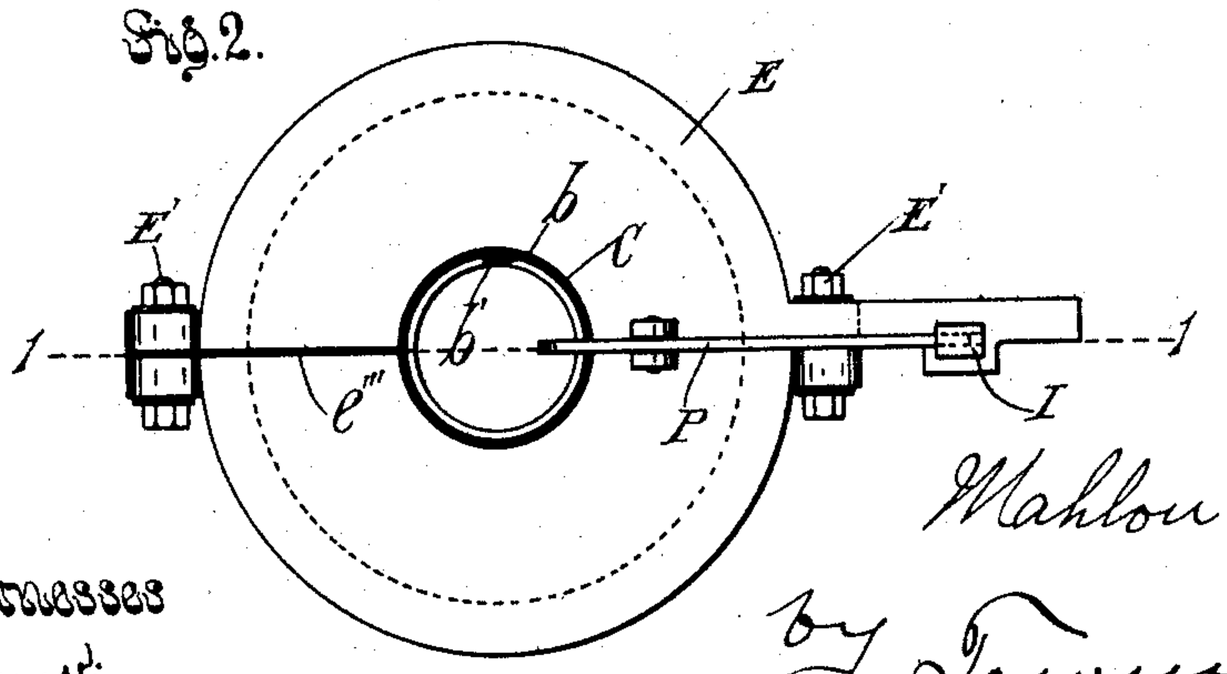


Fig. 2.



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UNITED STATES PATENT OFFICE.

MAHLON S. CONLY, OF LOS ANGELES, CALIFORNIA, ASSIGNOR OF ONE-HALF TO WILLIAM H. WILLSON, OF SAME PLACE.

ELECTROMAGNETIC RECIPROCATING ENGINE.

SPECIFICATION forming part of Letters Patent No. 630,448, dated August 8, 1899.

Application filed August 9, 1898. Serial No. 688,209. (No model.)

To all whom it may concern:

Be it known that I, MAHLON S. CONLY, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Long-Range Electromagnets, of which the following is a specification.

One great difficulty heretofore encountered in using electromagnets for the purpose of operating water, air, and oil pumps, rock-drills, stamp-mills, pumps, and other devices for which they are suitable has been the great loss of power encountered in transmitting the energy through the magnet. This loss of power arises principally from induced currents which have been generated in the magnet. Another difficulty has been the tendency of the switches to flash when the current is switched from one coil to another. When a strong current is passing through the magnet, this flash is sometimes sufficient to burn up the switch-points, thus damaging the machine, as well as causing loss of power and time.

One object of my invention is to produce an electromagnet which will be free from heating while in use, will be economical for the conversion of electrical power into motion, particularly reciprocating motion, will be adapted for use in water, air, and oil pumps, rock-drills, stamp-mills, power-hammers, electric guns, &c., and, in brief, for all purposes where reciprocating or extended forward motion in one direction is essential or desirable.

One particular object of my invention is to provide an electromagnet which will be devoid of induced currents and in which there will be no stray lines of force, all the magnetism developed being utilized.

A further object of my invention is to provide a method of operating electromagnets whereby flash is practically avoided when the current is switched onto or off of the coils.

My invention comprises the various features of construction and combinations of parts hereinafter set forth and claimed.

The accompanying drawings illustrate my invention.

Figure 1 is a longitudinal section of a device embodying my invention on line indicated by 1 1, Fig. 2. Fig. 2 is an end view of my device.

In the drawings, A represents a plunger, which is preferably made of soft iron.

B is a cylinder, which is preferably made of some non-magnetic metal—such, for instance, as brass. This cylinder is slotted or divided from end to end, as shown at *b*, and a strip of insulating material *b'* is inserted between the edges of the slot to insulate the two edges from each other and to break the circuit of the cylinder. Around this cylinder is a wrapping of insulation C, such as paper, tape, or other suitable material.

D D' D'' represent coils of insulated wire wound upon the cylinder. These coils are each covered with insulation, such as paper or other suitable material, and a magnetic metallic case E, which is longitudinally divided into two or more sections and is provided with ends *e e* and partitions *e' e''*, cast integral with the shell and adapted to fit between the coils, is placed over the tube and interposed between the coils, as shown in the drawings. These metallic partitions form a very important factor in utilizing the magnetism to the best possible advantage, as I will hereinafter more fully set forth. The sections of the case are insulated from each other by insulation *e'''* and are secured together by means of bolts E', which are insulated from the case. By this cheap and simple construction the circuit of the case is also broken.

I have shown in the drawings a form of switch whereby may be practiced my method of operating the magnets to prevent flashing of the switch-points. It must be understood, however, that the construction of the switch and the means by which it is operated may be varied from those shown in the drawings without departing from the spirit of my invention.

My improved method of operating electromagnets consists of, first, closing the break through the coil which is to be cut in while such coil is short-circuited elsewhere to shunt the current from it; second, breaking the short circuit of such coil; third, short-circuiting the coil which is to be cut out; fourth,

breaking the circuit of the coil which is to be cut out. Thus I open the coil to be cut in before breaking the short circuit of such coil and before short-circuiting the coil to be cut out, so that the current is free to pass through the coil to be cut in before it is switched off of the coil which is in operation, and when the short circuit of the coil to be cut in is broken the current is not only free to pass through such coil, but is also free to pass through the coil to be cut out. Then by short-circuiting the coil to be cut out the current is partially diverted from such coil and through the coil to be cut in, so that the final operation of breaking the circuit of the coil to be cut out is performed, while the tension of the current is relieved to such an extent as to practically avoid all flash at the switch-points.

In the drawings, D′ represents the central coil, which is always energized when the magnet is in operation.

D D″ are the two end coils, which are alternately thrown into operation and cut out of operation to cause the plunger to reciprocate back and forth within the cylinder.

M represents the generator or dynamo by which the electrical current is generated. One pole is connected with a binding-post F and the other pole is connected with another binding-post F′. The post F is, by means of a contact-plate Q, connected with a sliding switch-point *f*, and the post F′ is, by means of a contact-plate Q′, electrically connected with a sliding switch-point *f*′.

G is a spring-switch which is secured at one end to a post H, and G′ is a similar switch secured to a post H′. The switch G and the switch G′ are each provided with an inclined face *g g*′, respectively, against which the switch-points *f f*′ alternately contact as the switch is thrown into and out of operation. The switch-points *f f*′ are secured to a reciprocating frame I, which slides in suitable guideways, while the switches G G′ are attached to stationary supports S, within which the guideways are arranged.

J represents a wire connecting the post F with the coil D, and J′ is a wire connecting the post F′ with the coil D″.

K K′ respectively represent wires connecting the coils D D″, respectively, with metallic posts L L′, which are secured to a stationary portion of the frame. It will be understood that the various posts are insulated from each other and from the case.

O O′ represent wires respectively connecting the coil D′ with the posts H and H′.

P P′ represent pivoted levers which are adapted to be actuated by the plunger to shift the movable frame back and forth to operate the switch-points *f f*′.

The levers P P′ and the reciprocating frame I, with their connections, constitute a plunger-operated automatic electric switch. Any suitable form of automatic switch may be substituted for this form without departing from the spirit of my invention.

In practical operation, the device being in the position shown in Fig. 1 and the current being turned on from the generator M, such current passes from the generator to the post F′, the switch-point *f*″, spring G′, post H′, coil D′, through such coil out through the wire O to post H, along spring G to post L, wire K to coil D, wire J to post F, and thence back to the generator. In this position the coil D″ is open and is entirely cut out from the electrical current and remains in this condition until the plunger operates the lever P to shift the movable frame I downward. By breaking the circuit of the coil which is cut out the generation of extra current or counter electric current in such coil is avoided, which current retards the operation of the plunger and also causes the magnet to heat. When the plunger operates the lever P, the first movement of the frame slides the switch-point *f*′ down the incline *g*′ and permits the spring-switch G′ to rest upon the post L′. The current is thus switched onto the coil D″, but is short-circuited by the point *f*′. Further movement of the point *f*′ carries such point out of engagement with the spring G′ and throws the current through the coil D″. Practically at the instant the switch-point *f*′ leaves the spring G′ the point *f* is brought into engagement with the incline *g*, thus short-circuiting the current which passes through the coil D, and further movement of this point *f* lifts the spring G from the post L and breaks the circuit, so that the coil D is fully cut out from the circuit and the coil D″ is fully thrown into the circuit. By this arrangement the tension of the current is preliminarily relieved by the short circuits, so that when the short circuits are broken the current travels through the coils without producing any objectionable flash at the switch-point, since the circuits of two of the adjacent coils are always closed for the passage of the electrical current and for an instant the circuit of three coils being in series.

By reason of the cylinder B being divided longitudinally and a strip of insulating material inserted between the lips of the slot no induced current is generated within the cylinder. For a similar reason the insulated division between the sections of the case prevents induced currents in the case, and I find in practice that there are no stray lines of force and no heating whatever of the device when it is in operation.

When the magnet is in operation, the metallic partitions *e*′ *e*″ and the two ends *e e*‴ in connection with the shell of the case play a very important part in the development of high efficiency, since they form a practically unbroken magnetic circuit from one end of the field to the other. For instance, as shown in Fig. 1, the coils D D′ are active, and the end *e* and partition *e*″ in connection with the shell of the case E complete the circuit of the magnetic field, the partition *e*′ being neutral. When the switch is shifted to render the coils

D′ D″ active, the partition *e′* and end *e‴* complete the magnetic circuit, and the partition *e″* is neutral. This avoids stray lines of force and enables me to utilize practically all of the magnetism developed. The effect will be the same if the partitions are made separate from the case; but the construction will be more difficult than that which I have shown, and imperfect contact with the case is liable to render it less efficient.

It is obvious that more than three coils may be employed in my device and the succeeding rear coils cut out and the succeeding front coils cut in as the plunger advances, thus extending the range of the magnet to any degree desired.

When my device is used as a motor where reciprocating motion is desired, the switches are alternately shifted by the plunger as it reaches its limit of travel in either direction, so that continuous reciprocating motion will be kept up as long as the electrical current is applied to the coils.

It will be noted that when the device is placed with the axis of the plunger vertical, as indicated in the drawings, there is absolutely no friction in this device, the attractive force of the coils holding the metallic plunger always in central position with relation to the cylinder within which it moves, and since this plunger is slightly smaller in diameter than the cylinder there is practically no contact of the plunger with the cylinder unless such contact is produced by external forces, and therefore there can be no friction or wearing of the parts.

Now, having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination of an electrical generator; a magnetic plunger; a plunger-cylinder around the plunger and slotted along its length; insulation between the lips of the slot; coils surrounding the cylinder; a magnetic metallic case inclosing the coils and the cylinder and formed in two or more longitudinal sections; insulation to insulate the sections from each other; a plunger-operated automatic electrical switch; electrical connections between the generator and the switch; and electrical connections from the switch to the coils.

2. An electromagnet having its plunger-cylinder slotted from end to end; insulation between the lips of the slot; coils surrounding the cylinder; a magnetic metallic case inclosing the coils and the cylinder, formed in two or more longitudinal sections; and insulation to insulate said sections from each other.

3. In an electromagnet, the combination set forth of the plunger; the non-magnetic tube encircling the plunger and provided with a longitudinal division or slot; insulation therein; the insulating-wrapping upon the outside of the tube; coils of insulating-wire formed around the outside of the tube; insulating-covering for the coils; and a magnetic metal case covering the coils, divided longitudinally into two or more sections, such sections being secured together and insulated from each other.

4. In an electromagnet, the combination of the plunger; the cylinder surrounding the plunger, slotted along its length and having the lips of the slot insulated from each other; the coils surrounding the cylinder; and the magnetic metallic case, provided with magnetic metallic ends inclosing the coils and magnetic metallic partitions interposed between the coils.

5. An electromagnet comprising a plunger; a cylinder for the plunger; coils, surrounding the cylinder; a magnetic metallic case having magnetic metallic ends, inclosing the coils; and magnetic metallic partitions interposed between the coils.

6. An electromagnet comprising a plunger; a cylinder for the plunger; coils surrounding the cylinder; a magnetic metallic case inclosing the coils, formed in sections insulated from each other, and having metallic magnetic ends inclosing the coils and magnetic metallic partitions interposed between the coils.

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