(No Model.) 2 Sheets—Sheet 1.

C. J. VAN DEPOELE.

CIRCUIT CONTROLLER FOR ELECTRO MAGNETIC ENGINES.

No. 458,869. Patented Sept. 1, 1891.

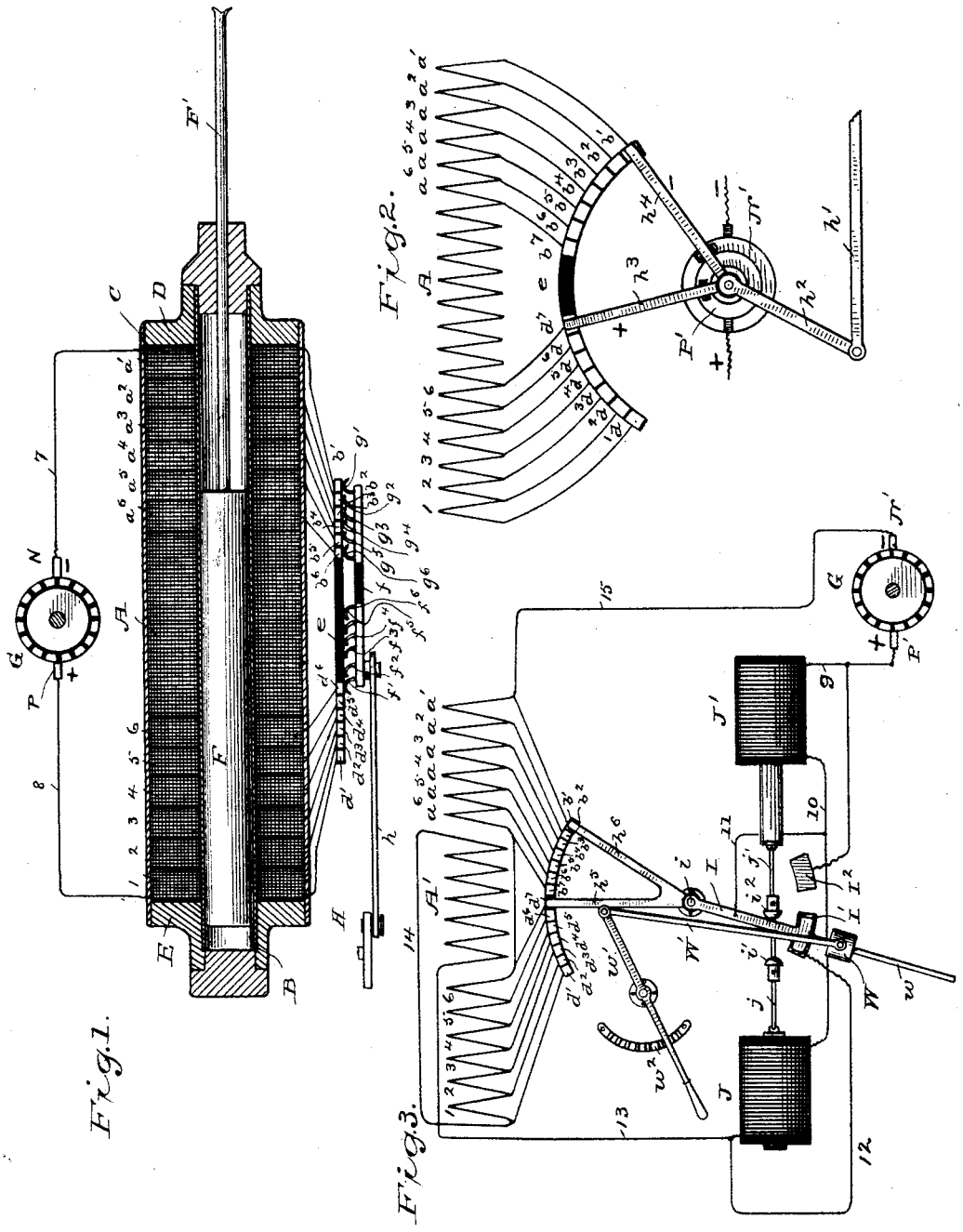

Fig. 1.

Fig. 2.

Fig. 3.

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Fig. 4.

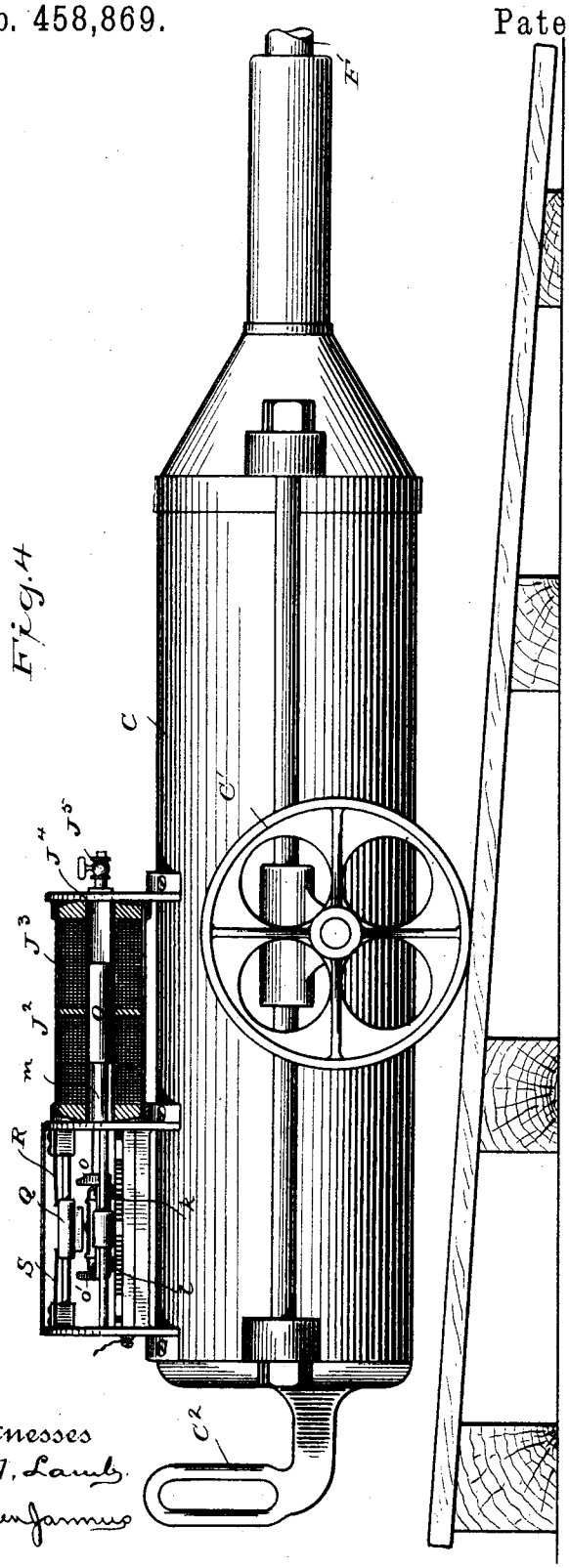


Fig. 6.

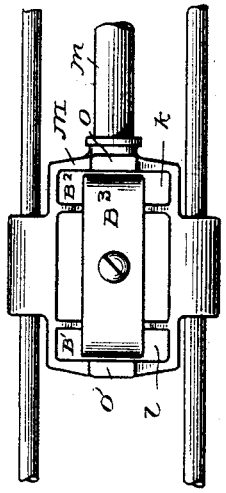
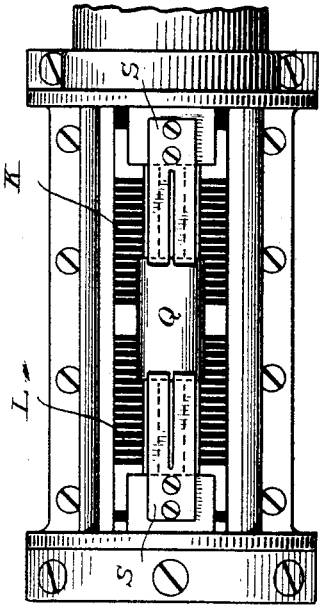


Fig. 5.



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UNITED STATES PATENT OFFICE.

CHARLES J. VAN DEPOELE, OF LYNN, MASSACHUSETTS.

CIRCUIT-CONTROLLER FOR ELECTRO-MAGNETIC ENGINES.

SPECIFICATION forming part of Letters Patent No. 458,869, dated September 1, 1891.

Application filed February 3, 1891. Serial No. 379,957. (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 Circuit-Controllers for Electro-Magnetic Reciprocating Engines, of which the following is a description, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon.

My invention relates to electro-magnetic reciprocating engines; and it comprises a machine composed of motor-coils, through which or within which a magnetic piston is reciprocated under the influence of currents supplied to the coils in alternation.

In my previous patents—for instance, in Patent No. 422,855, dated March 4, 1890, and others—I have set forth and claimed means for supplying the motor-coils with rising and falling currents of constant direction, the generator or source of current being in such instance provided with special appliances to secure these results. In the present instance the current supplied to the motor-coils also rises and falls to some extent; but instead of being controlled at the generator the reciprocating engine is provided with means for shifting the current from one set of coils to the other in order to produce the desired effect, and, furthermore, in order that the speed of each machine may be under the direct control of the operator. This is the preferred plan, although of course a number of machines might be so interconnected that one set of current-controlling apparatus would serve for them all. The machine in question is therefore supplied with a direct current, which is shifted in the motor-coils to produce reciprocation of the piston. The motor-coils comprise a central coil with a number of sectional coils at each end thereof. Continuous current is supplied to the central coil whenever the machine is in operation, and said current is shifted from the sectional coils at one end to those at the other end, in order to produce reciprocation of the piston, the magnetism of which is constantly maintained by the central coil. Obviously the rate at which the current is shifted from one set of end coils to the other determines the rate of the reciprocations of the piston. The current-shifting apparatus may be constructed and operated in a variety of ways, some of which will be hereinafter set forth, and described in the accompanying description and drawings.

In the drawings, Figure 1 is an elevation, partly in diagram and partly in section, showing a reciprocating engine embodying the invention, together with the necessary circuit connections. Fig. 2 is a diagram showing substantially what is illustrated in Fig. 1, although differing somewhat therefrom. Fig. 3 is a diagrammatic view, partly in elevation, showing the circuits of the engine in diagram and also current-shifting apparatus and means for controlling the same. Fig. 4 is an elevation, partly in section, showing an electric reciprocating engine arranged for use as a mining-machine. Fig. 5 is a top plan view of part of the circuit-controlling mechanism of Fig. 4; and Fig. 6 is a detail, also relating to Fig. 4.

As indicated in Fig. 1, my improved reciprocating engine comprises a central coil A, which may be longer or shorter, according to circumstances. At each end of the coil A are placed a number of sectional coils a' a^2 a^3 a^4 a^5 a^6, and at the other end of the central coil are placed a corresponding number of coils 1 2 3 4 5 6, it being understood, however, that more or fewer of the sectional coils may be employed, as desired. The coils are all mounted upon a central diamagnetic tube or lining B, and are incased within an iron envelope C, provided at either end with iron heads D E. An iron plunger F is arranged to be reciprocated within the tube B under the influence of the coils. G is the sectional commutator of a generator or other source of continuous current. P and N are the positive and negative commutator-brushes, which are connected by conductors 7 and 8 with the outer terminals of the end coils 1 and a'. The sectional coils are all connected in series with their adjacent coils, and all the coils of the engine are connected in one series.

As indicated in Fig. 1, the central coil A is to be constantly energized with continuous current, and the end coils are to be put in circuit therewith gradually, first from one end

and then from the other. This is accomplished by an independently-operated circuit-shifting device, which may be constructed in many different ways. As indicated in said Fig. 1, a set of insulated contacts b' b^2 b^3 b^4 b^5 b^6 are provided and connected, respectively, with the sectional coils a' a^2 a^3 a^4 a^5 a^6. A similar set of contacts d' d^2 d^3 d^4 d^5 d^6 are connected with the coils 1 2 3 4 5 6, and said two sets of contacts are arranged in juxtaposition, but effectually separated by a block or plate of insulating material *e*. A contact device is arranged to move with respect to the terminals, said contact device comprising a set of brushes f' f^2 f^3 f^4 f^5 f^6, adapted to engage the contacts d' d^2 d^3 d^4 d^5 d^6, and a second set of brushes g' g^2 g^3 g^4 g^5 g^6, similarly arranged to engage the contacts b' b^2 b^3 b^4 b^5 b^6, the two sets of brushes being mounted so as to move together, but separated by insulating material *f*. The contact-brushes are adapted to be moved back and forth upon the insulated contacts by any convenient means—as, for instance, a motor-wheel H and connecting-rod *h*—a similar action being shown in my prior patent, No. 337,897, March 16, 1886.

In the position shown in the drawings, the brushes g' and g^6 will short-circuit the coils a' a^2 a^3 a^4 a^5 a^6 while the last of the brushes on the other set—viz., f—is in contact with the contact d^6 of the opposite series, so that the current will flow from the positive commutator-brush by conductor 8 and pass successively through the coils 1 2 3 4 5 6, then through the central coil A, thence to contact b^6 through brush g^6, through the metallic support of the brushes g' g^2 g^3 g^4 g^5 g^6, through the brush g', and out through the outer coil of the section a', and by conductor 7 back to the negative commutator-brush. In the position shown the moving contacts are at the limits of their movement in one direction, the circuits being as stated. As the said contacts are moved in the opposite direction the coils 6 5 4 3 2 1 will be successively cut out and the coils a' a^2 a^3 a^4 a^5 a^6 will be gradually brought into circuit, the current at all times flowing through the central coil and such of the sectional coils as may be connected therewith through the moving brushes. Obviously the moving contacts may be caused to travel at any desired speed by means of a suitable motor applied to the driving-wheel H, and the plunger F, being magnetized by the central coil, will respond to shifting of current in the sectional coils and be moved back and forth in accordance therewith.

As indicated in Fig. 2, the motor-coils are the same as those in Fig. 1, the sets of sectional coils being connected to terminals, as described, except that they are shown as arranged in the arc of a circle. P′ N′ represent contact-surfaces engaged, respectively, by the opposite terminals of a source of continuous current. A pair of contact-arms h^3 h^4 are in electrical connection, respectively, with the positive and negative rings, and are insulated from each other and connected to a central pivot and arranged to be actuated by an arm h^2, which is connected with a pitman or other device h', for communicating radial motion thereto. The arms h^3 h^4 in their movement sweep across the two sets of terminals, and thereby shift the current from one set of sectional coils to the other at all times, including the central coil A. With the parts in the positions indicated in Fig. 2 the current flows from ring P′ through arm h^3, terminal d^7, thence through central coil A, and through the sectional coils a^6 a^5 a^4 a^3 a^2 a', thence from coil a' and terminals b', thence through the arm h^4, through contact-ring N′, and back to source. The arms h^3 h^4 move together, and as the arm h^3 moves from terminal d^7 toward terminal d' the arm h^4 will be moved from terminal b' toward the terminal b^7, thereby cutting out the coils a' a^2 a^3 a^4 a^5 a^6 before putting the coils 6 5 4 3 2 1 successively into circuit, together with the coil A.

Fig. 3 shows a self-acting device for shifting the current from one set of coils to the other. In said figure a central coil A′ is provided and sectional coils a' a^2 a^3 a^4 a^5 a^6 and 1 2 3 4 5 6 are arranged at the ends thereof, as already described; but in the present instance the sectional coils at both ends of the central coil are connected in series with each other, but the coils 6 and a^6 are not connected with the central coil, as in the previous figures. The sectional coils are connected to insulated terminals, which for convenience are shown as arranged in the arc of a circle, and a pair of arms h^5 h^6 in electrical connection with each other have their ends arranged at such distances apart that they will engage the inner terminals of one set of coils and the outer terminals of the other at the same time. As indicated, the arm h^5 engages the terminal d^7 and the arm h^6 the terminal b', and with this arrangement current will flow from the coil 6 to the outer terminal of the coil A′, the coils a' a^2 a^3 a^4 a^5 a^6 being thereby short-circuited. As the arms h^5 h^6 are moved to their opposite position, the coils 6 5 4 3 2 1 will be gradually cut out of circuit and the corresponding opposite coils a' a^2 a^3 a^4 a^5 a^6 gradually placed in circuit. The central coil A′ is in series with the circuit-supplying current to the sectional coils. The arms h^5 h^6 are mechanically connected to but insulated from an arm I and are mounted upon a suitable pivot *i*. The lower end of the arm I is adapted to engage either of one of two stationary contacts I′ I². J J′ are a pair of solenoids of equal capacity located on opposite sides of the arm I and provided with suitable iron cores. The iron cores of the solenoids are connected by rods *j j′*, which are provided with tappets i' i^2 engaging opposite sides of the arm I, so that when one or the other of the solenoids are energized the plungers will be moved and the tappets i' i^2 will move the said arm I together with the arms h^5 h^6 from

one position to the other, thereby shifting the current in the sectional coils.

The action of the machine is intended to be quite rapid—that is, several hundred strokes per minute. Consequently but little time can be allowed for the movements of the parts. The circuits and connections are therefore so arranged that one of the solenoids will be energized and draw in its plunger, which acting against the arm I, will throw the contact-arms in one direction and move the lower end of the arm I from one of the stationary contacts I′ I² to the other, which action will when completed serve to short-circuit the solenoid producing the movement. The moment the lower end of the arm I reaches the contact I′ toward which it is being moved it closes the circuit of the coil J′, opening the circuit of coil J and causing it to instantly become active and to move the arm I again in the opposite direction, which movement being kept up will produce a rapid shifting of the current in the auxiliary coils and a rapid reciprocation of the plunger F.

The circuits from the source G are as follows: As shown in the drawings, current passes from the positive commutator-brush by conductor 9 through the solenoid J′. From J′ the current passes by conductors 10 and 11 to arm I, down arm I to contact I′, thence by conductor 12, around the solenoid J, to conductor 13, thence to coil A′, and from thence by conductor 14 to sectional coil 1, thence, as seen, through coils 1 2 3 4 5 6 to terminal d^5, arms h^5 and h^6 to terminal b', and thence to conductor 15, leading to the negative commutator-brush. At the same time current will be flowing in the solenoid J′ and it will begin to draw in its plunger; but this movement will not affect the circuits until the tappet i' has traversed the space between it and the arm I. This will cause a slight pause at each change of circuit, and during such pause the current flowing in the different coils will have its full magnetizing effect. The weight W is supported by a pendulum W′, and is vertically adjustable through said pendulum and a lever w', which is suitably pivoted and is held in any desired position by a rack w^2, and the rapidity of the movement of the pendulum and the arm I and its contacts may be controlled by the position of the weight W.

In Figs. 4, 5, and 6 I have shown the apparatus organized in the form of a mining-machine, it being understood that the coils and connections of Figs. 1, 2, and 3 are contained within the cylinder C, which is mounted upon side wheels C′ and provided with suitable operating-handles C², the tool-stock being indicated by the projecting part F′. With this arrangement the terminals of the sectional coils are represented by two sets of commutator-sections K L, which are provided with two contact-brushes k l. The brushes k l are carried in a suitable frame M, which is connected by rod m with a piston or plunger O, arranged to be reciprocated within the solenoids J² J³, which, for convenience, are arranged together at the end of a suitable frame carrying the contact devices. A circuit-breaker Q is supported upon a guide-rod above the moving brushes l k, and is driven into engagement with one or other of the contact-springs R S by being struck by one or other of the tappets o o', which form part of the brush-carrying frame M, so that as the piston O is reciprocated within the solenoids J² J³ the contact-brushes l k will be moved across their commutators L K, directing the current alternately through the sectional coils at the opposite ends of the machine, and the circuit-breaker Q will alternately engage the contact-springs R S, thereby operating the solenoids J² J³. The solenoids J² J³ are provided with an internal tube J⁴, and also with a cock J⁵, at one end, by locating the opening in which the speed of the plunger O and the rate of reciprocation of the engine can be determined.

Various modifications and changes in the construction hereinbefore described may be made in accordance with the principles herein set forth without departing from the invention, and it should be understood that in addition to the devices herein set forth I may use in connection herewith any of the circuit-changing apparatus set forth in my prior patents.

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

1. An electro-magnetic reciprocating engine comprising a central coil and short sectional auxiliary coils at each end thereof, a magnetic plunger adapted to be reciprocated within the coils, and means for constantly energizing the central coil and for alternately placing the sets of end coils in circuit therewith.

2. An electro-magnetic reciprocating engine comprising a relatively long central coil and a set of short sectional auxiliary coils at each end thereof, a magnetic plunger adapted to be reciprocated within the coils, and means for constantly energizing the central coil and for gradually cutting out the sectional coils at one end thereof and for placing in circuit with said central coil the auxiliary coils at its other end.

3. In an electro-magnetic reciprocating engine, the combination of a source of continuous current, a central coil, auxiliary coils at each end thereof, a magnetic plunger adapted to be reciprocated within the coils, and means for constantly energizing the central coil, thereby magnetizing the plunger, and for alternately energizing the auxiliary coils at each end of the central coil.

4. In an electro-magnetic reciprocating engine, the combination of a source of continuous current, a large central coil, a plurality of short auxiliary coils at each end thereof, a magnetic plunger adapted to be reciprocated through the coils, and means for constantly energizing the central coil and for

gradually shifting the current from one set of sectional coils to the other.

5. An electro-magnetic reciprocating engine comprising a main central coil, sectional auxiliary coils at each end thereof, a magnetic plunger adapted to be reciprocated through the coils, a source of continuous current, insulated contacts representing the several coils, contact devices adapted to be moved upon the contacts to shift the current gradually from one set of auxiliary coils to the other, a motor for actuating the contact devices, and means for controlling the speed of the motor.

6. An electro-magnetic reciprocating engine comprising a main central coil, sectional auxiliary coils at each end thereof, a magnetic plunger adapted to be reciprocated through the coils, a source of continuous current, insulated contacts representing the several coils, contact devices adapted to be moved upon the contacts to shift the current gradually from one set of auxiliary coils to the other, connections between the auxiliary coils and the central coils, a motor for actuating the contact devices, and means for controlling the speed of the motor.

7. An electro-magnetic reciprocating engine comprising a main central coil, sectional auxiliary coils at each end thereof, a magnetic plunger adapted to be reciprocated through the coils, a source of continuous current, connections therefrom to the main and auxiliary coils, and an automatic circuit-changer for shifting current gradually from one set of auxiliary coils to the other.

8. An electro-magnetic reciprocating engine comprising a main central coil, sectional auxiliary coils at each end thereof, a magnetic plunger adapted to be reciprocated through the coils, a source of continuous current, connections therefrom to the main and auxiliary coils, an automatic circuit-changer for shifting the current gradually from one set of auxiliary coils to the other, and an adjustable regulator for controlling the speed of the circuit-changing mechanism.

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

CHARLES J. VAN DEPOELE.

Witnesses:

JOHN W. GIBBONEY,

CHAS. H. OLIN.