(No Model.) 2 Sheets—Sheet 1.

C. J. VAN DEPOELE, Dec'd.

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CONTROLLING MECHANISM FOR RECIPROCATING ELECTRIC ENGINES.

No. 479,960. Patented Aug. 2, 1892.

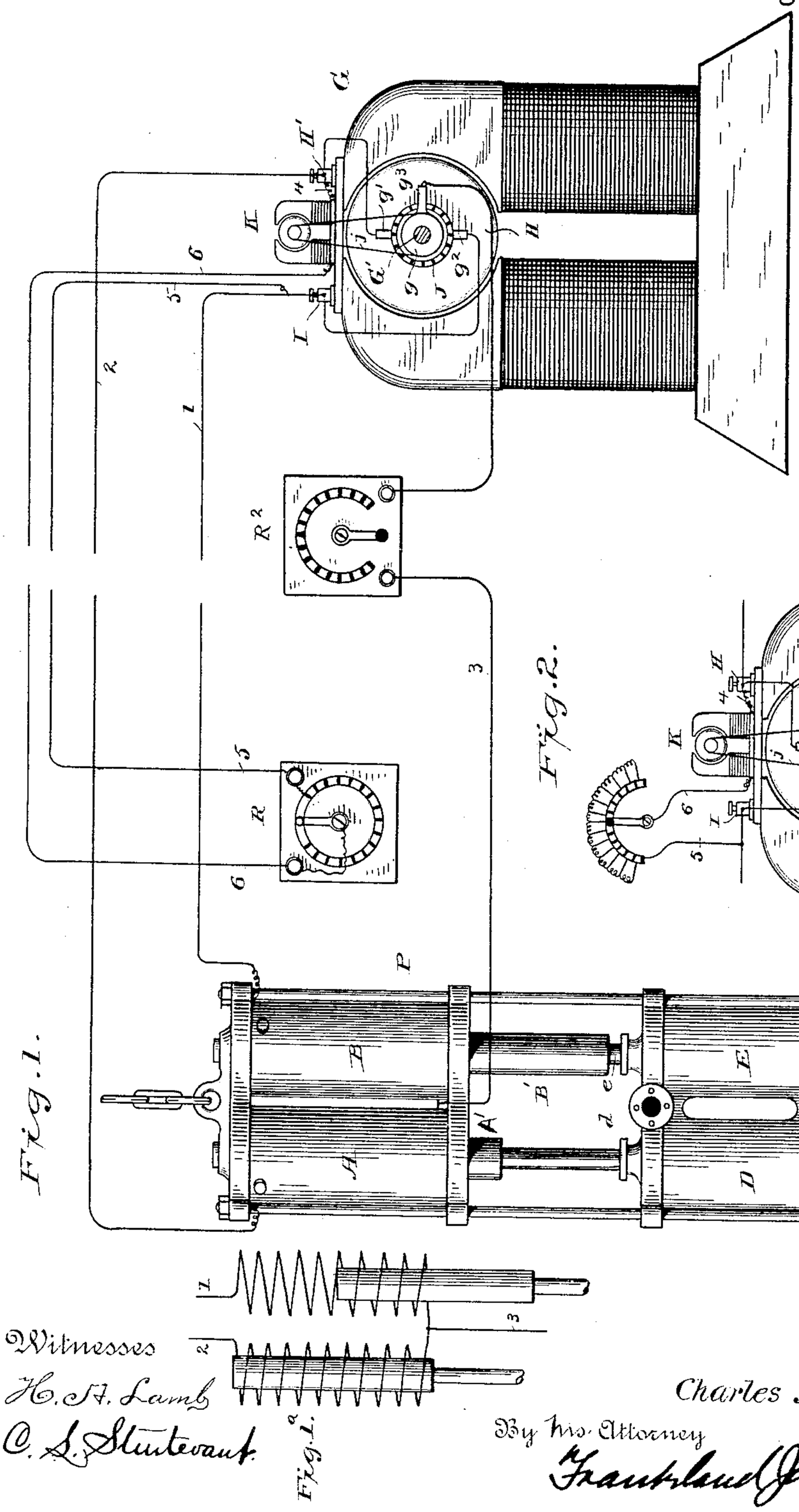

Fig. 1.

Fig. 2.

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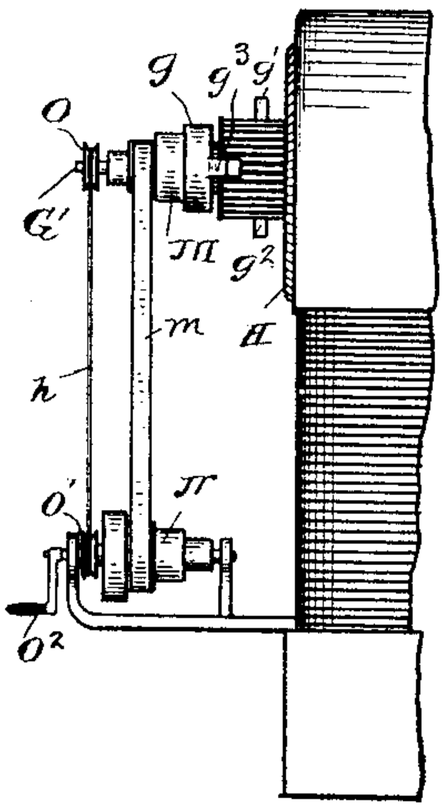
Fig. 4.



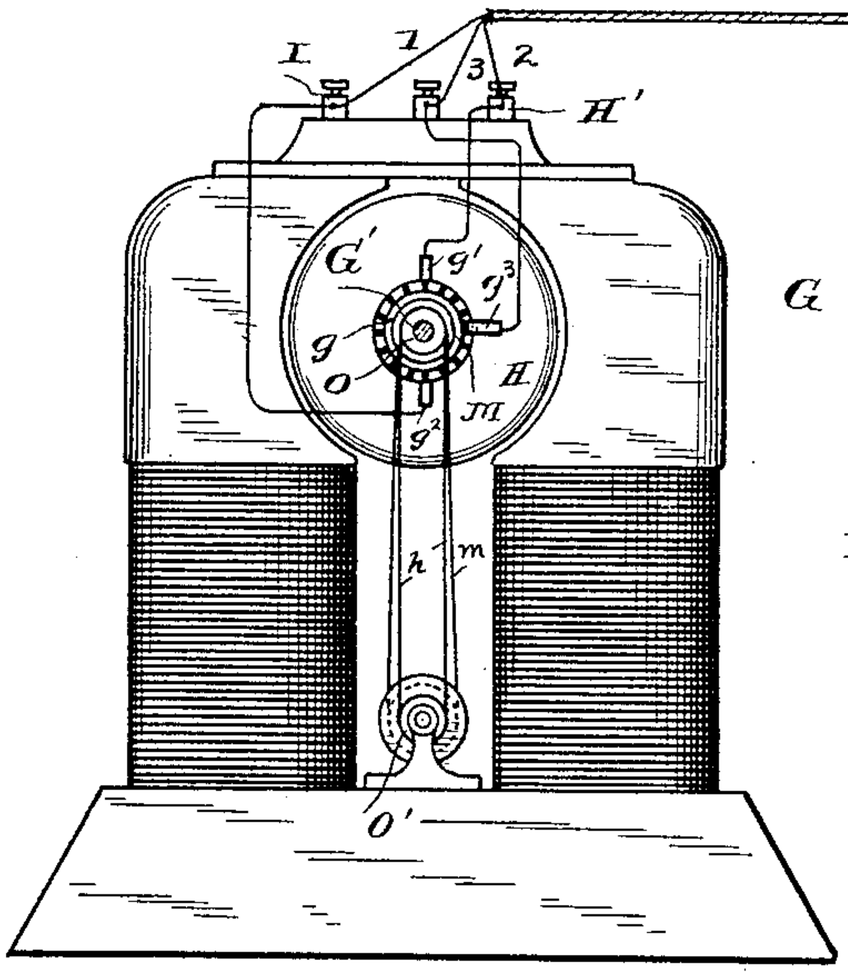
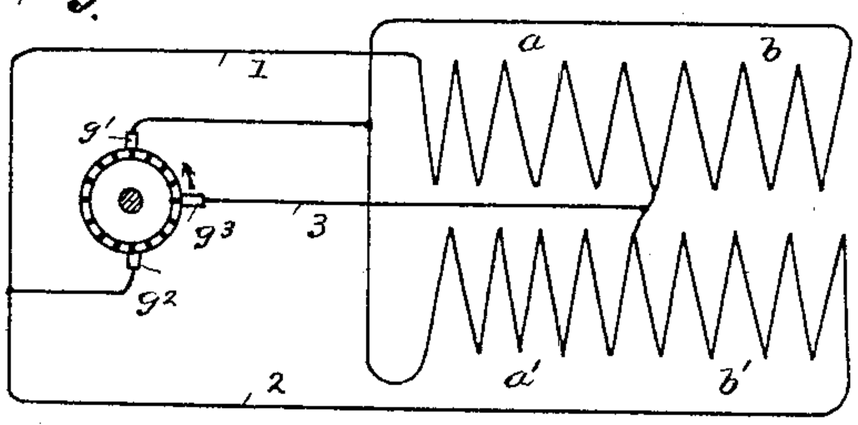
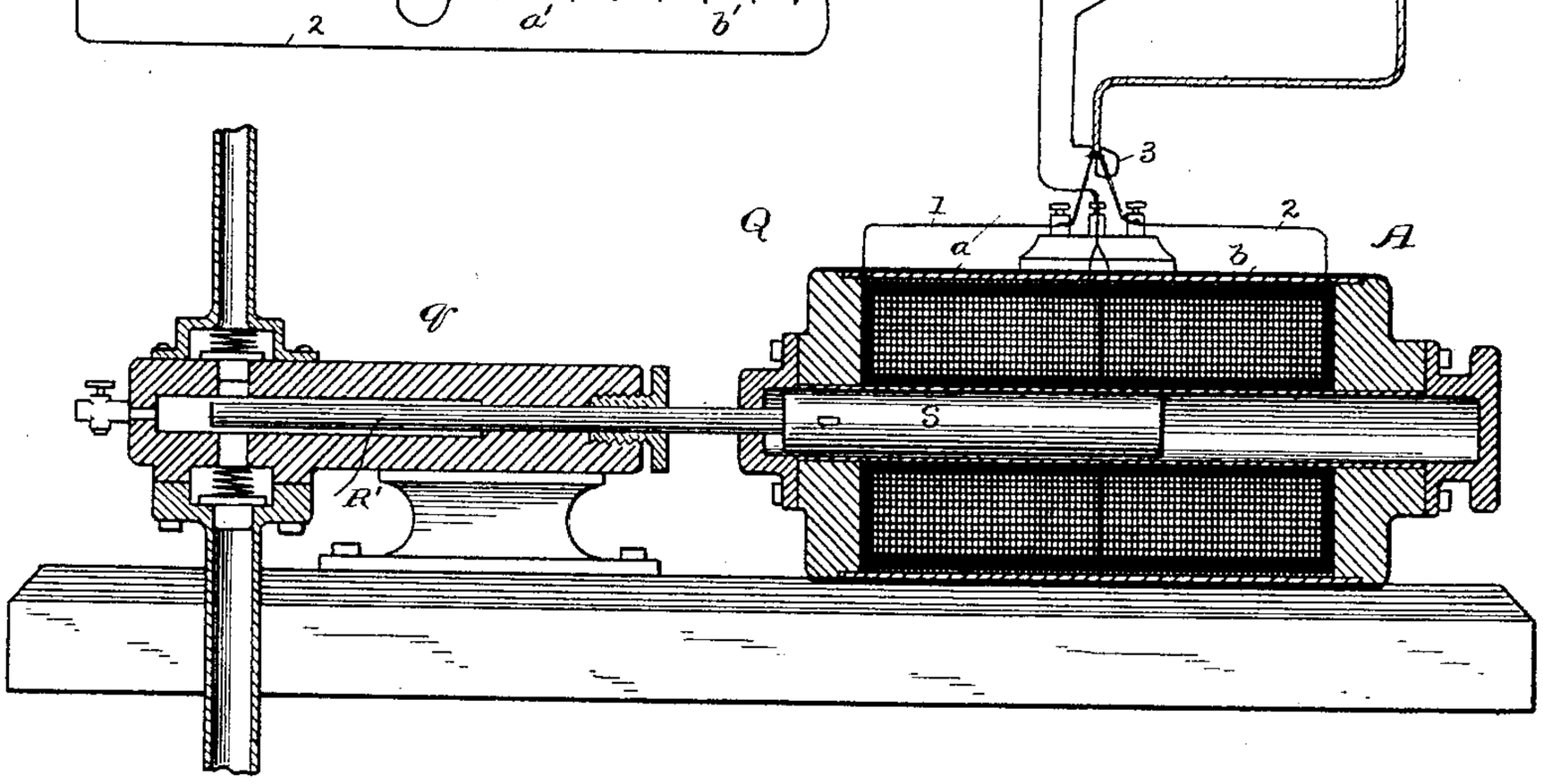


Fig. 3.

Fig. 5.





Witnesses
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UNITED STATES PATENT OFFICE.

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CONTROLLING MECHANISM FOR RECIPROCATING ELECTRIC ENGINES.

SPECIFICATION forming part of Letters Patent No. 479,960, dated August 2, 1892.

Application filed December 31, 1889. Serial No. 335,531. (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 Controlling Mechanism for Reciprocating Electric 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.

In an application filed by me December 2, 1889, Serial No. 332,274, I have described and claimed a reciprocating electric pumping-engine. My present invention relates to a similar application of electro-magnetic power; and it consists more particularly in means for regulating and controlling reciprocating electric engines generally, the system being hereinin illustrated as applied to electrically-operated pumping-engines. The invention is, moreover, available whether the engines be placed near the work or at or near the source of current.

The invention is illustrated in the accompanying drawings, and will be hereinafter described, and referred to in the appended claims.

Figure 1 is a diagrammatic view showing a portable or adjustable electro-magnetic pumping-engine in elevation, a dynamo-electric machine supplying current thereto, also in elevation, and means adjacent to the pumping-engine for controlling the current flowing from the generator through the coils of the pumping-engine, and also for regulating the speed of the current-waves operating the pumping-engine. Fig. 1ª is a detail view showing circuits and connections which may be employed to operate a vertically-acting pumping-engine. Fig. 2 is a detail view of a part of the current-supplying machine, together with a somewhat different arrangement of the current-controlling mechanism. Fig. 3 is a diagrammatic view showing a sectional elevation of an electrically-actuated reciprocating pump, together with an elevation of a dynamo-electric machine and means for controlling the current strength flowing therefrom to the motor-coils of the pump. Fig. 4 is a detail side view of the dynamo and phase-controlling mechanism or means for determining the number of strokes of the engine in a given time, showing four changes of speed. Fig. 5 is a diagram of a duplex arrangement of circuits and connections for a pumping-engine.

In Fig. 1 of the drawings is seen a form of electro-dynamic reciprocating pumping-engine shown in my said application, and designated as "self-contained"—that is to say, the apparatus as a whole forms one integral machine, which may be suspended by a rope or chain and raised or lowered, as in sinking shafts or wells. The entire apparatus, being self-contained, can be operated in a vertical or inclined position as well when suspended as when mounted upon a stationary base.

One form of the present invention is particularly adapted to the apparatus seen in Fig. 1, which is wound for lifting or working vertically, although said pump can be operated in any position if wound properly. The invention also includes means for affording the desired control of the supply-current when employed to operate stationary pumps, as will appear in connection with the form seen in Fig. 3.

In said Fig. 1, P indicates an electro-magnetic reciprocating pumping-engine in which A B are cylindrical metallic iron casings. The casings A and B each contain a motor coil or coils to be operated as electro-magnetic reciprocating pumping-engines. The motor-coils may be arranged in any desired manner without affecting the present invention, one method being indicated in Fig. 1ª and another in Fig. 3, by way of illustration.

A′ B′ are plungers or movable cores of magnetic material of suitable form and proportions to be acted upon and to be propelled back and forth by the solenoids or motor-coils contained within the casings A B.

D E are pump-cylinders, which may be constructed in any desired manner. The pistons of the pumps D E are connected by rods *d e* with the plungers A′ B′ of the reciprocating electric engines, so that the said pump-pistons are actuated directly thereby, substantially in the same manner as the well-known

direct-acting steam-pumps, which the apparatus herein shown and described closely resembles in many respects, although possessing in practice many desirable features not found in steam-actuated apparatus intended for a similar purpose.

With the arrangement of motor-coils shown in Fig. 1ª two single-acting coils *a b* are employed, one being contained within each of the casings A B and each having a magnetic piston A′ B′, movable within and by the magnetic force of each coil. As indicated in said Fig. 1ª, the pistons *d e* are arranged to be forcibly lifted when their respective motor-coils are energized, the said pistons dropping back to their lower positions when the current ceases to flow or is shifted from one coil to the other, and vice versa.

With the form seen in Figs. 3 and 5 two motor-coils *a b* or two groups of coils *a b a′ b′* are arranged to act alternately upon the same piston to propel it positively first in one direction and then in the other.

Several methods of operating electric pumping-engines are pointed out in my aforesaid application, the apparatus being as a general thing attached to and carried by the pump. In the present instance, however, I show means for controlling the action of the pump. The controlling mechanism is preferably placed near the pump, so that the generator may be in one place, the pump at the work in another, and the current-controlling apparatus in the hands or within reach of the operator, who may be near enough to the pump to observe and direct its action. Such an arrangement is seen in Fig. 1 of the drawings, in which G is the generator or source of currents, having a suitably-constructed armature H of the continuous-current type, P a movable pump, and R the regulator for controlling the speed of the current-impulses. The main commutator-brushes g' g^2 of the generator G are connected to binding-posts H′ I, from which extend main conductors 1 2, which are connected to opposite ends of the motor-coils of the pumping-engine. It is immaterial just how the coils of the said reciprocating engines are arranged, although they may be, for example, as seen in Fig. 3, which resembles what is shown in Fig. 2 of Letters Patent No. 401,231, dated April 9, 1889. With such arrangement the conductors 1 2 would be connected to the opposite main commutator-brushes g' g^2 of the source of current G, and the said conductors are also connected to the outside terminals of two sets of coils, arranged to be energized in alternation. (See Fig. 5.) A third conductor 3 is connected to the inner terminals of said coils, so as to form a common return therefor. The coils may of course be arranged to act separately and on separate plungers, if desired, as indicated in Fig. 1ª. The conductor 3 is connected to a third commutator-brush g^3, which is secured to and carried by a rotatable sleeve *g*, which is mounted upon the armature-shaft G′.

J is the commutator, and the brushes g' g^2 are suitably sustained in operative relation thereto as near as possible to the theoretical diameter of commutation. The third brush g^3 represents a common return, and is rotated about the commutator at any desired speed, and when so moved serves to alternately shift the main current from one set of coils to the other, which, as set forth in my said prior patent, results in alternately raising and lowering the magnetic strength of each of the motor-coils and thereby causing reciprocations of the plunger or plungers to be actuated thereby. So long as the apparatus is in operation the current never ceases flowing in one or the other of the coils, the action of the moving brush being to cause the same to rise and fall in the said motor-coils alternately. It will be readily understood that the current in the working circuit can be controlled by means of a rheostat R^2, placed in the return circuit. Where a number of reciprocating devices are supplied from a source of current of constant potential, it becomes necessary to vary the amount of current in the working coils—as, for instance, in starting a pump and before the weight of the water is active, or where the action of the pump needs greater or less strength. The current regulation is therefore entirely independent of the speed (phase) regulation, as will appear.

Any number of coils may be connected to act in unison, and it is immaterial which of the forms of coil or reciprocating engine already invented by me is applied to the present purpose, as, also, instead of an outside resistance-regulating device the coils can be wound with independent circuits to be energized according to power required. The brush g^3 is here shown as being operated by a small independent electric motor K, the armature-shaft of which is provided with a suitable pulley, which is arranged to transmit motion to the sleeve *g* and moving brush g^3—as, for instance, by a belt *j*, extending between the armature-shaft of the motor K and the part supporting the moving brush g^3. One side of the circuit of the motor K is connected, as by conductor 4, with one of the main binding-posts H′, and the said motor is connected, say, in derivation between the main terminals of the main generator G. The other side of the circuit of the motor K extends therefrom by conductor 5, which passes to an adjustable resistance *k*, through said resistance, and thence by conductor 6, the extremity of which is connected with the other binding-posts I of the generator G. With this arrangement the motor K is connected between the terminals of the generator G and has in circuit with itself the adjustable resistance *k*. By means of the conductors 5 6 or any equivalent arrangement the resistance *k* is brought into convenient proximity to the pumping-engine, and it will be apparent that the operator by manipulating the resistance *k* can control the speed of the motor K as de-

sired. Since the motor K is connected to the moving brush, the movement of which controls the speed of the current-phases in the pump-coils, it follows that the speed of the motor K will control that of the moving brush g^3 and that the speed of the motor K can be controlled by means of the resistance *k*. The adjustable resistance being thus arranged in convenient proximity to the pumping-machine the motions of which are to be controlled places the same entirely under the control of the operator. The conductors 1 2 3 and also the conductors 5 and 6 are desirably formed into one cable, which extends between the source of current and the work to be performed by the pumping-engine, and it must be understood that while I have spoken of a pumping-engine this method of control applies to all reciprocating engines of any kind whatsoever which embody the principles of operation herein set forth.

The herein-described method of control is quick in action and as complete as possible, and provision of this kind is absolutely essential to the successful operation of any pumps, since it will frequently happen in sinking shafts, &c., that the water will give out and the pump have to be started over again after each change of position or from other causes. If the full force of current and speed were turned on at starting, the movement of the pump-pistons might be far too rapid and the valves fail to act; but with the arrangement just described or anything equivalent thereto the operator may stand in position to observe the movements of the machine and by controlling the speed of the motor K and also regulating the current strength by means of the rheostat R^2 can control the strength of one and shift the main current in the motor-coils, as may be desired, and thereby impart to the pump-pistons movement corresponding thereto, so that the pump may be started up very slowly indeed, and when fully primed the speed and strength of the current-pulsations and the full force of the pump developed without the loss of time which would occur if it were necessary to communicate with the person in charge of the generator or source of current.

It may in many instances occur that some form of electrically-operated machine will possess advantages for employment as a stationary pump, and where such is the case the current-phase-controlling device will be placed in the motor-circuit, but all in fixed relation, when of course the action of the apparatus can be observed and directed, as above set forth.

It is well known that in starting an ordinary pump, whether operated by hand or by an expansible fluid, if the full power be applied before the pump is fully charged with water the piston will be driven violently back and forth in the cylinder, not only at great risk of injury to the parts, but without accomplishing the object in view. In addition to the means of regulation of speed of stroke, hereinbefore described, I also diminish the flow of the main current in the motor-coils at starting by means of the regulator R^2, above described. I find that by causing the said currents to alternately rise and fall in the forward and backward motor-coils the movement of the magnetic piston therein will be slow and gradual and in direct accordance with the rate at which the main current rises and falls if the full load is on; but in starting the pump there would be too much power, hence the need of the current regulation. Furthermore, as pointed out in my said prior application the main current is not cut off, and therefore the same magnetic force that moves the plunger back and forth serves to prevent it from passing beyond the motor-coils, and this effect I have termed the "magnetic cushion." In starting up a pump the magnetic cushion will insure the safety of the parts and prevent jarring or injury thereto, so that by causing the currents to rise and fall at a low rate of speed and by suitably reducing the strength thereof the movements of the piston and of the parts thereto attached can be controlled as desired and the pump be started without jar or injury.

Where a stationary pump is to be operated, it will frequently happen that the source of pulsating current can be placed adjacent thereto. The source of current may be a generator, as indicated; but it may also equally well be a dynamo-electric machine provided with a moving brush and receiving current from a suitable continuous-current circuit, said motor being employed as a distributer, substantially as shown and described in my said prior application for Letters Patent filed March 23, 1889, Serial No. 304,544, and also in a division thereof filed October 4, 1889, Serial No. 326,023. With such arrangement I may employ the devices shown in Fig. 2—that is, the regulator placed near the generator or distributer; but it must be understood that I may attain the same results by mechanical means, as indicated in Figs. 3 and 4. The dynamo-electric machine G (indicated in said figures) may be either a generator or a motor—that is to say, current may be produced by forcible rotation of the armature thereof, or current may be supplied thereto through the main commutator-brushes—and when so rotated as a motor the machine will act to distribute pulsating currents in any desired number of working circuits connected to the said main commutator-brushes and to an additional brush arranged and adapted to be moved about said commutator with a rate of speed corresponding to the desired rate of rise and fall in the currents sent to the working circuits.

The main stationary commutator-brushes are seen at g' g^2. The moving brush g^3, as indicated and more clearly shown in Fig. 4, is carried by a rotatable sleeve *g*, which is rotatably mounted upon the counter-shaft. As in Figs. 1 and 2, the brush-carrying sleeve *g*

is belted to a small electric motor K, by which it is rotated and the brush g^3 moved about the surface of the commutator-cylinder toward and away from the main stationary commutator-brushes. As seen in Figs. 3 and 4, the brush-carrying sleeve *g* is arranged to be actuated mechanically, and is secured to a step-pulley M, showing four changes of speed, although more or fewer may be employed, as desired. A second and corresponding step-pulley N is mounted in line with the step-pulley M, and the bearings therefor may be connected to the frame of the machine G or supported in any other convenient manner. The step-pulleys are connected by a belt *m*, which can be shifted from step to step to change the relative speeds of the said pulleys, as desired. A pair of cone-pulleys would be the equivalent of the step-pulleys here shown. The pulley N is preferably driven by a belt *h*, extending from a pulley O, secured upon the armature-shaft G′, and to a pulley O′, secured upon the axis of the pulley N. It may, however, be desired to rotate the brush-moving mechanism by a separate or constant speed-motor, as by a clock or weight, and such means might be substituted for that here shown without departing from the invention. In starting up the pump Q it may be desired to move the brush-actuating mechanism with extreme slowness, and I therefore provide the axis of the pulley N with a hand-crank O^2, by means of which the brush-actuating mechanism may be moved with any desired speed. When the hand-crank O^2 is employed, the driving-belt *h* should be thrown off, or one of the pulleys O O′ may be provided with a clutch, so that the brush-actuating mechanism may be entirely under control by means of the hand-crank O^2 until the desired speed has been reached, when by throwing the driving-pulleys O O′ into gear the apparatus will be rendered automatic and moved in accordance with the speed of the armature-shaft and of the gearing employed. The pumping apparatus Q (here shown) includes a horizontal pump *q* of any desired type, the piston R′ of which is connected to the plunger S of the reciprocating electric engine A, by which the same is actuated. The said engine A includes two motor-coils *a b*, arranged to be energized, substantially as shown and described in my patent, No. 401,231, dated April 9, 1889. The electric reciprocating engine herein shown being merely by way of illustration, it will be understood that no more detailed description thereof is required and that the current-controlling devices herein shown and claimed may be employed with any form of apparatus to which they are applicable.

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

1. The combination, with a reciprocating electric engine comprising a magnetic piston and motor-coils for imparting motion thereto, of a circuit supplying alternating currents to said coils and means located near the engine for regulating and controlling the current strength and also the rate of its alternations or phases in the motor-coils.

2. The combination, with a reciprocating electric engine comprising a magnetic piston and motor-coils, of a dynamo-electric machine and circuit extending therefrom for supplying currents to said coils in alternation and means for regulating and controlling the rate of such alternations irrespective of the rate of rotation of the armature of the dynamo-electric machine.

3. The combination, with a reciprocating electric engine comprising a magnetic piston and motor-coils, of a generator and a circuit for supplying currents to said coils in alternation and means connected with the source of said supply-currents for raising and lowering the rate at which they are supplied to the motor-coils of the engine irrespective of the rate of rotation of the generator-armature.

4. The combination, with a reciprocating electric engine comprising a magnetic piston and motor-coils, of a source of current, conductors extending between said source and the motor-coils of the engine, means for directing the supply-currents to the circuits of the motor-coils in alternation, and means located near the engine for raising or lowering the rate at which the supply-currents rise and fall in the respective coils.

5. The combination, with a reciprocating electric engine comprising motor-coils and a magnetic piston, of a source of current therefor, conductors extending from said source to the engine, mechanism located near the engine and connected with the source of current for distributing said current alternately in the motor-circuits, and manually-actuated means, also near the engine, for controlling the speed of the current-distributing mechanism.

6. The combination, with a reciprocating pumping-engine, of a reciprocating electro-magnetic engine having its piston connected to the piston of the pump, circuits extending from a suitable source of current to and including the motor-coils, and means located near the engine for reducing the speed of the electric engine when starting the pump and for regulating the flow of current according to the work.

7. The combination, with a reciprocating pump, of a magnetic plunger connected to the piston thereof, a motor coil or coils for imparting reciprocating motion to the magnetic plunger and the pump-piston, a distant source of current and circuit connections extending therefrom to the motor coil or coils, and means adjacent to the pumping-engine for controlling the current-supply at the distant source.

8. The combination of a portable electrically-operated reciprocating pump, a distant source of current, electrical connections be-

tween the source and the motor-coils of the pumping-engine, and a portable current-controlling device adapted to be placed near the pumping-engine.

9. The combination of an electrically-operated reciprocating pump, a source of rising-and-falling currents connected by circuits to the motor-coils of the pump, and means for varying the rise and fall and the amount of current supplied to the motor-coils irrespective of the rate of rotation of the armature supplying the currents at the source.

10. The combination, with a reciprocating electric engine comprising a magnetic piston and motor-coils adapted to be energized in alternation, of a source of current remote therefrom, supply-conductors extending from the source to the motor-coils of the engine, means connected with the source of current for directing the same alternately to the respective motor-coils, and means adjacent to the engine for controlling the current-distributing mechanism at the distant source of supply-current.

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

CHARLES J. VAN DEPOELE.

Witnesses:

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FRANKLAND JANNUS.