(No Model.)

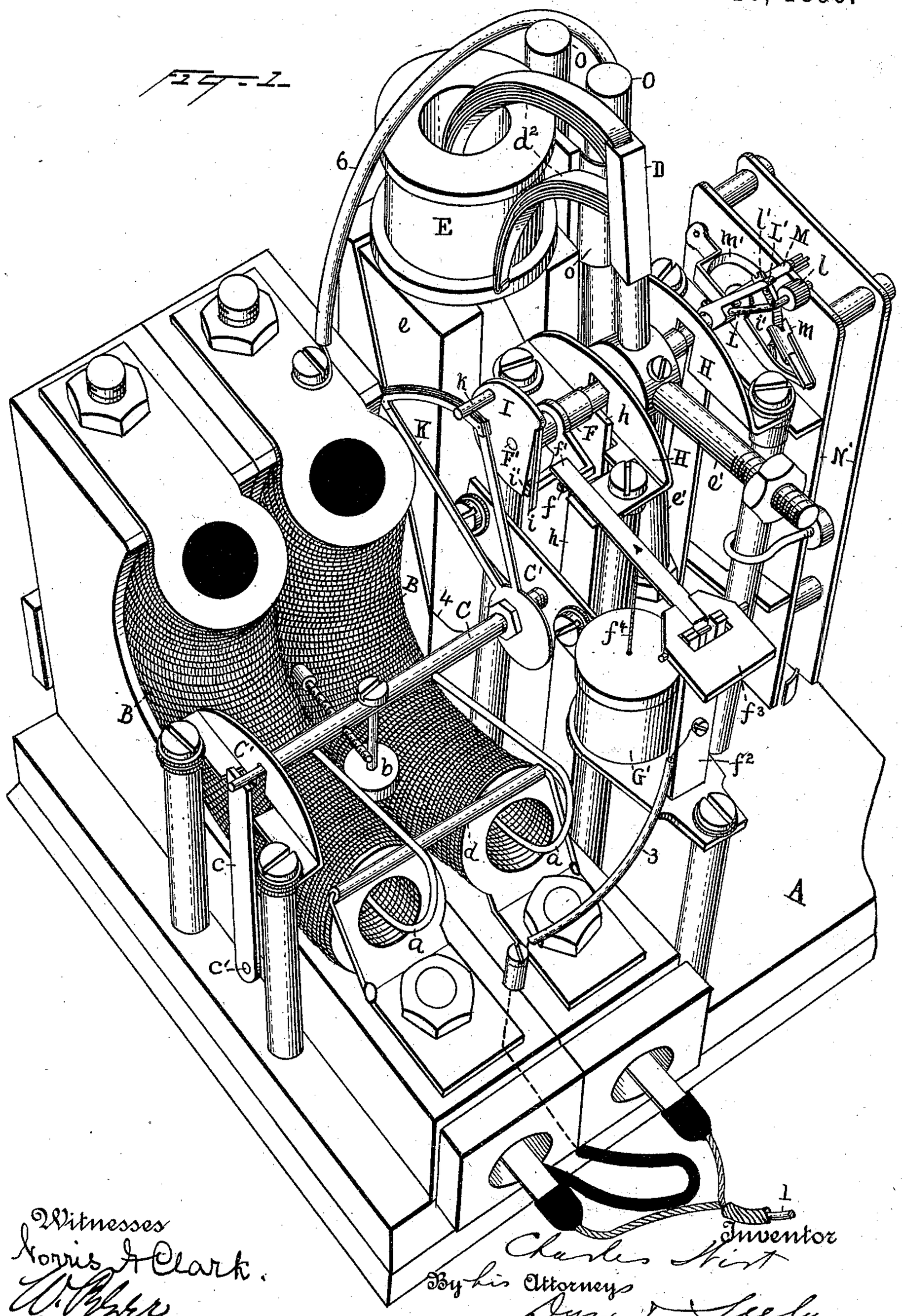
6 Sheets—Sheet 1.

C. WIRT.

ELECTRIC METER.

No. 555,992. Patented Mar. 10, 1896.

Fig. 1.



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(No Model.) 6 Sheets—Sheet 2.

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ELECTRIC METER.

No. 555,992. Patented Mar. 10, 1896.

Fig. 2.

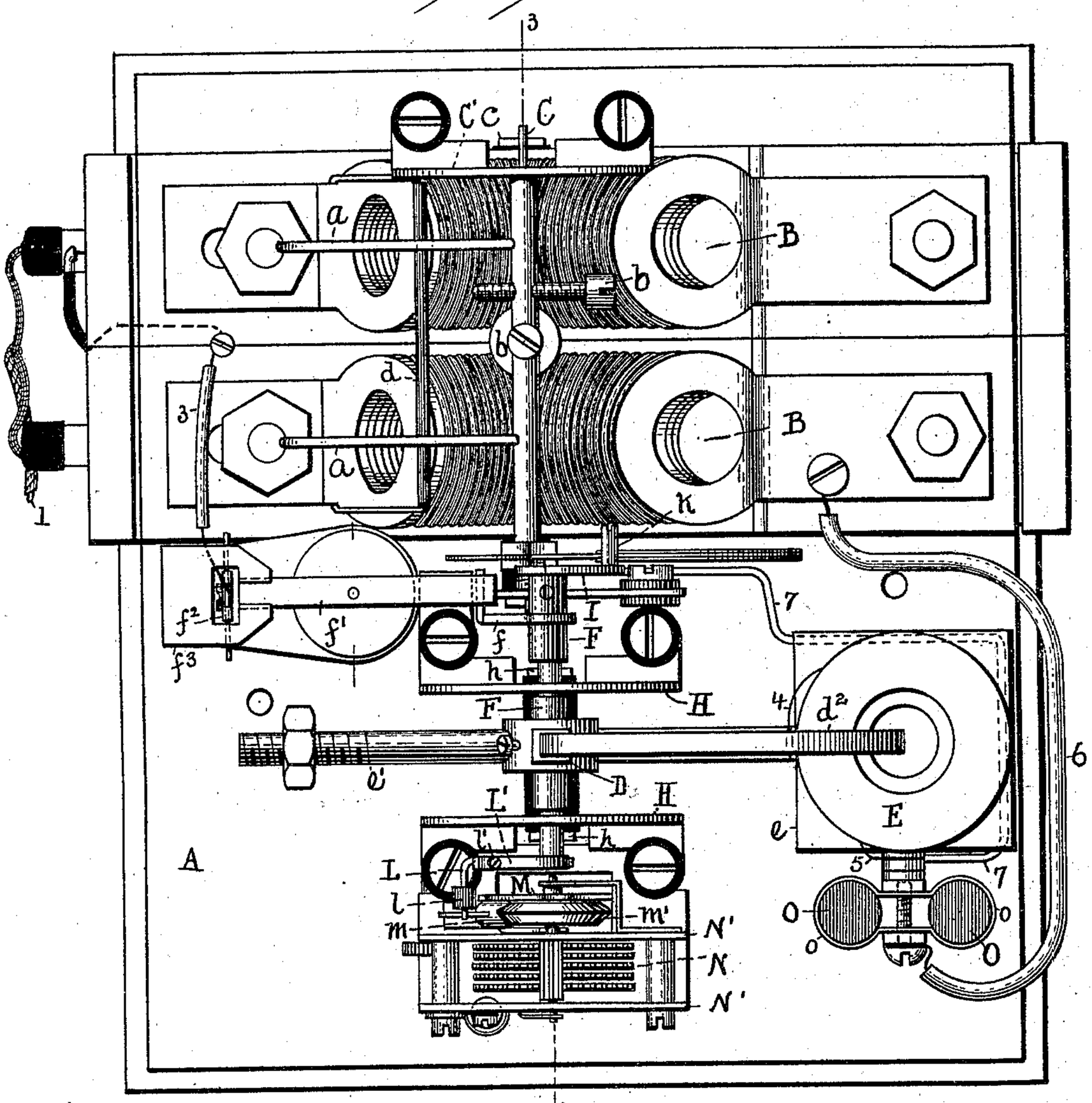


Fig. 6.

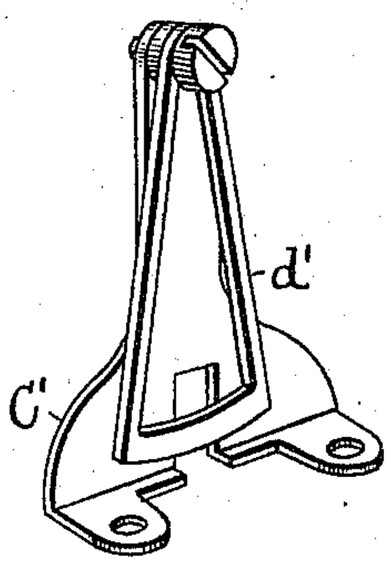
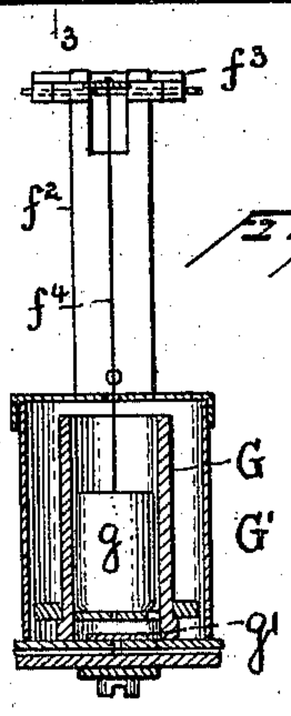


Fig. 5.



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6 Sheets—Sheet 3.

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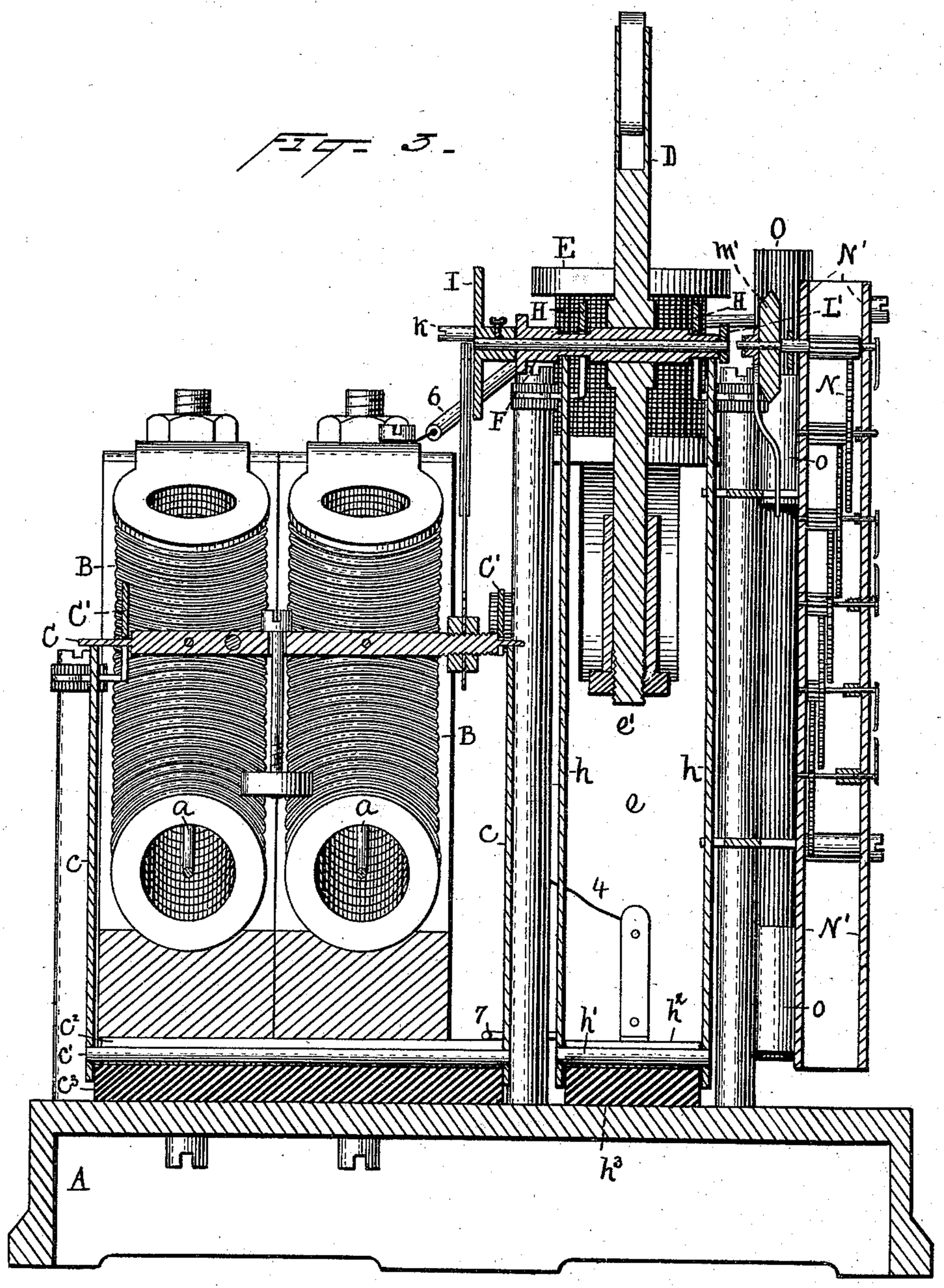
ELECTRIC METER.

No. 555,992. Patented Mar. 10, 1896.

Fig. 3.



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(No Model.) 6 Sheets—Sheet 4.

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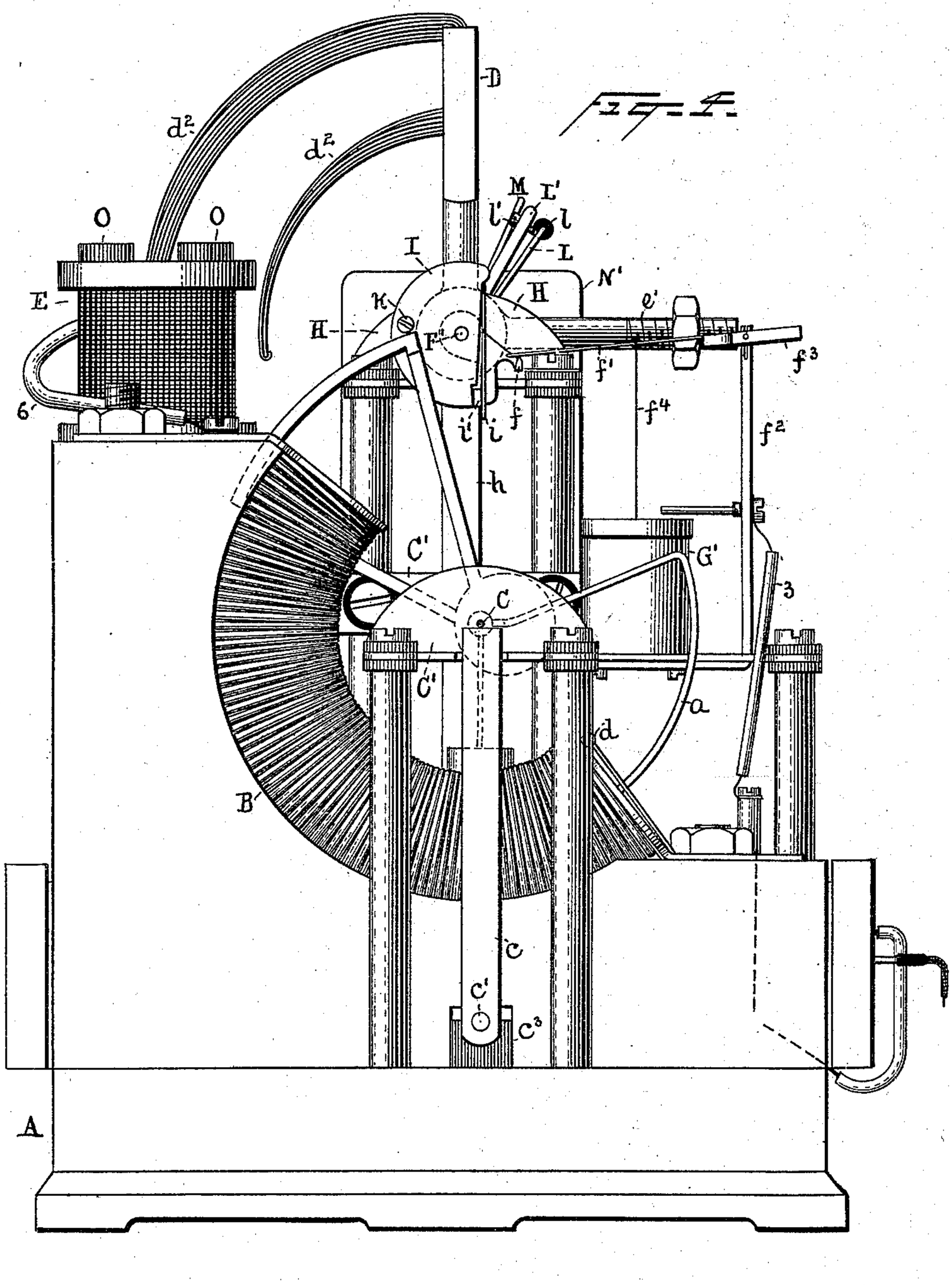
ELECTRIC METER.

No. 555,992. Patented Mar. 10, 1896.

Fig. 4.



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(No Model.) 6 Sheets—Sheet 5.

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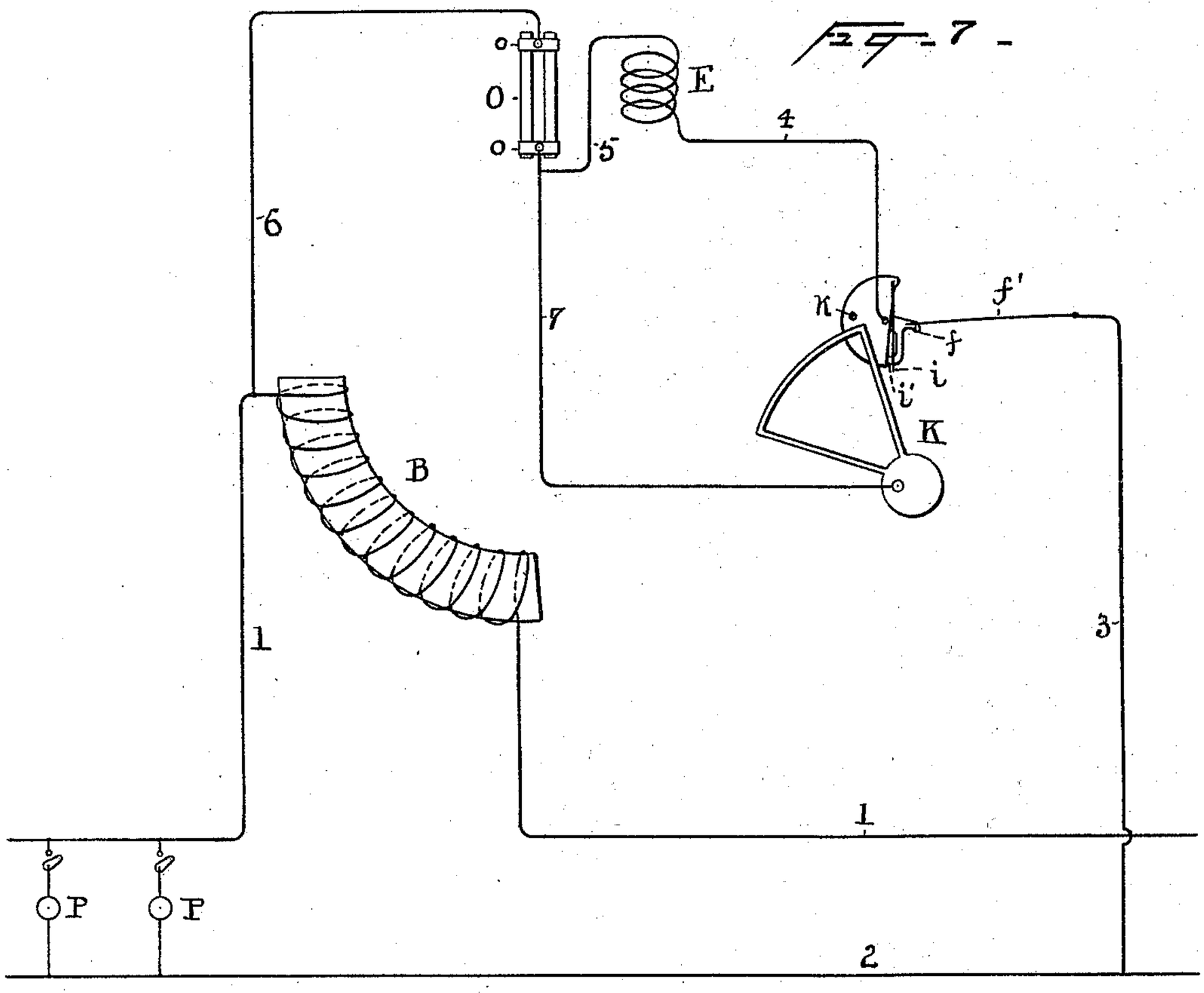
ELECTRIC METER.

No. 555,992. Patented Mar. 10, 1896.

Fig. 7.



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(No Model.) 6 Sheets—Sheet 6.

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ELECTRIC METER.

No. 555,992. Patented Mar. 10, 1896.

Fig. 8.

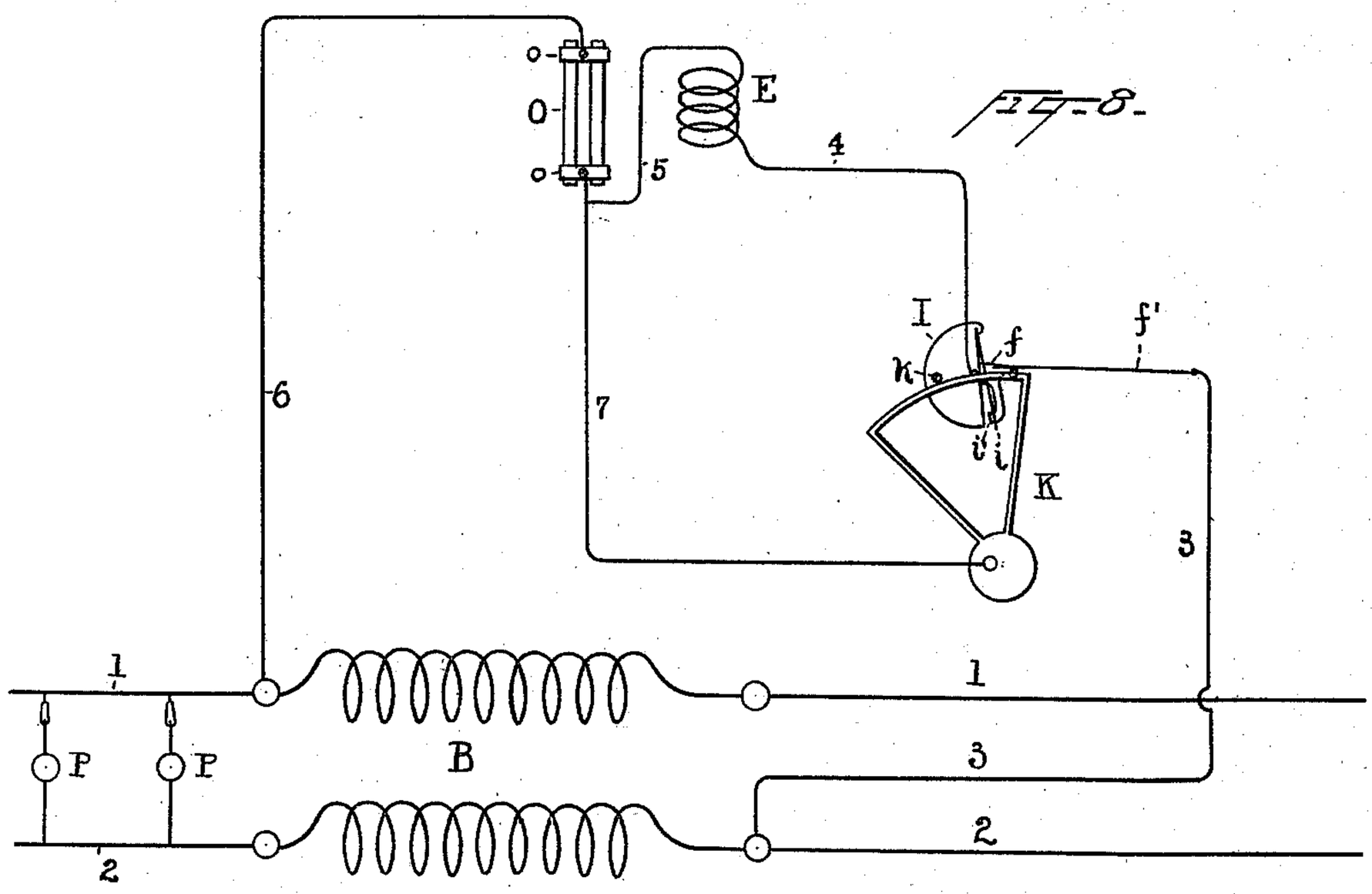
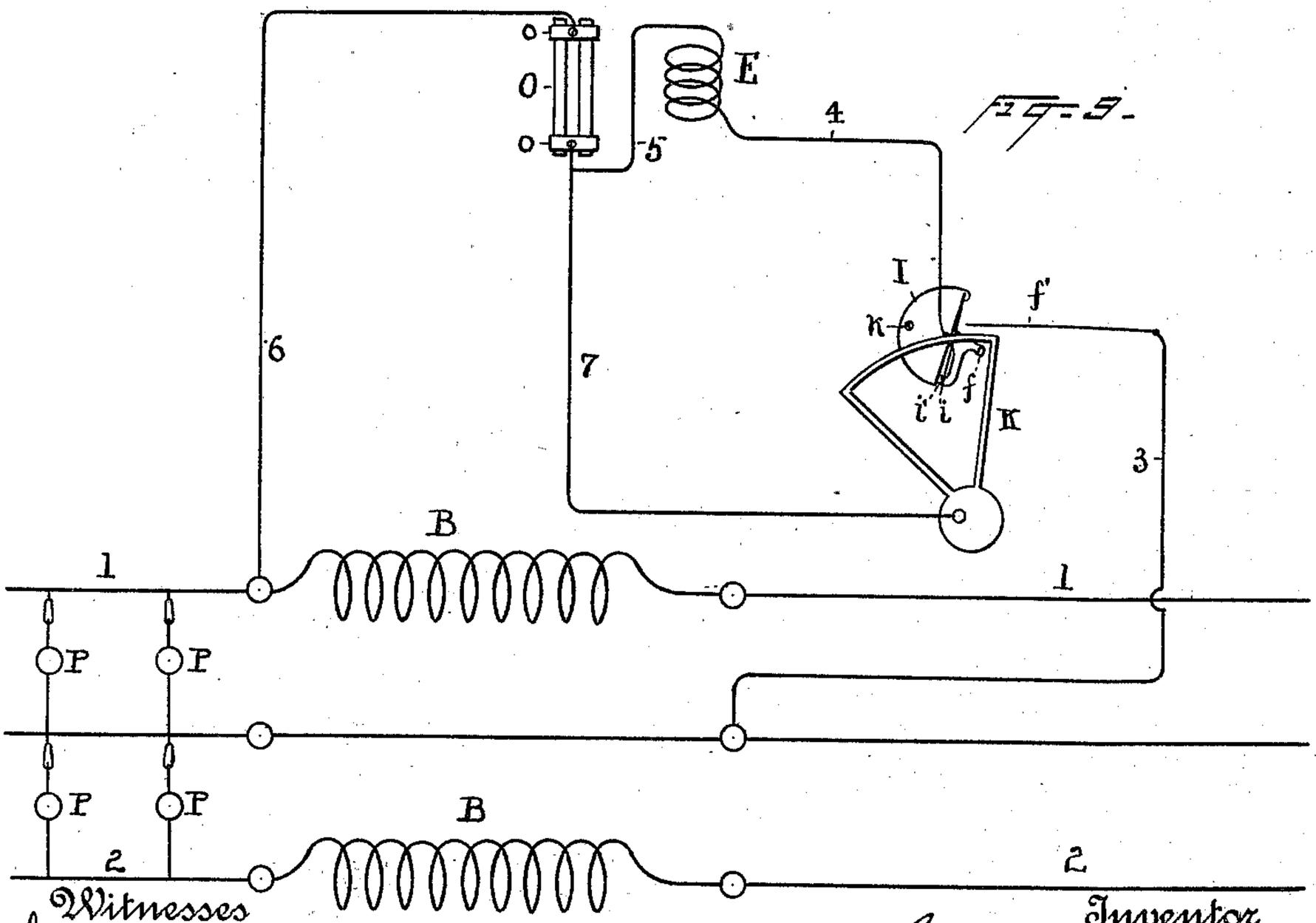


Fig. 9.



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UNITED STATES PATENT OFFICE.

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ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 555,992, dated March 10, 1896.

Application filed November 30, 1894. Serial No. 530,365. (No model.)

To all whom it may concern:

Be it known that I, CHARLES WIRT, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful Improvement in Electric Meters, of which the following is a specification.

The object I have in view is to produce a simple and efficient meter for recording the electric current by means of a dial-indicator. This I accomplish by utilizing the chrono-electric motor which I have already described in my Patent No. 533,108, dated January 29, 1895, and combining therewith a current-indicator of approved construction, which is arranged to adjust the cut-off cam of my motor, such cam being shaped so as to permit ranges of movement corresponding accurately with the variations in the current acting upon the indicator. The device thus formed is further combined with a registering train of wheels which is moved intermittently by the motor to a distance determined by the position of the cam under the control of the current-indicator.

In addition to the general features of novelty thus indicated, my meter also possesses other features of novelty in the details of its construction, which will appear from the specific description of the apparatus.

In the accompanying drawings, forming a part hereof, Figure 1 is a perspective view of a meter embodying my invention. Fig. 2 is a top view of the same. Fig. 3 is a vertical section on line 3 3 in Fig. 2. Fig. 4 is an end elevation of the meter. Fig. 5 is a sectional view through the retarding dash-pot which controls the movement of the floating contact of the motor. Fig. 6 is a perspective view of a modification of one of the details of construction. Fig. 7 is a diagram of the circuit connections when the meter is constructed for a two-wire system; and Figs. 8 and 9 are diagrams of the circuit connections for a two-wire system and a three-wire system, respectively, when the meter is constructed for use in either system.

A is the base of the instrument, upon which are mounted two solenoid-coils B B formed upon the arc of a circle. These solenoid-coils act upon soft-iron wire cores *a a*, which are carried by a shaft C having suitable counterbalancing-weights *b*. This device is an approved form of current-indicator. The two coils are provided so that the meter may be used for a three-wire circuit as well as for a twowire circuit. In the for mer case the coils are connected one in the line of one of the outside main conductors and the other in the line of the other of the outside main conductors. In the latter case the two coils may be joined in multiple in the line of one of the main conductors; but the preferred way would be to connect one coil in each of the main conductors. In order to make the current-indicator less liable to inaccuracies by reason of friction, I mount the ends of the shaft C upon rocking bars *c c*, which rise from the base of the machine, where they are connected by a rod *c'*, which lies in a metal trough c^2 mounted upon an insulating-block c^3. The reduced ends of the shaft C rest upon the upper ends of these rocking bars *c*, which are confined in their movement by plates C', which also prevent the dislodgment of the shaft. These plates C' are mounted upon suitable posts, from which they are insulated. A cross-bar *d* of insulating material is provided to prevent the wire cores *a* from striking the metal end pieces of the solenoids B B. The shaft C, the supporting rocking arms *c*, and the retaining-plates C' are therefore insulated from the base and from other parts of the apparatus. The rocking arms *c c* form an exceedingly effective antifriction-bearing for the shaft C, since, as the shaft turns, it rolls on the upper ends of these arms and the arms rock back and forth. Owing to their length the movement at the pivot of the arms is exceedingly slight, and consequently the friction is reduced to a minimum.

Instead of having the rocking arms rising from the base of the machine, the plates C' may be extended upwardly and carry triangular links *d'*, which are pivoted at the upper ends of the extended plates and receive the ends of the shaft C at the lower ends, as shown in Fig. 6. This construction is simply a reversal of that which is shown in the other figures of the drawings, the triangles *d'* being rocking bars having a long leverage on the

friction at their pivots and having the minimum movement at such pivots, as in the case of the rocking arms *c*.

Adjoining the current-indicator there is mounted upon the base of the machine one of my chrono-electric motors, such as is described in the application already referred to. The elements of this motor comprise a pivoted pendulous arm D, carrying solenoid-cores d^2, which co-operate with a stationary solenoid-coil E, mounted upon a block *e* rising from the base A. The object of employing two cores d^2, one working within the solenoid-coil E and the other working outside of said coil, as shown, is to secure an increased magnetic effect.

The pendulum includes suitable adjustable counterweights *e'*, which overbalance the cores d^2 and keep such cores normally retracted from the solenoid-coil E. The pendulum D is mounted upon a sleeve F, Fig. 3, which is carried by shaft F'. The pendulum-contact *f* projects from the inner end of the sleeve F and engages with the floating contact *f'*. This floating contact is a finger pivoted upon an upright f^2 and having a counterweight f^3, which slightly overbalances the finger *f'*, and tends to throw it upwardly. A thread f^4 connects the finger *f'* with a weight *g*, Fig. 5, which works in a dash-pot G. This dash-pot is surrounded by a protecting-casing G' and carries in its bottom an inwardly-opening valve *g'*. The weight *g* also constitutes the dash-pot plunger. It has a free upward movement, because the valve *g'* admits air beneath it; but its downward movement is retarded by the closing of the valve *g'*. The dash-pot weight *g* is sufficiently heavy when raised to pull down the floating contact-finger *f'* in its downward retarded movement. The circuit of the chrono-electric motor (as described in the application referred to, and as will be more fully hereinafter set forth) passes through the floating contact *f'* and the pendulum-contact *f*, and also through the solenoid-coil E. The effect is to draw the cores d^2 into the solenoid E, thus swinging the pendulum and turning the sleeve F, which throws upwardly the pendulum-contact *f*, carrying with it the floating contact *f'*. On the return movement of the pendulum the pendulum-contact *f* leaves the floating contact *f'*, breaking the circuit to the solenoid E' and permitting the pendulum to swing in the opposite direction to the end of its movement, the contacts *ff'* not meeting again until in the second forward movement of the pendulum the contact *f* reaches the point to which the floating contact has in the meantime fallen, when the circuit of the solenoid E is again closed and another impulse given to the pendulum. The sleeve F turns on rocking bars *h*, which are connected together at their lower ends by a rod *h*, Fig. 3, resting in a metal trough h^2 and supported by a block of insulating material h^3.

The rocking arms *h* and the sleeve F are limited in their movement by plates H, which are supported upon and insulated from suitable posts. These parts correspond precisely with the similar parts which support the shaft of the current-indicator and form an effective antifriction-bearing for the rocking sleeve F. The pendulum and the parts carried by the sleeve F and shaft F' are insulated from the other parts of the machine, and it should also be said that the upright f^2, the dash-pot G, and the surrounding casing G' are also insulated from the standard which supports them in order to give proper direction to the current.

Instead of the rocking bars *h*, the sleeve F may be hung from suspended rocking bars of the construction illustrated in Fig. 6, the same as in the case of the rocking bars which support the shaft of the current-indicator.

On the inner end of the shaft F' is rigidly secured a disk I, to which is attached a leaf-spring *i*, Figs. 1 and 4, and beneath the leaf-spring *i* is a stud *i'*, projecting from the same arm which carries the pendulum-contact *f*. By means of the leaf-spring *i* and stud *i'* the sleeve F and shaft F' are flexibly connected together, so that the rocking movement of the sleeve F, which it receives from the pendulum, will be communicated to the shaft F' until such shaft is positively arrested by the means which will be presently described, when the spring *i* permits a further movement of the sleeve F and the pendulum carried by it without the shock or hammering due to the sudden arresting of these heavier parts.

Upon the inner end of the shaft C of the current-indicator is mounted a cam K, which projects upwardly and has a curved outer end located close to the disk I on the inner end of the shaft F'. This cam K is the cut-off cam of the chrono-electric motor described in the application referred to, which, instead of being adjusted by hand, as described in said application, is, in my meter, adjusted by the movements of the current-indicator. The disk I has a stud *k*, which in the forward movement of the pendulum strikes the rim of the cam K, which rim is formed with reference to the movements of the current indicator produced by variations in the current flowing through the solenoids B, so that the disk I will be permitted to move at each oscillation of the pendulum an angular distance corresponding accurately with the variations in current in the solenoids B.

Rigidly attached to the outer end of the shaft F' is a crank-arm L, carrying on its end a small block of insulating material *l*. This crank-arm, as a means of procuring a fine adjustment, is made somewhat flexible and is located parallel with a rigid arm L', through which a screw *l'* passes and impinges against the crank-arm L, so as to vary the distance between the arms L L'. In the movement of the shaft F' the insulated end *l* of the crank L strikes a clutch-arm M, which, through a

friction-clutch *m* operating like a pawl and ratchet, turns a wheel *m'*, which wheel is on the first shaft of a register-train N, such register-train being of any usual or suitable construction and being mounted in suitable front and back plates N'.

The crank L, which operates the register, being rigidly connected to the shaft F', has a movement which is definitely determined by the striking of the stud *k* on the limiting-segment K, although the pendulum may have a still greater movement permitted by the spring *i*. If the oscillating motor is in operation and no current is passing through the indicator-coils B, the cam K will not permit a sufficiently great forward movement of the disk I to cause the crank L to move the clutch. When, however, any current flows through the indicator-coils B, the segment K will be moved so as to permit the disk I to have a greater movement, and the crank L will also have a greater movement and will move the clutch-arm M, thus imparting an intermittent movement to the register-train.

It will be understood that the striking of the pin *k* against the rim of the cam K not only mechanically arrests the crank-arm, but also at the same time short-circuits the motor-coil E, thus withdrawing the current from the motor-coil, as described in the application before referred to, and permitting the pendulum to start back freely without retardation from the coil E. The additional movement which the pendulum has by reason of the flexible connection of sleeve F with disk I causes it to break the motor-circuit at the floating contact *f'* on the backward swing of the pendulum before the shunt is broken by the separation between the stud *k* and the segment K. The supply of current will be first cut off from the motor-coil E by the separation of the pendulum-contact *f* and floating contact *f'*. The shunt around the coil E, formed by contact between K and *k*, will still be closed, and the coil will discharge through this shunt, and no sparking will occur when K and *k* separate. This arrangement prevents all sparking at the contacts. This will be better understood by reference to the diagram of the circuits shown in Figs. 7, 8, and 9, which will be presently described.

In addition to the parts of the apparatus already described, I provide a suitable resistance composed of one or more rods O, which are constructed preferably of a composition of powdered carbon with earthy materials, so as to have an excessively-high resistance, and are connected in circuit by suitable metal clamps *o*. The coil E, it should also be understood, is made of a great length of fine wire and has a high resistance, since the motor is designed to be continuously in circuit and to operate with the expenditure of a minimum quantity of current. On the other hand, the indicator-coils B are made of a relatively few turns of coarse wire, since those coils are designed to be placed directly in the main circuit.

Referring now to Fig. 7, this figure illustrates the circuit connections when the meter is constructed for and used upon a simple two-wire multiple-arc circuit and has only one indicator-coil B. 1 and 2 are the main conductors, to which are connected the lamps or other translating devices P. The coil B is introduced directly in the circuit of the conductor 1. The other parts of the meter are introduced into a multiple-arc circuit between the conductors 1 2, which circuit consists of a wire 3 extending from the main conductor 2 to the floating contact *f'*; also, a wire 4 extending from the disk I to one end of the motor-solenoid E; also, a wire 5 extending from the other end of the solenoid E to the lower end of the resistance-rod O, and, finally, of a wire 6 extending from the upper end of the resistance-rod O to the main conductor 1. A shunt around the motor-solenoid E is formed by a wire 7 extending from the segment K to the lower end of the resistance-rod O. In this figure the lamps P are cut out, and hence there is no current flowing through the current-indicator, and the cam K is shown in its normal position. The circuit to the motor-coil E, however, is closed, and the motor-pendulum is free to oscillate; but the arc of vibration will not be sufficient to permit of its driving the registering-train, as before explained.

In Fig. 8, which illustrates the circuit connections when a meter constructed for a three-wire system is used on a two-wire system, the connections are exactly like those of Fig. 7, except that the extra coil B is placed in the line of the main conductor 2. In this figure the switches to the lamps P are closed and the cam K is moved by the current-indicator to a position corresponding to the amount of current flowing through the coils B. The disk I is shown in the position at which the motor-coil E is cut out—that is, the stud *k* making contact with the rim of cam K. As before explained, the pendulum is capable of forward movement after stud *k* strikes cam K by reason of the flexible connection between sleeve F and disk I. In this figure the free end of spring *i* is pulled away from disk I by stud *i'*, which is carried by sleeve F, and in this position the pendulum is about to start on its backward swing. As the pendulum swings backward, the contacts *f* and *f'* separate before stud *k* and cam K separate, since the disk I cannot move backward with the pendulum until stud *i'* meets it, and hence sparking at the contacts *f* and *f'* is avoided.

In Fig. 9, which illustrates the circuit connections of a meter for a three-wire system, the connections are like those of Fig. 8, except that the multiple-arc circuit 3 6, in which the motor is placed, is connected between the neutral wire of the three-wire system and the outside main conductor I. In

this figure the cam K is shown in the same position as in Fig. 8, and the disk I is shown in the position to which it is carried upon the backward swing of the pendulum D and just before the pendulum starts on its next forward swing, the contact *f* and floating contact *f'* being separated. The contact *f* will meet the floating contact *f'* before the stud *k* strikes the cut-off cam K, which closes the circuit to the motor-coil E and gives another impulse to the pendulum, as above explained.

The several circuit-wires, where they appear in the other figures of the drawings, bear reference-letters corresponding to the reference-letters of Figs. 7, 8, and 9.

It will thus be seen that the oscillating motor is always in circuit and is running, but that the register is not operated except when there is current flowing through the coils B. Since the current flowing through the coils B will be precisely proportional to the amount used in the lamps or other translating devices, and since the cam K permits the oscillating shaft to move an angular distance corresponding accurately to the amount of current in the coils B, that oscillating shaft will move the register through the crank-arm and clutch at each oscillation of the motor a distance corresponding to the quantity of current flowing through the coils B, and the register will show at its dials the quantity of current used. The current-indicator is free to adjust the segment K at all times except when the stud *k* is pressing against that segment, and hence its position will be an accurate indication at every moment of the amount of current which is being used.

What I claim is—

1. In an electric meter, the combination of an electric motor for driving a register said motor oscillating continuously when current is passing through the meter, and means controlled by a current-indicator for controlling the arc of vibration of said motor, whereby the movement of the motor is made proportional to the current to be measured, substantially as set forth.

2. In an electric meter, the combination of an electric oscillating motor for driving a register, and a cut-off controlled by a current-indicator for cutting off the current to said motor at each oscillation, whereby the arc of vibration is made proportional to the current to be measured, substantially as set forth.

3. In an electric meter, the combination of an oscillating electric motor, a register-train, a driving device actuated by said motor and adapted to intermittently drive said register-train, a flexible connection between said driving device and motor, and means controlled by a current-indicator for limiting the forward movement of said driving device, whereby each movement of the register-train is made proportional to the current to be measured, substantially as set forth.

4. In an electric meter, the combination of an electric motor, a shaft actuated by said motor which oscillates continuously when current is passing through the meter and adapted to drive a register-train, and means controlled by a current-indicator for limiting the forward movement of said shaft with each oscillation of the motor, whereby the forward movement of said shaft is made proportional to the current to be measured, substantially as set forth.

5. In an electric meter, the combination with an oscillating chrono-electric motor comprising a pendulum, an operating-solenoid and a circuit-breaker, of a register-train driven intermittently by said motor, a current-indicator, and a cam adjusted thereby for varying the extent of movement of the register-train, substantially as set forth.

6. In an electric meter, the combination with an oscillating chrono-electric motor comprising a pendulum, an operating-solenoid and a circuit-breaker which closes the circuit to the solenoid during a part only of the forward swing of the pendulum, of a register-train driven intermittently by said motor, a current-indicator, and a cam adjusted thereby for varying the extent of movement of the register-train, substantially as set forth.

7. In an electric meter, the combination with an oscillating chrono-electric motor comprising a pendulum, an operating-solenoid and a circuit-breaker, of a register-train driven by said motor during the swing of the pendulum in one direction and for a part only of the entire swing of the pendulum in that direction, a current-indicator, and a cam adjusted by said current-indicator for varying the extent of movement of the register-train, substantially as set forth.

8. In an electric meter, wherein a controlling-cam adjusted by the current limits the extent to which an electric motor intermittently moves a register-train, a circuit controlled by said cam for withdrawing the current from said motor when the limit of motion for which said cam is adjusted is reached, substantially as set forth.

9. In an electric meter, the combination with a current-indicator and a controlling-cam moved thereby, of an oscillating electric motor, a register-train moved intermittently by said motor to an extent regulated at each movement by the position of said controlling-cam, and a shunt around said electric motor closed by contact between said controlling-cam and the part of the motor which engages therewith, substantially as set forth.

10. In an electric meter, the combination with a current-indicator and a controlling-cam moved thereby, of a motor, a limiting-stop flexibly connected with the motor and moved thereby and engaging said controlling-cam, and a register-train connected with said limiting-stop and receiving an intermittent movement from the motor through said stop, whereby the register will be moved intermittently to an extent regulated at each move-

ment by said controlling-cam independently of the excess of movement which the motor may have, substantially as set forth.

11. In an electric meter, the combination with a current-indicator and a controlling-cam moved thereby, of an oscillating electric motor, a limiting-stop flexibly connected with said motor and moved thereby and engaging with said controlling-cam, a register-train, and a register-operating device rigidly connected with said limiting-stop, and a shunt for the motor closed by the contact of said cam and limiting-stop, substantially as set forth.

12. The combination with a current-indicator and controlling-cam moved thereby, of a chrono-electric motor comprising a pendulum, an operating-solenoid, pendulum and floating contacts, and cut-out contacts cooperating with the controlling-cam, and a register-train moved intermittently by said motor to an extent regulated at each movement by the position of said controlling-cam, substantially as set forth.

13. In an electric meter having one or more oscillating shafts, the combination, with such shafts, of rocking arms carrying said shafts and constituting antifriction-bearings therefor, substantially as set forth.

14. In an electric meter, the combination with a register-train, of a shaft for intermittently driving said train, a sleeve on said shaft, a motor for actuating said sleeve, and a flexible connection between said sleeve and shaft, substantially as set forth.

15. In an electric meter, the combination with a register-train, of a shaft for intermittently driving said train, a clutch connecting said shaft with said train, a sleeve on said shaft, a motor for actuating said sleeve, and a flexible connection between said sleeve and shaft, substantially as set forth.

This specification signed and witnessed this 21st day of November, 1894.

CHARLES WIRT.

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