(No Model.)

2 Sheets—Sheet 1.

A. G. WATERHOUSE.

ELECTRIC METER.

No. 562,680. Patented June 23, 1896.

Fig. 1.

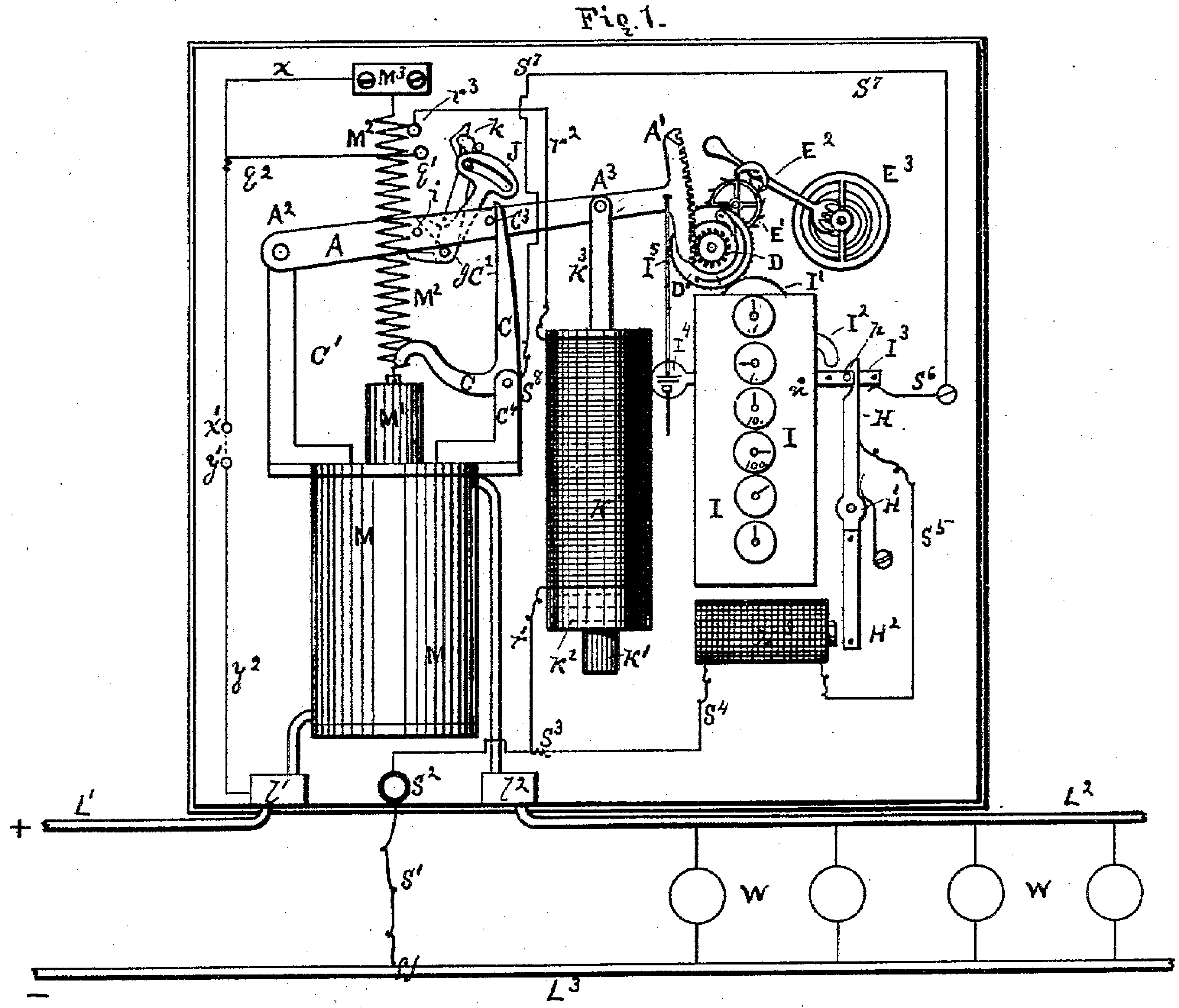
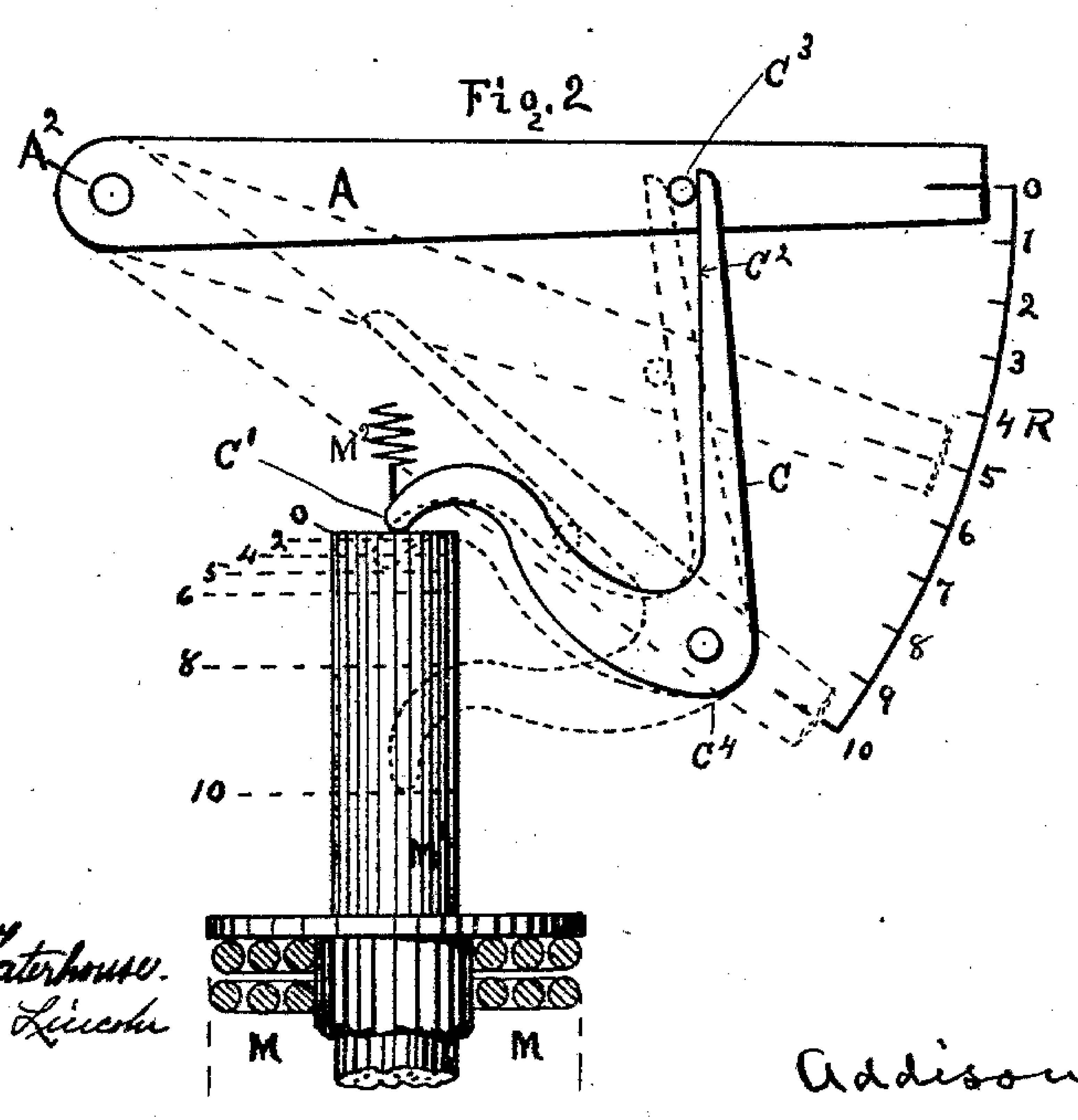


Fig. 2



Witnesses,
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Brooks H. Lincoln

Inventor.
Addison G. Waterhouse

(No Model.) 2 Sheets—Sheet 2.

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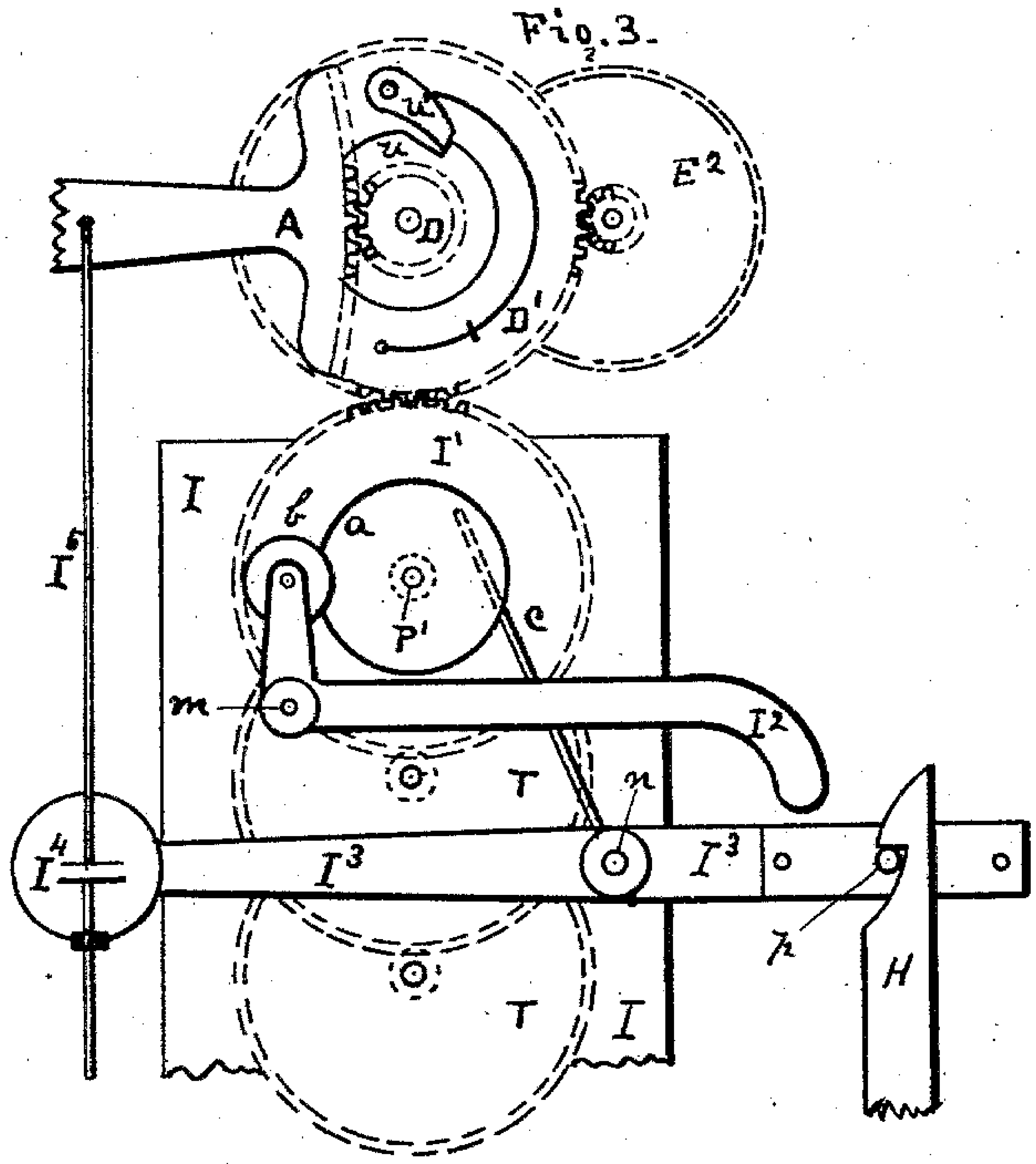

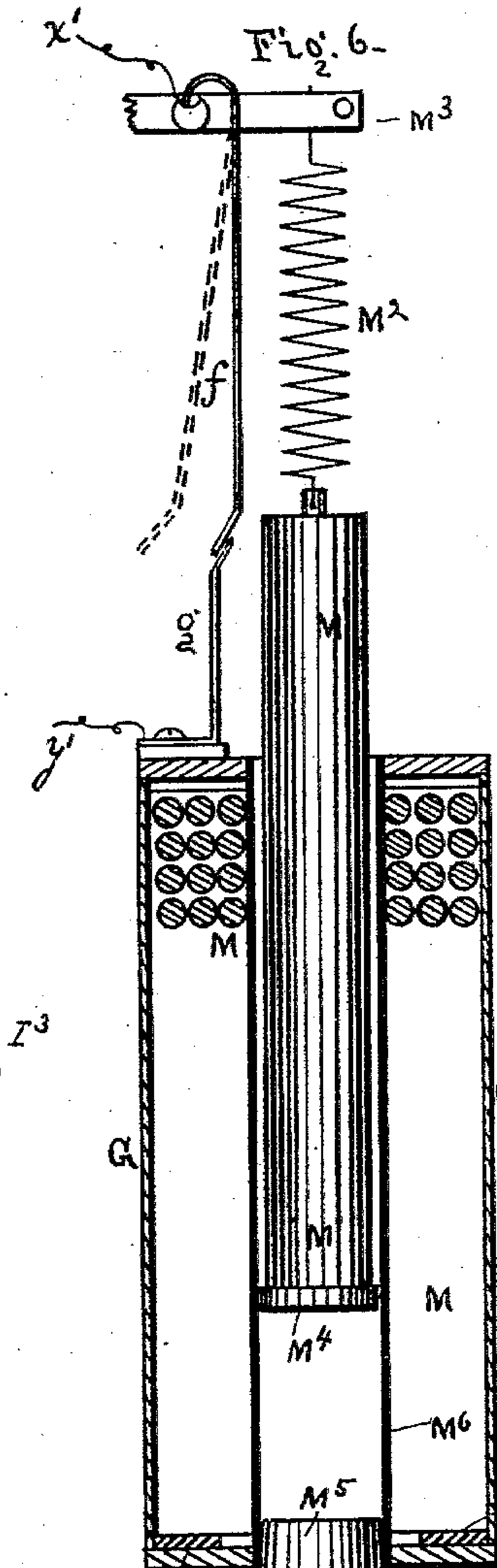

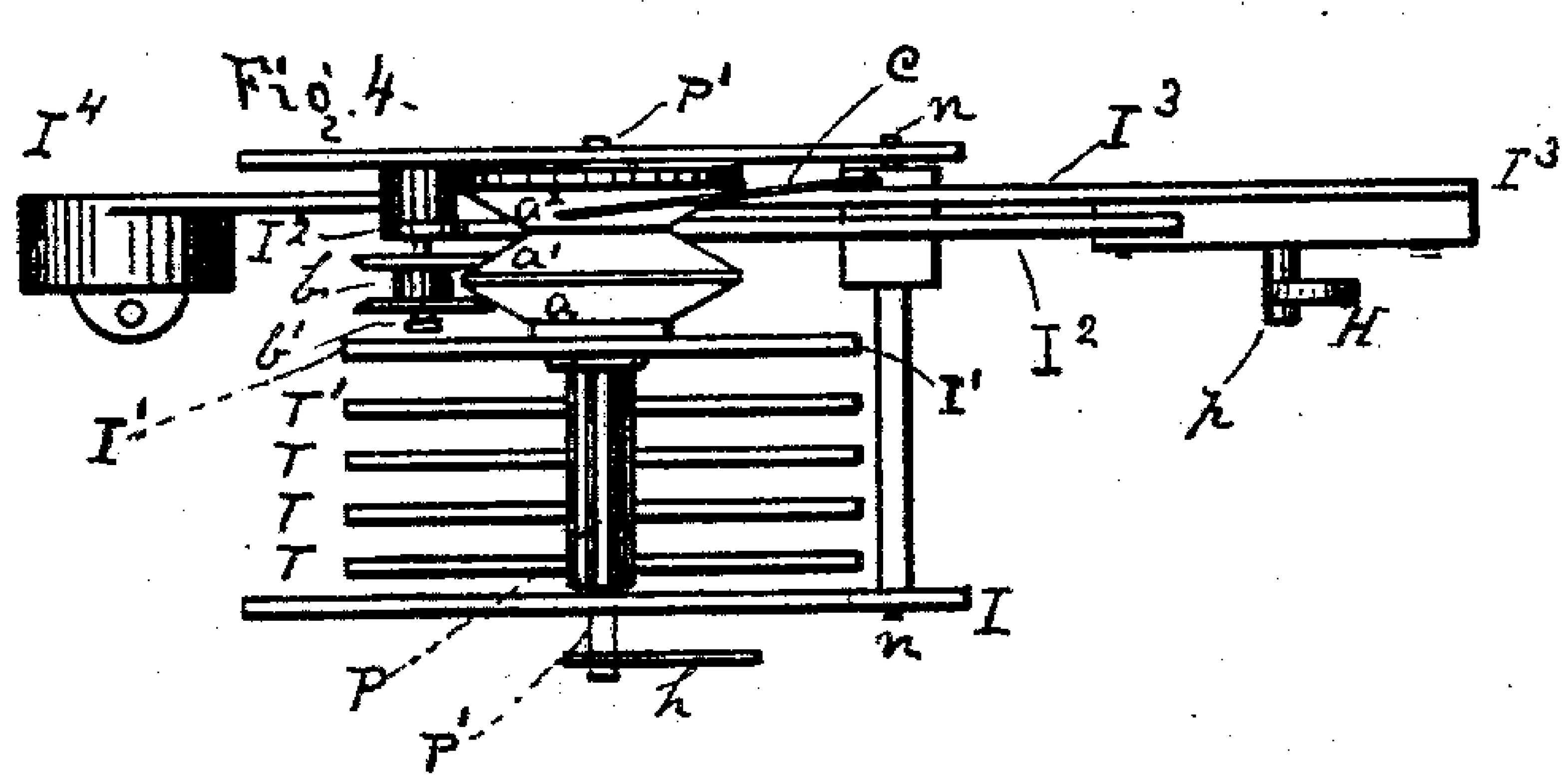

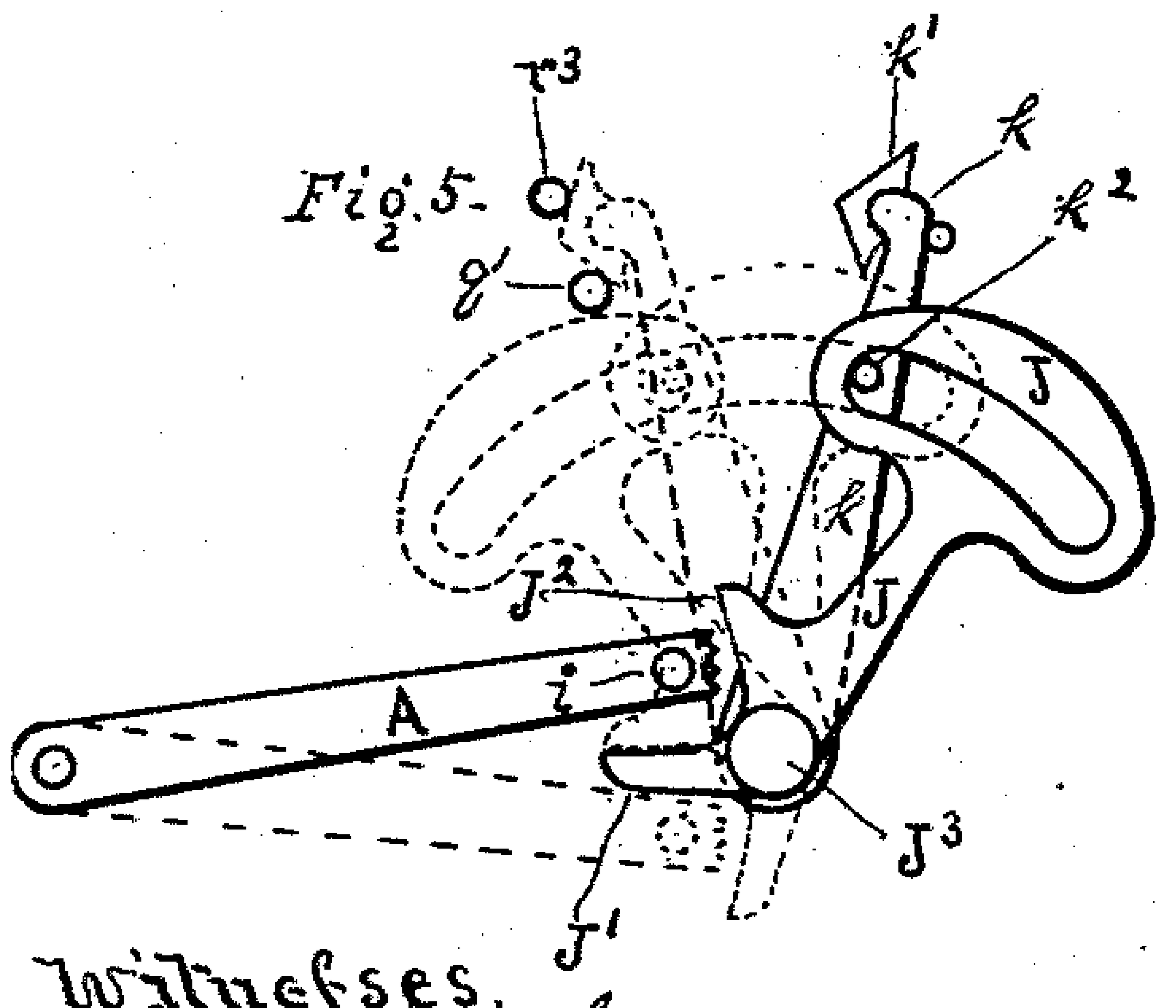

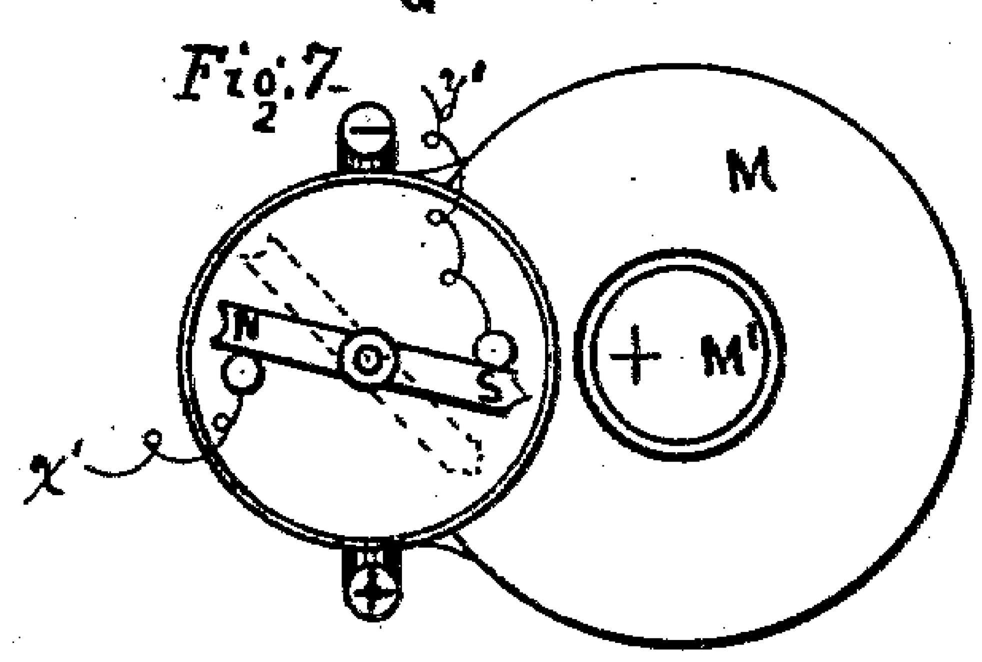

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UNITED STATES PATENT OFFICE.

ADDISON G. WATERHOUSE, OF HARTFORD, CONNECTICUT.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 562,680, dated June 23, 1896.

Application filed March 25, 1895. Serial No. 543,179. (No model.)

To all whom it may concern:

Be it known that I, ADDISON G. WATERHOUSE, a citizen of the United States, residing at the city of Hartford, in the State of Connecticut, have invented new and useful Improvements in Electric Meters, of which the following is a specification.

My invention relates to that class of meters known as "electric-current meters," used for indicating the amount of electrical energy consumed during any period of time; and it consists of the combination of three essential parts, which are an ammeter for measuring the volume of current, a time mechanism for causing equal periodical actions, and a registering device for periodically recording the readings of the ammeter and registering the sum of such readings.

Figure 1 shows all the parts of the meter with the electrical connections thereto. Fig. 2 is a diagram showing a means for compensation for the unequal movement of an armature due to the different volumes of current. Fig. 3 is a detail showing part of the registering or recording mechanism. Fig. 4 is a plan of parts of Fig. 3. Fig. 5 is a detail of an electric switch or circuit-breaker. Fig. 6 is a sectional view of an electromagnet with other details. Fig. 7 shows a device for making and breaking a circuit.

Referring to the drawings, Fig. 1 shows the ammeter formed by the main solenoid M, formed by part of the main current-conductors L′ L^2, which extends to and from the binding-posts l' l^2. This solenoid M draws the armature M′ downward, while the suspending spring M^2, which is supported by the lug M^3, holds it up, so that more or less current passing through the solenoid M will cause the armature M′ to assume different positions, which will not be in direct proportion to the volume of the passing current, nor to the square root of the current, but owing to the effect of magnetic saturation of the armature M′ its movements will only approximately correspond to the square root of the current and produce a movement to the armature which will bear an irregular proportion to the volume of the passing current, so the mechanism of this meter is adapted for causing the irregular movements of the armature M′ to impart a movement to a register which will exactly correspond to the volume of the current without encumbering the motion of the armature M′ with any mechanism whatever. This I accomplish as follows: The arm A, which is pivoted at A^2, is provided at its moving end with a toothed segment A′, the teeth of which mesh into a pinion D. This pinion carries a toothed wheel D′, which is ratcheted to the pinion D, so as to rotate D′ only in the direction the pinion is turned while it is rotated by the downward motion of the segment A′, which is caused by gravitation.

The wheel D meshes into a pinion of the escapement-wheel E′, which in turn drives the lever E^2 and balance-wheel E^3. This escapement acts as a time or retarding mechanism, which not only causes the slow descent of segment A′, but causes its descent to be performed during an exact space of time, so that when A has moved down, and is instantly lifted, it will again resume its descent for the same space of time, which will be repeated. In this case we assume it runs down every six minutes and is lifted every time, so that it makes ten strokes per hour. The work of lifting the segmental arm A is performed by the magnet K, which is energized by a derived-circuit current, which extends from the negative main L^3 to the binder S^2, then on wire r' to magnet K, then on wire r^2 to point r^3, then from r^3 to point q', and on wires q^2 and y^2 to binder l', which is part of the positive main. Normally this circuit is broken between the points r^3 and q', but when the arm A has swung down its pin i strikes the arms of the hammer J and causes it to slowly swing to a perpendicular position and then drop over to the left. This will pull the switch k over and close the circuit between r^3 and q'. This starts the current, draws up armature K′, and through the link K^3 raises the arm A, when the pin i tips the hammer J and it draws the switch k back and breaks the circuit between r^3 and q', when the arm A, assisted by the weight of the armature K′, again descends as fast as the time-escapement E will allow it. The driving-wheel D′, which drives the escapement E, also meshes into one of the register-wheels I′ and causes it to rotate one way. This wheel I′, while connected to the train of wheels in the register I, would carry them forward; but it is arranged so that it is connected part of the time, and that part depends upon the position of the armature M′, which is controlled by the strength of the main-circuit current. The wheel I′ is connected to the train in I when the arm A is raised, and remains connected from the beginning of its descent until the finger C′ of the compensating angle C touches the top of the armature M′, and this period is prolonged or shortened by the position of M′, which is regulated by the volume of current passing through the solenoid M. The means employed for connecting and disconnecting the wheel I′ to or from the register-train in I consists of the magnet H^3, the electrical connections of which are those of the derived circuit leading from the negative wire L^3 to the binder S^2, then via wire S^3 and S^4 to magnet H^3, then on wire S^5 to hook H, through pin p, lever I^3, spring S^6, wire S^7 to the pivoted compensator C. When the C′ end of C touches the armature M′, the circuit is continued up through spring M^2, lug M^3, wire x via x' and y', and on wire y^2 to the binder l' at the positive main. As soon as this circuit is formed by the compensating angle C touching the armature M′ it is instantly broken by the magnet H^3 drawing up the armature H^2 and unhooking the lever I^3, which also disconnect sthe register-train in I from the wheel I′. The mechanical means for performing this work will be shown hereinafter.

The movement of the compensating angle C, which is pivoted at C^4, is caused by the pin C^3 and the arm A sliding down the edge of its upright arm and causing its finger C′ to swing down with an irregular motion which depends upon the angle or form of the edge of its upright arm against which the pin C^3 in A slides, and this irregular motion is made so as to compensate, or correct the irregular motion of the armature M′, and make the movements of arm A while passing equal parts of its motion, correspond with the equal changes in the volume of current, which causes unequal movements to the armature M′. To illustrate the action of the compensator C and the motion of the armature M′, I will refer to Fig. 2, which is a detail of part of Fig. 1, and shows like parts by like letters. The various positions of compensator C, as related to the movement of the segmental arm A and the various positions of the armature M′, as related to the volume of current to be measured, and which actuates it, are shown in dot lines.

The positions of armature M′ are shown in dot lines, with the volume of current required to draw the armature to each position marked in amperes. It will be seen that the movement of two amperes is very small, and that the motion of one, or a part of one, ampere would be too small to be used for any direct registering purposes, while the two amperes added to eight make a very extensive movement from "8" to "10," so that the proportion of motion produced in M′, and due to equal increments of current, is irregular and not adapted for registering purposes. To convert this irregularity to a symmetrical form, by means of a cam movement worked by the movement of M′ is impractical, owing to the friction of such mechanism encumbering its movements, and the fact that its movements due to the minimum current to be measured would be too small for any practical purpose. To overcome this objection, I work the register by means of the arm A, as described. As the arm A moves down through equal spaces it advances the register, as shown by the numbers at R, which indicate one, two, three, &c., amperes. This reading stops as soon as C touches the armature M′. Now the motion of C is imparted from A and is irregular, that is, while A moves from "0" to "1" or part of that distance, the motion of C would be exceedingly small, while the motion of A from "8" to "10" would cause a comparatively rapid motion of C, so in this way the irregular effect of equal increments of current upon the armature M′ is compensated for by the irregular motion of the compensator C in a way that would cause the movement of arm A to advance the register in a direct proportion to the volume of current which actuates armature M′, and not encumber the movement of the armature in any way whatever. This effect may be produced by either locating the pivoted position of C in its relation to the curve described by the pin C^3 in the arm A or by shaping the edge C^2 of C or both.

Fig. 3 is a detail of the register marked I in Fig. 1, and shows part of the segmental arm A, also the driving-wheel D′ with its pinion D connected to the wheel by the ratchet u and pawl u'. Wheel D′ meshes into wheel I′ and rotates it one way. Wheel I′ is free to revolve on spindle P′ without rotating the register-train of wheels T T, &c., except when the lever I^3 is held down by the hook H. Then the weight of the lever I^2 forces the roller b against clutch-cones a and causes the train to rotate with the wheel I′. When the weight I^4 drops, it raises the lever at I^3 and also the lever I^2. This takes the pressure of roller b from the cones, so as to liberate the wheel I′ from the train T T, &c., and at the same time swings the friction-wire c against one of the cones that stops the motion of the train T T, &c.

Fig. 4 is a plan of Fig. 3, which shows wheel I′ with its attached cone a. These are free to revolve on the spindle P′. The double cone a' a^2 are of one piece, and rigidly attached to spindle P′, which is part of the pinion P, that drives the train T T, &c. When the wheel b is pressed against the cones a and a', it forces them together and causes wheel I′ to move the train. When wheel b is separated from these cones, the train stops, and to make the stop sure, the same motion that lifts the wheel b from the cones also presses the wire-brake against the cone *a*, which stops the train, and also separates cone *a'* from the revolving cone *a*.

Fig. 5 is an enlarged detail of part of Fig. 1, showing the switch, which is worked by the arm A, and is used to work the electromagnet K, that raises the arm A after it has run down.

Fig. 6 is a detail of the ammeter or main-current magnet, showing the solenoid M, movable armature M', lifting-spring M^2, supports or lug M^3. The lower part of M' has a plunger M^4, which fits closely in the tube M^6 of the solenoid M, the lower part of which is closed by a stopper M^5, so that an air dash-pot is formed which makes the movement of the armature dead-beat. Outside of the wire of the solenoid M is placed a cylinder or wrapping of iron G, which offers a path for the outside lines of force, and increases the strength of the magnet very much. To still further increase its strength, the iron may be extended partly in at the ends, as at G, but in practice I only use the cover G.

In some meters where a derived-circuit current is used, it is best to have such derived circuit broken, when the meter is not in active use. To do so, the minimum motion of the armature, worked by the main current, is employed; but this means is objectionable, owing to the very slight motion produced by the minimum current to be measured, as shown in Fig. 2. To avoid this objection, I use a more delicate mechanism, such as the swinging iron wire or plate *f*, which is drawn by the slight magnetism in M', so as to contact with *g* and complete the circuit between *x'* and *y'*, as shown in Fig. 1, and which allows this circuit to be broken as soon as the magnetism in M' dies out.

Fig. 7 shows another means for causing the smallest current to be measured by the meter, to make and break the derived circuit, by means of a compass-needle or swinging magnet, (marked N S.) There is a small stationary magnet (marked + and −) which keeps the needle N S from the contact-points *x' y'*, but as soon as a slight magnetism is produced in the movable armature M' the needle is drawn so as to connect the points *x'* and *y'* and complete the derived circuit. I know that heretofore meters have been made in which the movement of the main-current armature has been used to work a cam, or a mechanism which would allow an advanced movement of the register, which would to some degree correspond with the volume of the main current, but this means is objectionable, as set forth. In case this meter is to be used upon an alternating-circuit current, the armatures therein must be made of laminated iron or wire, and where brass parts are used in which local currents would be produced such must be suitably slotted and insulated.

What I claim as my invention is—

1. In an electric meter, the combination of an ammeter having a movable part, a compensator having a periodical movement from a zero position through a distance regulated by the position of the movable part of the ammeter, a time mechanism for producing periodical movements to the compensator driven by the movable part of an electro magnet or motor, a registering device driven by or with the time mechanism and a separate electric circuit formed by the contact between said compensator and the movable part of the ammeter for controlling the movement of said registering device, substantially as and for the purposes set forth.

2. In an electric meter, the combination of an ammeter having a movable part, the motion of which will vary with the different increments of current, a movable compensator having a variable movement which will correspond with and be regulated by the movable part of said ammeter and an intermittently-operating registering device regulated by a separate electric current in a circuit formed by a contact between said compensator and the movable part of the ammeter, substantially as set forth.

3. In an electric meter the combination of an ammeter having a movable part actuated by the electric current to be measured and a compensator and registering device worked by one or more derived-circuit currents, substantially as and for the purposes set forth.

4. In an electric meter an ammeter worked by the current to be measured an intermittently-acting registering device worked by a force independent of the motion of the ammeter, a compensator worked by a force independent of the movement of the ammeter and a separate electric circuit formed by the contact between said ammeter and compensator for controlling the movement of said registering device substantially as described.

5. In an electric meter, the combination of a current-indicator, having a movable part, the position of which is determined by the current to be measured, an intermittently-formed derived, or separate circuit, having a current during periods regulated by the position of the movable part of said indicator, and a registering mechanism acted upon or controlled by said intermittent current, substantially as and for the purposes set forth.

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Witnesses:

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BROOKS M. LINCOLN.