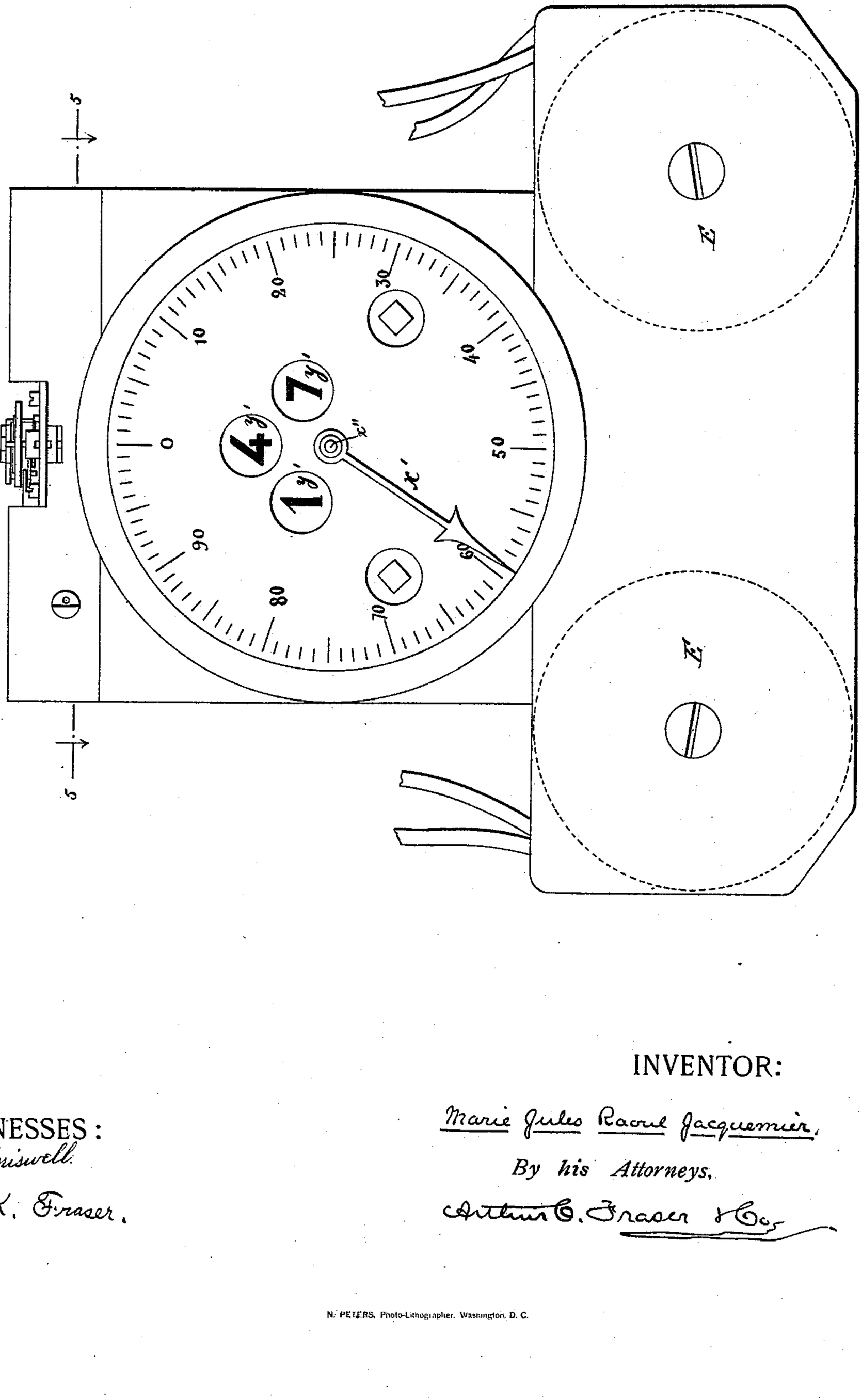
(No Model.) 7 Sheets—Sheet 1.

M. J. R. JACQUEMIER.

ELECTRIC METER.

No. 396,403. Patented Jan. 22, 1889.



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(No Model.) 7 Sheets—Sheet 2.

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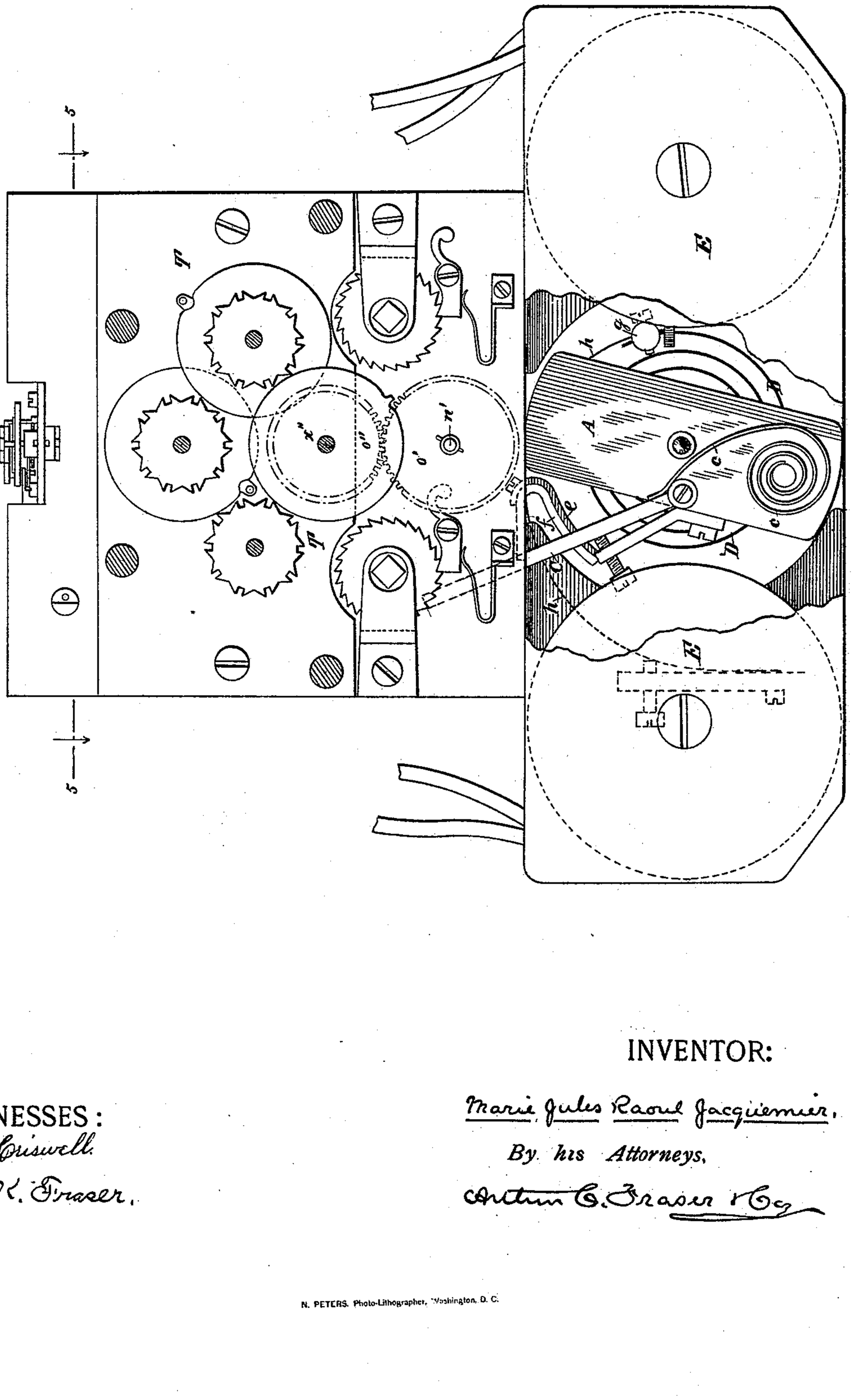
Fig. 2



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(No Model.) 7 Sheets—Sheet 3.

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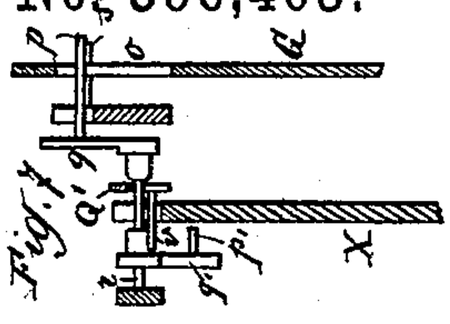

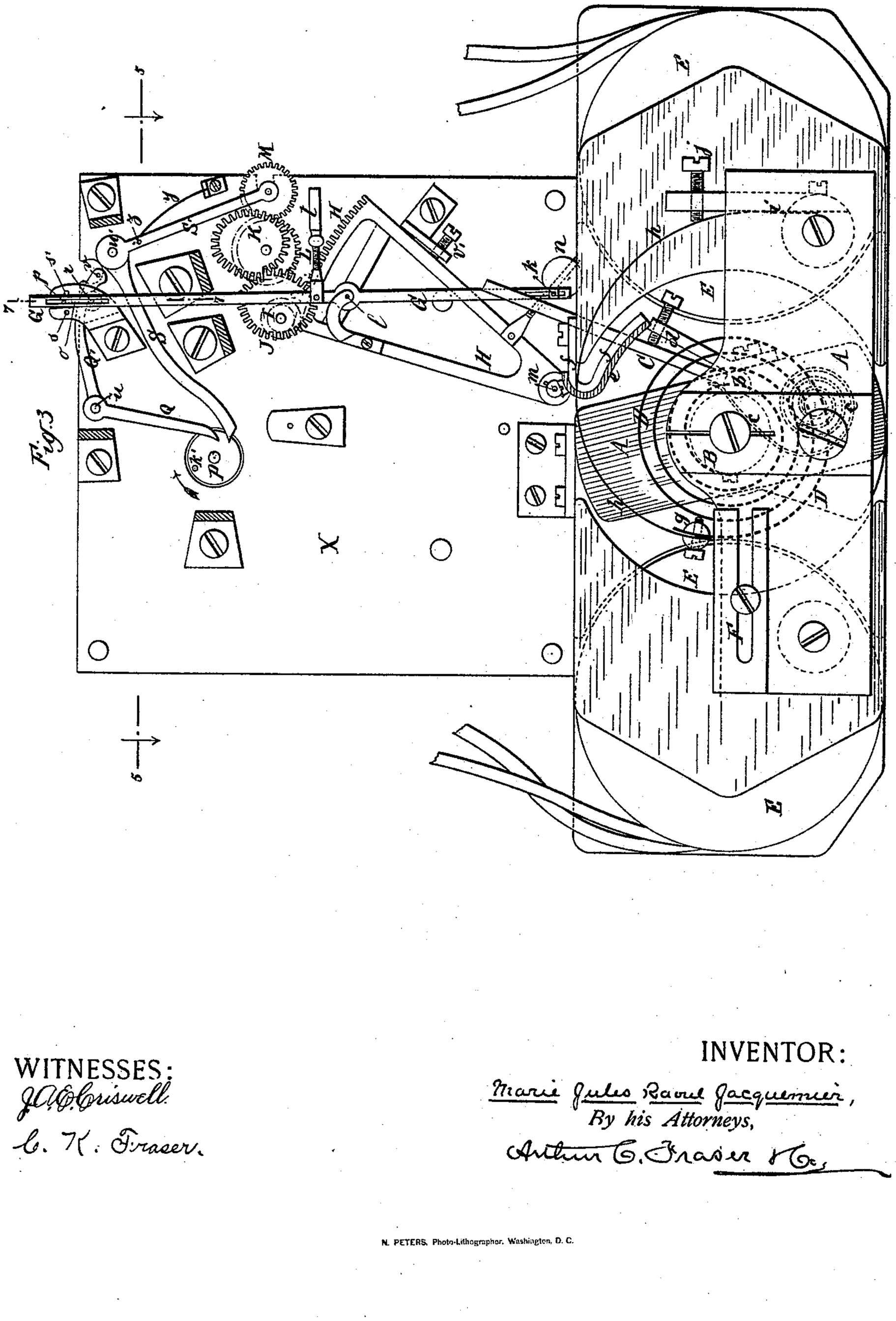

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(No Model.) 7 Sheets—Sheet 4.

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ELECTRIC METER.

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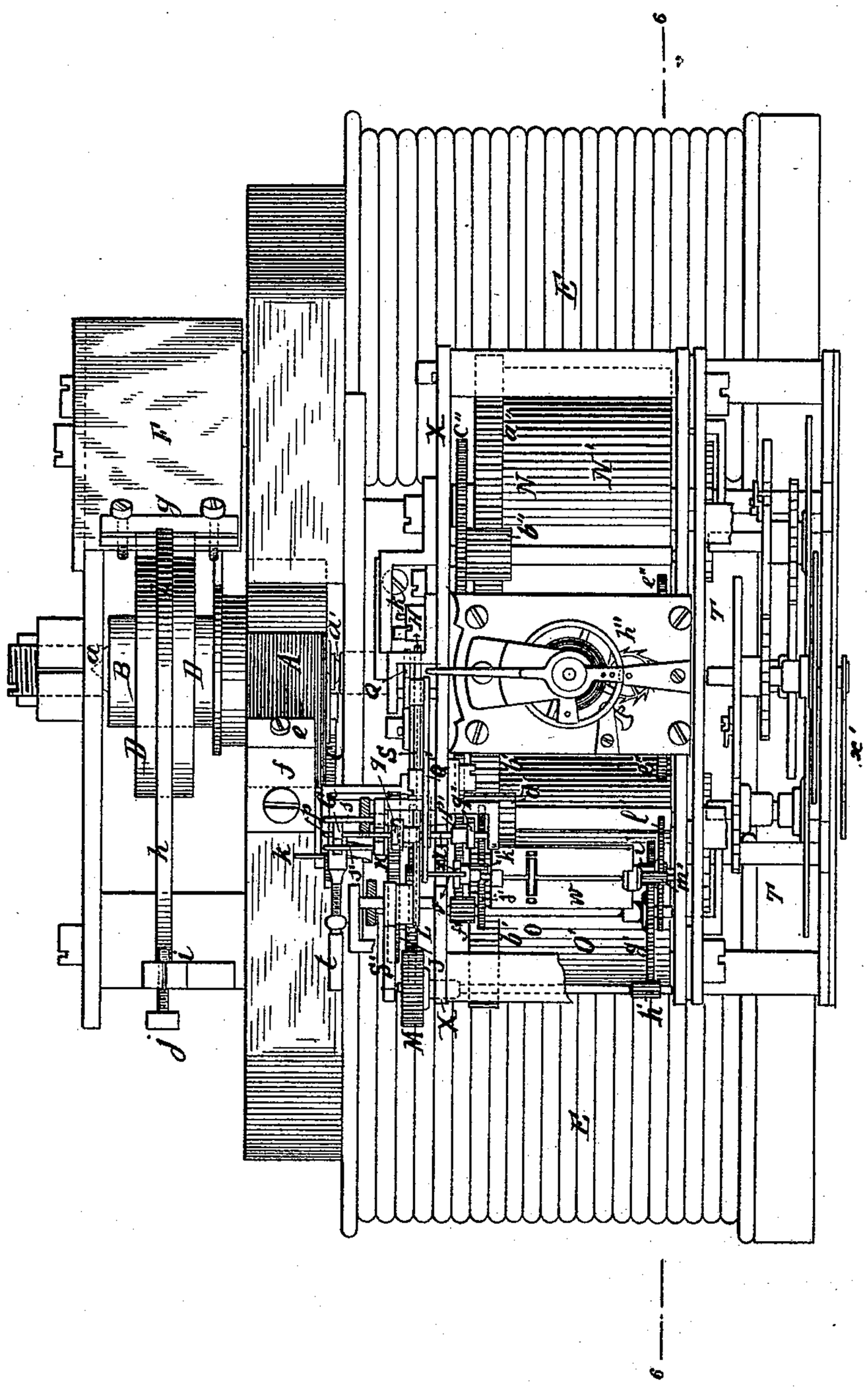
Fig. 4



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(No Model.) 7 Sheets—Sheet 5.

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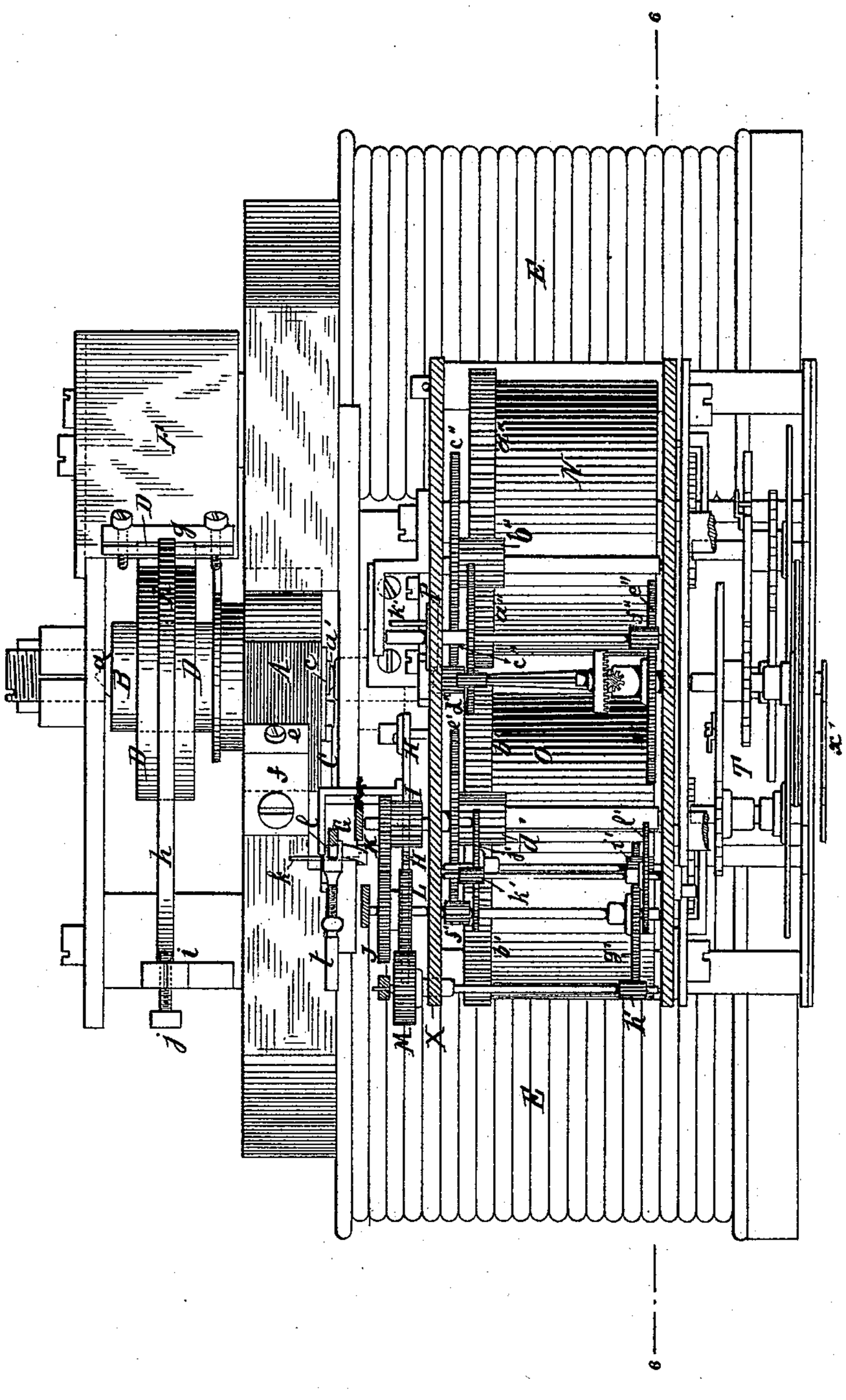
Fig. 5



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(No Model.) 7 Sheets—Sheet 6.

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ELECTRIC METER.

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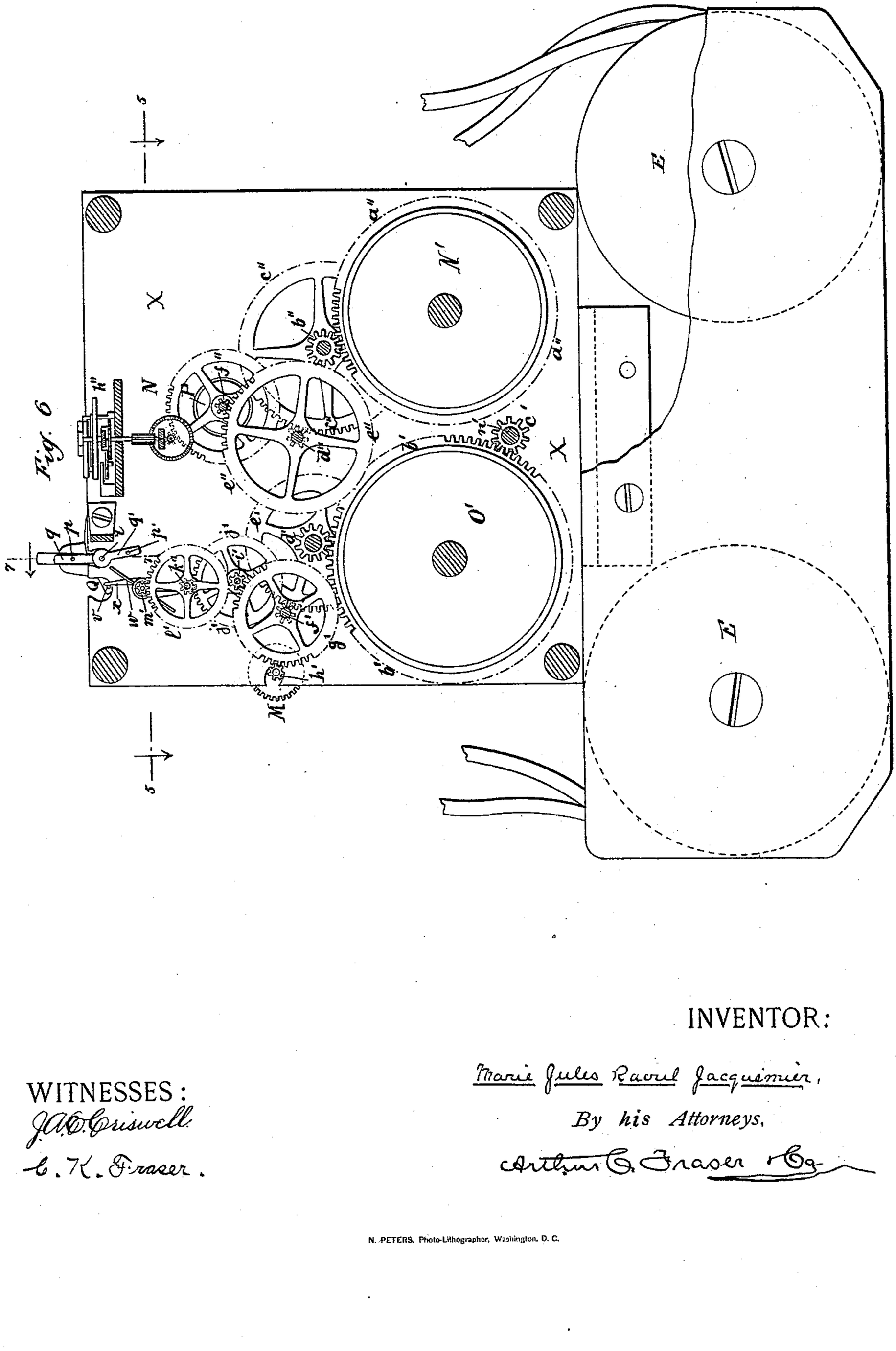
Fig. 6



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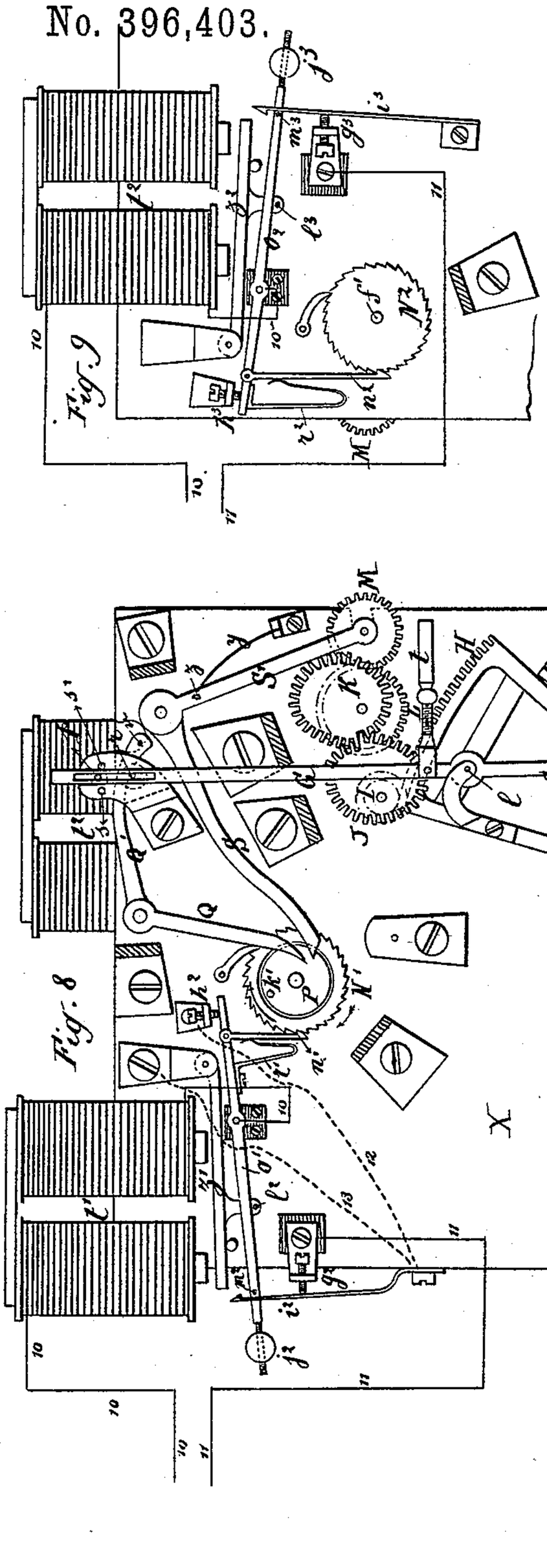

Fig. 9

Fig. 8

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UNITED STATES PATENT OFFICE.

MARIE JULES RAOUL JACQUEMIER, OF PARIS, FRANCE.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 396,403, dated January 22, 1889.

Application filed August 20, 1888. Serial No. 283,172. (No model.) Patented in France April 12, 1887, No. 182,820; in England October 19, 1887, No. 14,226; in Germany October 22, 1887, No. 45,422; in Belgium October 24, 1887, No. 79,297, and in Italy November 26, 1887, XVI, 22.688, XLIV, 490.

To all whom it may concern:

Be it known that I, MARIE JULES RAOUL JACQUEMIER, a citizen of the Republic of France, residing in Paris, France, have invented certain new and useful Improvements in Electric Meters, of which the following is a specification.

This invention has been patented in the following countries, viz: France, by Patent No. 182,820, dated April 12, 1887, and a patent of addition thereto dated December 27, 1887; Great Britain, No. 14,226, dated October 19, 1887; Germany, No. 45,422, dated October 22, 1887; Belgium, No. 79,297, dated October 24, 1887, and Italy, No. 22,688, Vol. XVI, and No. 490, Vol. XLIV, dated November 26, 1887.

This invention relates to that class of electric meters which operate on the principle of automatically taking the reading of an ammeter at stated intervals of time and mechanically adding the successive readings together by means of a registering or totalizing mechanism. Such meters involve, essentially, the following parts, viz: First, an ammeter consisting of an electro-motive device—such, for example, as an electro-magnet or solenoid—the movable member of which is displaced in accordance with the variations of the electric current acting upon it; second, a movable part or detector for taking the ammeter-readings adapted to move from its initial position and to be stopped after moving a greater or less distance, proportional to the varying displacement of said electro-motive device; third, a clock-work adapted at successive and equal intervals of time to set in motion said moving part or detector; fourth, and registering mechanism for recording the extent of the movement of the said moving part or detector. This registering mechanism is any kind of counting or adding mechanism or totalizer adapted to add together the successive movements of said moving part or detector, and to indicate the same on one or several dials, so that an inspection thereof will show the total quantity of electric energy expended at any time.

My invention in its preferred construction is designed to operate under the following conditions: At regular intervals of time a movable part or detector undergoes a displacement depending on the intensity of the current which is passing in the circuit, and consequently in the coils of the electro-magnet or ammeter. To each displacement of this movable part or detector corresponds an advance of the wheel-work of the totalizer, which advancement is proportional to the intensity of the current. The graduations of the totalizer are such as to indicate the quantity of electricity expended during the successive and uniform intervals of time at which the totalizer is set in movement. The organs which permit the aforesaid totalizer to undergo an advancement, which should be at each moment proportional to the intensity of the electric current to be measured, consist on the one part of an arm connected to the armature of the electro-magnet, and against which is moved the detector constructed, preferably, as an oscillating balance-lever, and on the other part of a system of two gear-wheels interposed between the wheel-work which actuates the totalizer and the part which causes the said balance-lever to advance toward the armature-arm. The particular characteristic of this device is that these two intermeshing-wheels are not circular, but their contour is calculated in such manner that the angular displacement of the gear-wheel which actuates the totalizer from its initial position until the arrival of the detector-lever in contact with the armature-arm is proportional to the intensity of the current.

Having thus explained the principal of my system, I will proceed to describe the construction of my electric meter with reference to the annexed drawings, wherein—

Figure 1 is a front elevation of the apparatus. Fig. 2 is a front view partially in section, the dial being removed. Fig. 3 is a rear elevation, partly in vertical section. Fig. 4 is a plan. Fig. 5 is a horizontal section on the line 5 5 in Figs. 1, 2, 3, and 6. Fig. 6 is an elevation looking from the front, partly in vertical section on the line 6 6 in Figs. 4 and 5. Fig. 7 is a fragmentary transverse section cut on the line 7 7 in Figs. 3 and 6. Fig. 8 is a rear sectional elevation corresponding to Fig. 3, showing a modified construction. Fig.

9 is a fragmentary front elevation, partly in vertical section, of the construction shown in Fig. 8.

I will first describe the construction shown in Figs. 1 to 7, inclusive.

The electro-motive device or ammeter, which is acted upon by the electric current, consists in this instance of an electro-magnet, E E, between the poles of which is arranged the armature A, of which the axial spindle B is rotatively mounted between conical points *a a'*, Figs. 4 and 5. This armature carries an arm, C, mounted on the spindle B, drawn by a spring, *c*, to rest against a stop, *d*, consisting of an adjustable screw. The armature, when unattracted, rests against a stop, *f*, which is covered with a cushion, *e*, of india-rubber, cloth, cork, or felt, which serves to soften the shock when the armature strikes the stop.

Around the spindle B is coiled a spiral spring, D, of which the inner end is fixed to said spindle, while its outer end is designed to serve as an abutment, in order that the spring shall be wound up more or less in proportion as the armature A is more or less attracted. In order that the apparatus may be very sensitive as well to very feeble currents as to those which strongly displace the armature A, the outer end of the spring D is attached to a cross-piece, *g*, which, when the parts are at rest, is slightly above the metallic support F. To this cross-piece *g* is attached a light spring, *h*, the other extremity of which is fixed at *i*. The regulating-screw *j* permits of the adjustment of the tension of this light spring *h*. When a current passes in the coils of the electro-magnet E, the armature A is deflected toward the left in Fig. 3. If its deflection is slight, it is resisted by the light spring *h*, which acts until the deflection becomes sufficient to draw the cross-piece *g* into contact with the support F. From this instant the heavy spring D becomes the retractile device, which opposes the displacement of the armature A and its arm C.

The moving part or detector, which follows the armature at intervals and is stopped in positions proportional to the deflection thereof, consists of a balance-lever, G, Fig. 3, which carries at its lower part a pin, *k*, designed to encounter the arm C of the armature. This detector-lever G is pivoted at *l* to a toothed sector, H, which is pivoted at *m*, and is provided with a counterpoise, *n*, which tends always to restore it to its initial position, which is the one shown in Fig. 3, whenever it has been thrown over by the mechanism, which will hereinafter be described. The upper end of the detector-lever G is formed with a slot, *o*, into which projects a pin, *p*. This pin is fixed, as shown in Figs. 3, 6, and 7, on an arm, *q*, carried on an axis, *r*, which axis also carries on the front side of the plate X another arm, *q'*, projecting downward and provided with a pin, *p'*, the function of which will be explained presently. Furthermore, the upper end of the detector-lever G is free to vibrate between two fixed pins, *s s'*, and it is also provided with a little counter-weight, *t*, which normally draws its upper end against the right-hand pin, *s'*, Fig. 3. It results from this that the pin *p* and arm *q* are drawn toward the right, while the pin *p'* and the arm *q'* are moved toward the left. The toothed sector H gears with the pinion I, Figs. 3 and 5, formed solidly with a non-circular gear-wheel, J, which meshes with a second non-circular gear-wheel, K, the latter being fixed solidly to a pinion, L, which meshes with a gear, M.

The apparatus comprises two clock-work mechanisms, N and O. The first, which may be called the "timing" clock-work, is driven from a spring-barrel, N', Fig. 6, and acts at equal and regular intervals of time—for example, every five minutes—to effect a disengagement of the other clock-work. This second clock-work, driven from a spring-barrel, O', is designed to cause the wheel-work of the totalizer to advance at each disengagement produced by the timing clock-work. The clock-work O drives the arbor of the wheel M through the medium of the spring-barrel O' and gears *d'*, *e'*, *f'*, *g'*, and *h'*, as shown in Fig. 6. This clock-work terminates through wheels *g'*, *i'*, *j'*, *k''*, *l'*, and *m'* in the flier *w*, for limiting its speed, this flier having a finger, *x*, on its arbor. The clock-work O is normally restrained by a pin, *v*, which holds this finger *x*. The clock-work N consists, as shown in Fig. 6, of the spring-barrel N' and wheels *b''*, *c''*, *d''*, *e''*, and *f''*, driving the arbor of a cam-disk, P. The speed of this clock-work is governed by an escapement, *h''*, like any clock or watch movement.

The totalizer T is driven from the clock-work O by a pinion, *c'*, Fig. 6, meshing with the barrel O', and which transmits motion through a spindle, *n'*, and gears *o'* and *o''*, Fig. 2, to the axis *x''* of the index *x'*, Fig. 1, and to the adding-wheels of the counter. The totalizer presents no particular novelty, the index *x'* indicating on the dial the units of ampère hours up to one hundred at one turn, and openings or windows *y' y'*, rendering visible the figures on the counter-disks indicating the hundreds, thousands, and tens of thousands.

The cam-disk P, already referred to, is designed, as shown in Fig. 3, to act successively by means of a pin or cam projection, *k'*, on two levers, Q and S. The lever Q, pivoted at *u*, carries on the end of its arm Q' a pin, *v*, destined in the normal position of rest to restrain the finger *x* on the axis of the flier *w* of the second clock-work mechanism, O. The other lever, S, pivoted at *u'*, carries on its arm S' the rear end of the arbor of the gear-wheel M. A little spring, *y*, pressing against a pin, *z*, on the arm S', tends to hold the wheel M in mesh with the wheel L.

I will now explain the operation of my apparatus.

While at rest at any time between two suc-

cessive disengagements by the cam-disk P the cam projection k' of this disk, which is turning in the direction of the arrow, Fig. 3, does not touch either of the levers Q or S. The totalizer is held stationary by the pin v of the arm Q′, which restrains the finger x of the flier w of the wheel-work O. The pin p' on the arm q' is pressed toward the left, while the upper extremity of the detector-lever G is pressed toward the right against the fixed pin s'. The wheel M meshes with the wheel L and the toothed sector H rests against its adjustable stop-screw v'. Let us suppose that the moment of disengagement has arrived. The pin k' strikes the lever Q, and thereby lifts the arm Q′ and its pin v. The flier w is thus set free, and the wheel-work O is set in movement. The wheel M, being turned thereby, turns the pinion L. The non-circular gear K turning therewith drives the other non-circular wheel, J, which turns the pinion I, and this latter, being geared with the sector H, moves the latter to the left in Fig. 3. In this movement the axis l of the detector-lever G is carried to the left, and this lever, turning then around its upper end, being continually pressed against the right-hand pin, s', by means of its counter-weight t, the pin k at its lower end is thereby moved toward the arm C of the armature of the electro-magnet. As soon as the pin k strikes the arm C the detector-lever G finds thereby a resistance opposed to its lower end, and its axis l continuing its displacement toward the left with the sector H the upper end of the lever G is moved toward the left, thereby leaving the pin s' and coming against the pin s. At the same time it presses the pin p and the arm q toward the left, so that the pin p' and arm q' are moved toward the right. This pin p' (see Fig. 6) is thereby moved into the path of the finger x of the flier w, which it arrests, thereby instantly stopping the wheel-work O, and consequently the totalizer. The wheel-work O has thus been running down as long as the detector-lever G has not yet reached the arm C—that is to say, it has made more or less turns, according as the arm C is more or less drawn over, or, in other words, in proportion as the armature is more or less attracted by reason of the passage through the electro-magnet of a current of greater or less energy. The movement of the wheel-work O has acted on the totalizer T through the intermediation of the pinion c', and the totalizer has consequently been advanced. Continuing now to consider the operation of the pin k' on the cam-disk P, we see that after having passed the lever Q, which falls back of its own weight, it comes to act against the lever S, thereby displacing its arm S′ and the gear M until the latter is moved out of mesh with the gear L. Thereupon the wheels J and K and the sector H, as also the detector-lever G, being no longer held, since the spring of the wheel-work O no longer tends to press them forward, the whole system returns to its position of rest, as in Fig. 3, being impelled by the counter-weight n. It is then ready to undergo a new movement, when the pin k' shall again cause its action to be recommenced. As already stated, the shape of the wheels J and K is calculated in such manner that the angular movement of the wheel L from its initial position until the arrival of the detector-lever G in contact with the arm C is proportional to the intensity of the current. At each interval of time the counter advances thus to an extent proportional to the intensity of the current, and, as this effect is repeated at equal intervals of time, its integral movement well represents the quantity of electricity which has passed through the coils of the electro-magnet. As previously stated, the arm C is not fixed rigidly to the armature A; but instead thereof it is connected through the intermediation of a spring. This arrangement is for the purpose of preventing too great a shock of the arm C against the detector-lever G when the current is suddenly interrupted or reduced, so that the armature quickly flies back under the impetus of the retractile spring D.

The hereinbefore-described apparatus, as has been seen, comprises two clock-work mechanisms driven by springs inclosed in spring-barrels. These springs may be wound up either by hand every fortnight—for example, like an ordinary clock—or at more frequent intervals of time by the action of the current itself. For the latter operation I have devised the arrangement which I will now describe.

Fig. 8 is a figure corresponding to Fig. 3 and showing the mechanism for rewinding the timing clock-work. The spring-barrel containing the motor-spring is arranged directly on the axis of the cam-disk P, which carries the pin k'. This barrel is shown at N′, and it is formed with ratchet-teeth acted on by a pawl, n', jointed to a rock-lever, o', a spring, r', being arranged to press the pawl against the ratchet. The rock-lever o' is itself actuated by an electro-magnet, t', and its armature z'. The spring contained in the barrel N′ is engaged with the arbor of the disk P, which on the opposite side of the plate X actuates the gear-wheels which drive the escapement h'' or other regulator, this gearing being the same as that between the arbor of the disk P and the escapement in Fig. 6.

The electro-magnet t' actuates the ratchet mechanism at suitable intervals in order to keep the spring in the barrel N′ wound up to approximately a uniform tension. To this end the wires 10 and 11 of the circuit or branch in which this magnet is installed lead either from the opposite pole to the battery or from the positive and negative terminals by which the current enters the local distribution-circuit. The rock-lever o' and the contact-screw g^2, with which the wires 10 and 11 respectively connect, are insulated from the

plate X by plates of ebonite. The armature z', the stop-screw h^2, and the spring i^2 are, on the contrary, in electric communication with the plate X.

When the counter-weight j^2 is at the bottom of its movement, contact is established between the lever o' and the stop h^2, and the circuit is closed through the electro-magnet t', the current flowing through the wire 10, lever o', stop h^2, plate X, as shown by dotted line 12 in Fig. 8, spring i^2, contact-screw g^2, and wire 11. The armature z' is then attracted, and as soon as its pin l^2 touches the lever o' it closes the circuit in another way, so that the current flows through the wire 10, lever o', pin l^2, armature z', plate X, as shown by dotted line 13 in Fig. 8, spring i^2, screw g^2, and wire 11, so that the current continues to flow through the electro-magnet t' in spite of the rupture which is produced between the lever o' and stop h^2 when the armature leaves the lever. The armature z' then continues to be attracted and to lift the counter-weight j^2 until the teeth at the top of the spring i^2 are reached by the pin m^2, fixed on the lever o', whereby it is parted from the screw g^2, whereby the current is finally broken. The armature z' then falls to rest and the counter-weight j^2 remains lifted, acting as a motive force through the pawl n' upon the ratchet of the spring-barrel N'. When the spring runs down until its tension is no longer sufficient to uphold the weight j^2, the latter descends and correspondingly winds up the spring, and when the weight again reaches the bottom of its movement a new contact is formed between h^2 and o' and the action of lifting the weight again takes place as before. During the lifting of the weight j^2 the spring contained in the barrel N' serves as the motor and continues the movement of the wheel-work.

It will be understood that with this arrangement the first spring-barrel as well as the two first wheels of the timing clock-work are dispensed with.

The means of electric rewinding which actuates the second clock-work mechanism, O, the one which operates the totalizer, is arranged on the opposite face of the counter to the one shown in Fig. 8. It is shown in Fig. 9, which is a partial front elevation of the counter from the dial side.

The spring-barrel N^2, having ratchet-teeth, is mounted on the arbor of the second wheel, g', of this wheel-work—that is to say, on the arbor which drives the arbor of the gear M, Figs. 3 and 6. The ratchet-wheel work n^2, r^2, o^2, and j^3 is identical with that shown in Fig. 8. It is actuated by an electro-magnet, t^2, and the current flows through wires 10 and 11, terminating in the levers o^2 and the contact-screw g^3, as before. The operation is the same as already described with reference to Fig. 8.

In lieu of the electro-magnet E having a core of soft-iron, a simple coil may be employed, or any arrangement used in ampère meters or electro-dynamometers may be substituted.

I claim as my invention in electric meters the following defined novel features and combinations, substantially as hereinbefore specified, viz:

1. The combination of an electro-motive device, a moving part or detector, and a totalizer, with a motor clock-work adapted to impart motion to said detector and totalizer, a detent normally restraining said clock-work, a timing clock-work, and a cam driven thereby and adapted at certain intervals of time to displace said detent and free the motor clock-work.

2. In an electric meter, an electro-motive device, the moving member of which is displaced more or less according to the varying energy of the current to be measured, a retracting-spring acting against said moving member in opposition to the current, a movable stop, against which said retracting-spring is re-enforced, and a more sensitive supplemental spring tending to displace said stop, acting on said moving member through the main retracting-spring and adapted to retract it against feeble currents.

3. The combination, with an electro-motive device, a detector, and a totalizer, of a clock-work adapted to impart motion to said detector and totalizer, a detent adapted to arrest said clock-work upon the contact of the detector with the moving member of said electro-motive device, and a timing clock-work adapted to release said parts at certain intervals of time.

4. The combination, with an electro-motive device, a detector, and a totalizer, of a clock-work adapted to impart motion to said detector and totalizer, a timing clock-work adapted to release said clock-work at certain intervals of time, and thereby permit the advance of the detector and totalizer, a detent for arresting said driving clock-work upon the stoppage of said detector by the moving member of the electro-motive device, and a disengaging device for throwing said driving clock-work out of engagement with said detector during the return of the latter to its normal position.

5. The combination, with an electro-motive device, of a detector-lever adapted to be arrested thereby, a toothed sector to which said lever is pivoted, said lever adapted to make contact at one end with the moving member of said electro-motive device, a detent connected to the other end of said lever, and a clock-work adapted to impart motion to said sector and to be arrested by said detent.

6. The combination, with an electro-motive device, of a detector-lever adapted to be arrested thereby, a toothed sector to which said lever is pivoted, said lever adapted to make contact at one end with the moving member of said electro-motive device, a detent connected to the other end of said lever, a clock-

work adapted to impart motion to said sector and to be arrested by said detent, a retractile device acting to restore said sector after its displacement, and a disengaging device for disconnecting said clock-work from said sector.

7. The combination, with an electro-motive device, a detector, and a totalizer, of a clock-work adapted to impart motion to said detector and totalizer, and intermeshing toothed wheels arranged between said detector and totalizer, said wheels having such shape that the angular displacement of the totalizer from the starting position until the detector is stopped by the moving member of said electro-motive device is proportional at each instant to the energy of the current acting on the said electro-motive device.

8. The combination, with an electro-motive device and a detector-lever, of a clock-work adapted to impart motion to the fulcrum of said lever, and a detent adapted to be displaced by the movement of said lever upon its encounter with the moving member of the electro-motive device, and on such displacement to arrest said clock-work.

9. The combination, with an electro-motive device, of a detector-lever adapted in its movement to be stopped by the moving member of said electro-motive device, a clock-work for imparting motion to said lever, a detent normally engaging the flier of said clock-work in order to restrain the same, a timing clock-work adapted to release said detent at intervals, and a detent adapted to be displaced by said detector-lever upon its stoppage by the moving member of said electro-motive device, and by such displacement to arrest the clock-work.

10. The combination, with an electro-motive device, of a detector-lever, a carrier to which said lever is pivoted, a clock-work adapted to impart motion to said detector through said carrier, a disengaging device for disconnecting said clock-work from said carrier, a detent for restraining said clock-work, and a timing clock-work adapted at intervals to first release said detent, and thereby permit said clock-work to effect the movement of said detector, and subsequently to operate said disengaging device to permit the restoration of said detector and its carrier to their normal positions.

11. The combination, with an electro-motive device, a detector, and a clock-work for imparting motion to said detector, of a detent for restraining said clock-work, a lever, Q, for operating said detent, a disengaging device for disconnecting said clock-work from said detector, a lever, S, for operating said disengaging device, a timing clock-work, and a rotary cam, P, driven by said timing clock-work and adapted to displace successively said levers Q and S.

12. The combination of an electro-motive device, a detector, and a clock-work for moving said detector at intervals toward the moving member of said electro-motive device, an arm connected to and moved by said moving member and arranged to contact with and stop said detector, and a yielding connection between said arm and moving member for reducing the shock of the arm against the detector in case of the sudden movement of said moving member due to a sudden change in the current.

13. The combination of an electro-motive device, a detector adapted to move at intervals until stopped by such electro-motive device, a clock-work for imparting motion to said detector, and means for winding said clock-work, consisting of an electro-magnet and a circuit-closer in circuit therewith, adapted to close the circuit thereto upon the relaxation of the spring to be wound below a certain tension, and mechanical connections between the armature of said magnet and said spring for winding the latter upon the excitation of the magnet.

14. The combination, with an electro-motive device, a detector adapted to move at intervals from its initial position until stopped by said electro-motive device, a clock-work for imparting motion to said detector, and a timing clock-work for setting said clock-work in motion at intervals, of means for rewinding said clock-work, consisting of an electro-magnet and a circuit-closer in circuit therewith, adapted to close the circuit thereto upon the relaxation of the spring to be wound below a certain tension, and mechanical connections between the armature of said magnet and said spring for winding the latter upon the excitation of the magnet.

15. In an electric meter, the combination, with a clock-work, of an automatic rewinding device therefor consisting of an electro-magnet, a rock-lever provided with a retractile weight, a ratchet-and-pawl connection between said rock-lever and the spring to be rewound, a circuit-closer adapted to close the circuit through said magnet upon the fall of said rock-lever under the impetus of its retractile weight to its lowest position, and a connection between the armature and said rock-lever, whereby the attraction of the armature by the magnet serves to rock said lever and lift its retractile weight, whereby the spring is kept wound to a tension proportional to the retractile tension of said weight.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

MARIE JULES RAOUL JACQUEMIER.

Witnesses:
ROBT. M. HOOPER,
AMAND RITTER.