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J. OULTON & J. EDMONDSON.

ELECTRIC METER.

No. 430,432. Patented June 17, 1890.

Fig. 5.

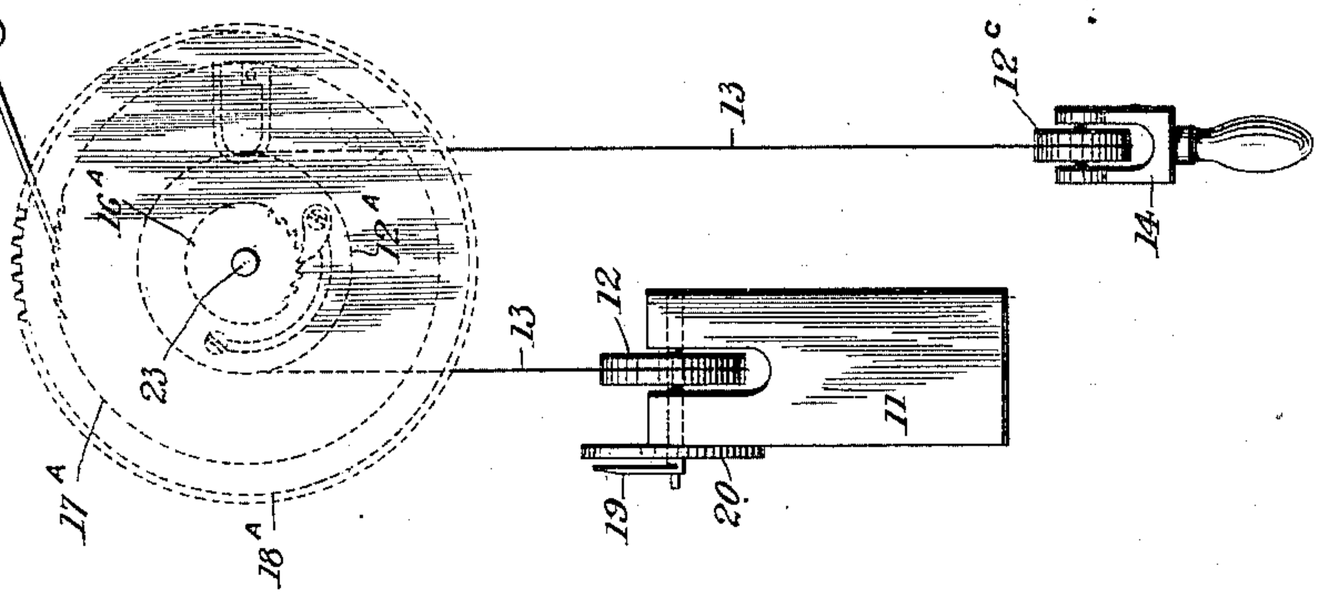

Fig. 4.

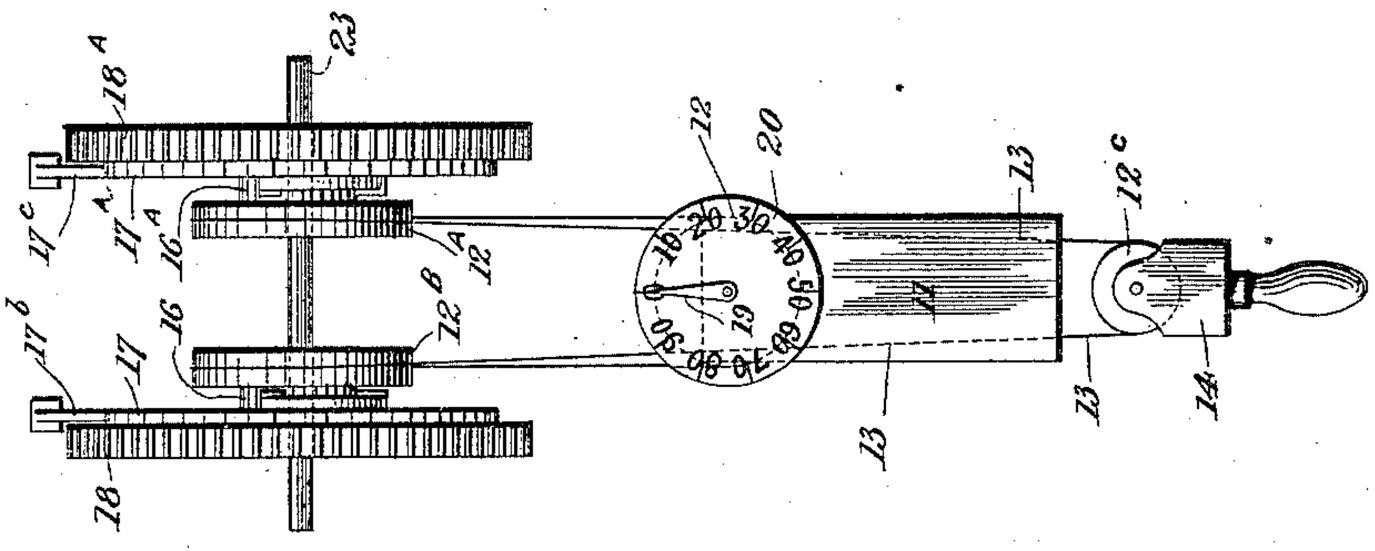

Fig. 1.

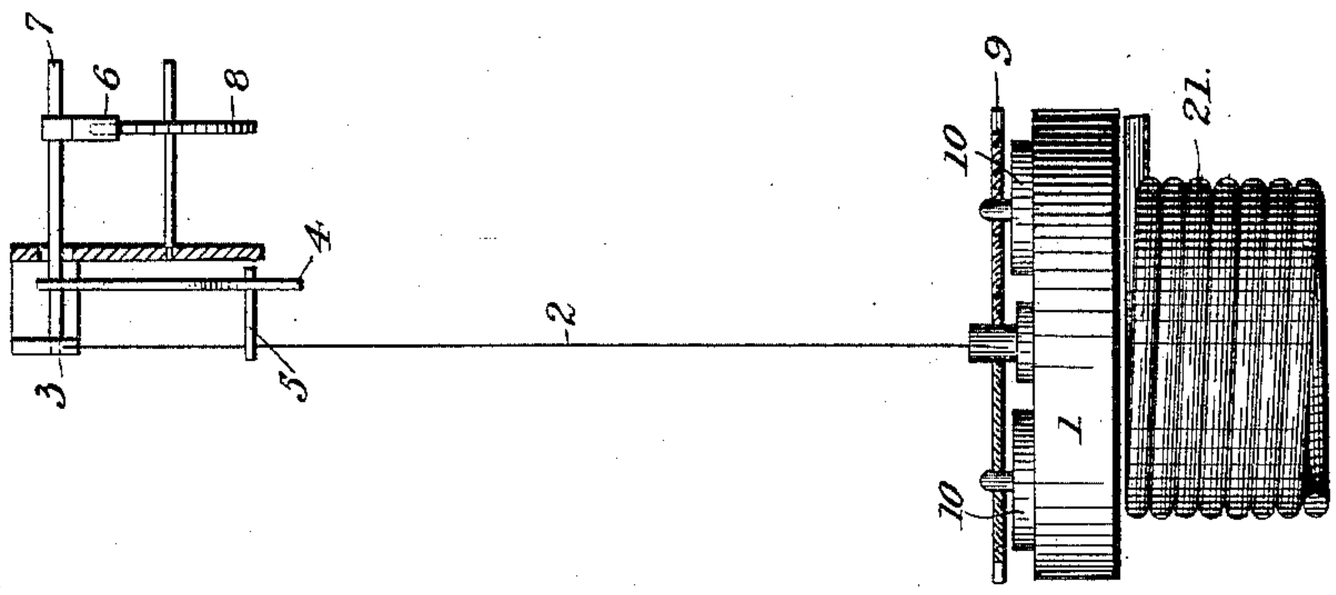

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Fig. 3.

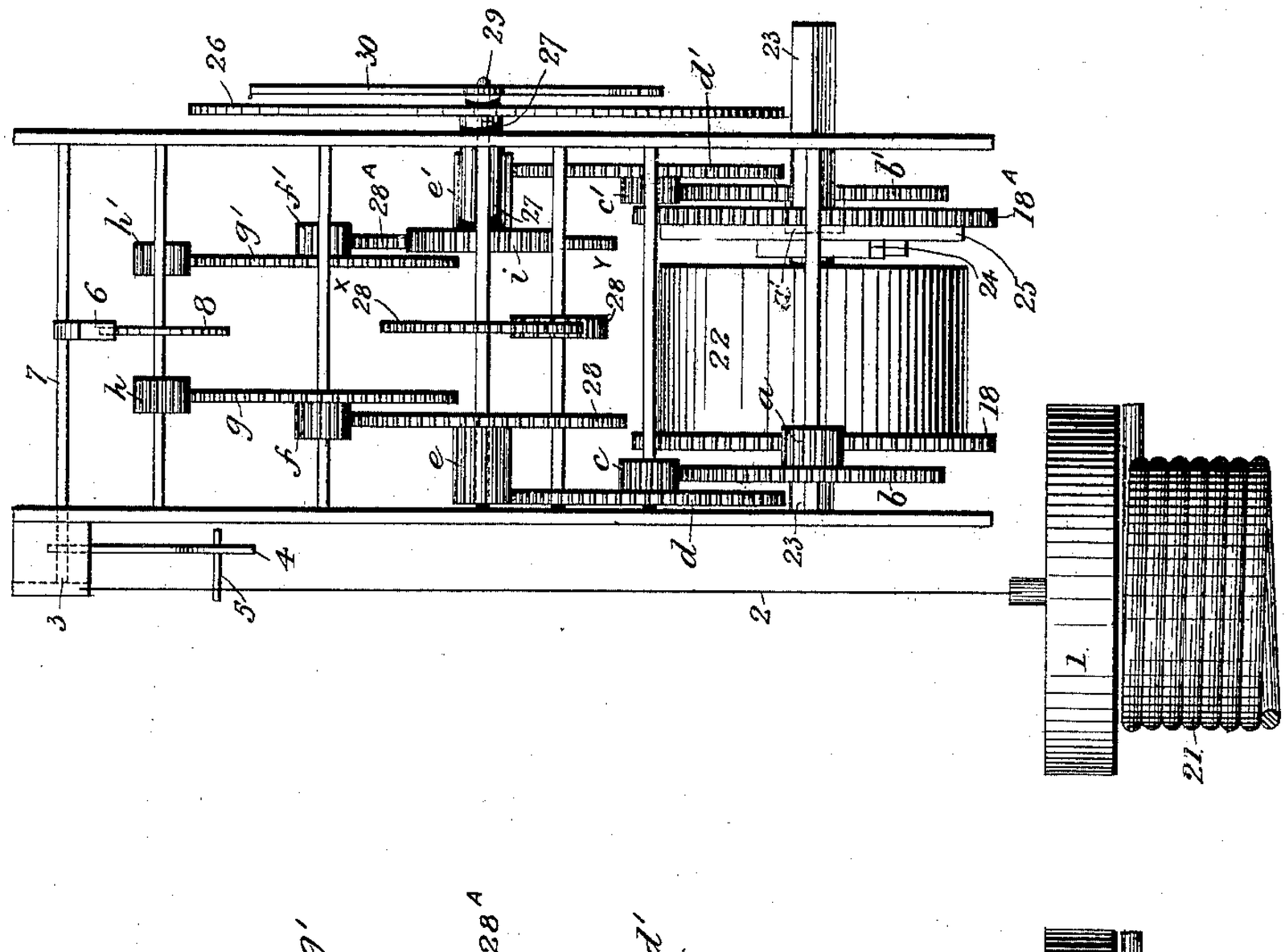
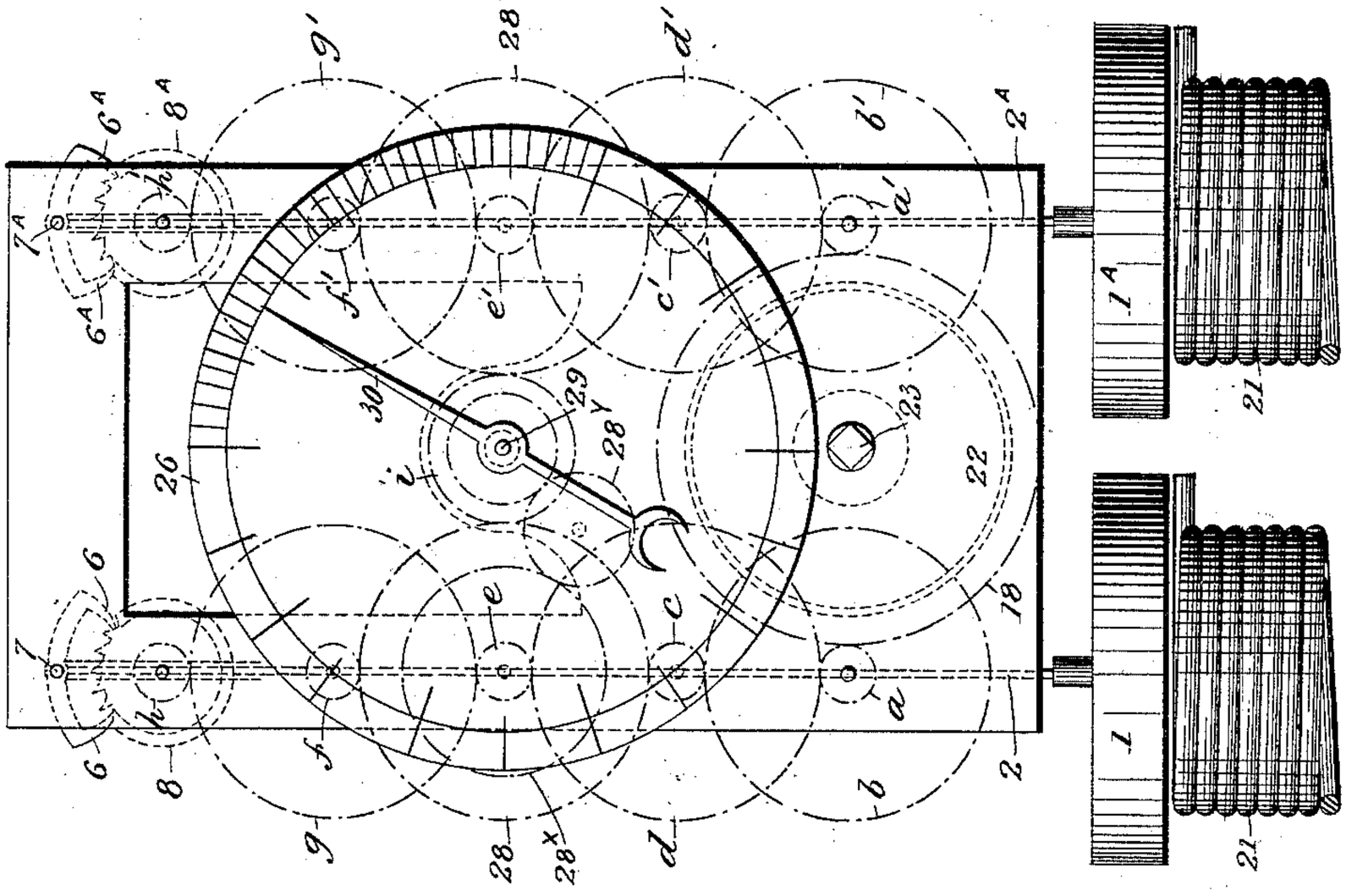


Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

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Fig. 7.

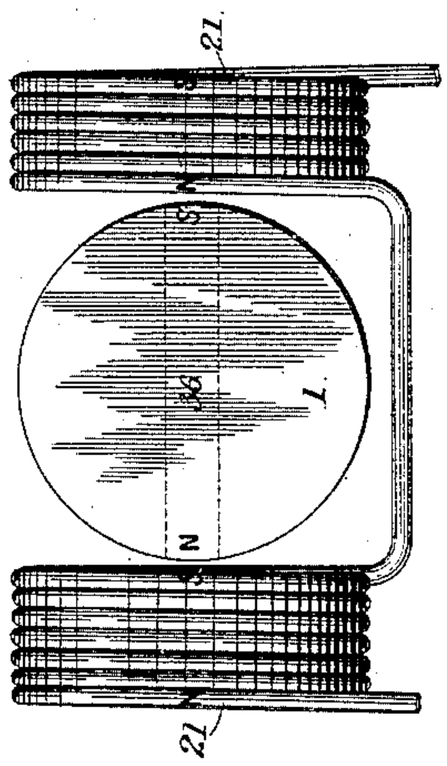


Fig. 8.

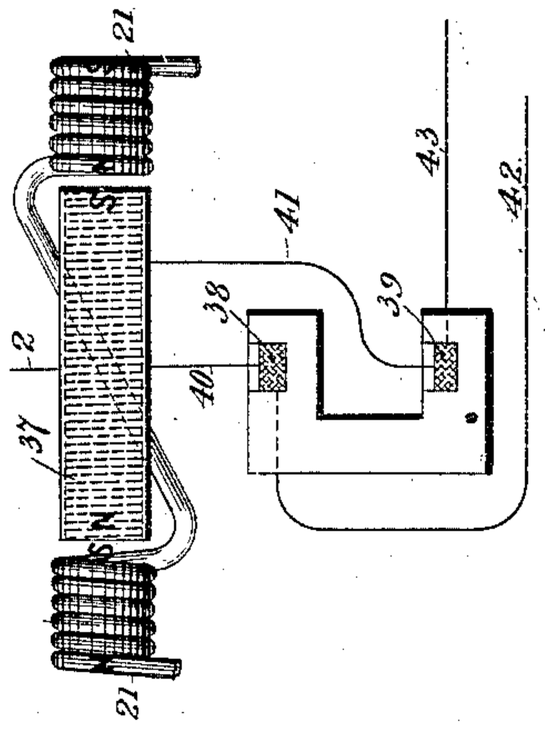
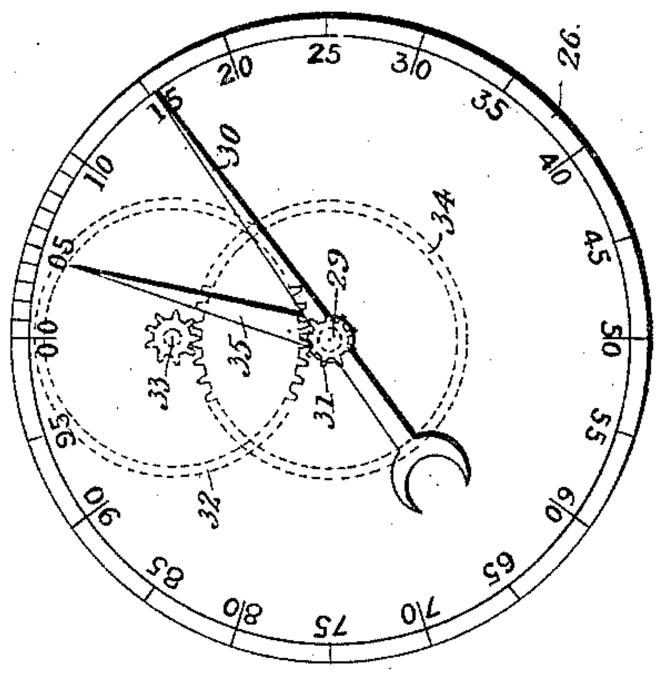


Fig. 6.



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UNITED STATES PATENT OFFICE.

JOSEPH OULTON AND JOSEPH EDMONDSON, OF BRADFORD, COUNTY OF YORK, ENGLAND.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 430,432, dated June 17, 1890.

Application filed December 12, 1889. Serial No. 333,510. (No model.) Patented in England October 16, 1888, No. 14,843; in Belgium July 15, 1889, No. 86,999, and in France July 15, 1889, No. 199,587.

To all whom it may concern:

Be it known that we, JOSEPH OULTON and JOSEPH EDMONDSON, both subjects of Her Majesty the Queen of Great Britain, residing at Bradford, in the county of York, England, have invented new and useful Improvements in Electric Meters, (for which we have obtained Letters Patent in Great Britain, No. 14,843, dated October 16, 1888; in Belgium, No. 86,999, dated July 15, 1889, and in France, No. 199,587, dated July 15, 1889,) of which the following is a specification.

This invention relates to apparatus for measuring and integrating electric currents, the object being to provide a convenient and compact device which will give indication of the amount of current consumed, that may be easily read off at a glance.

The device consists of a train of clock-work having a torsion-balance, the vibrations of the balance being accelerated or retarded by the current to be measured, the difference between the known normal speed of the clock-work and its speed when influenced by the current indicating the amount of current consumed. Two synchronous torsion-balances are driven by two escapements and wheels, which are impelled by a weight acting on them equally by means of a pulley and an endless chain, one being free from and the other under the influence of the current; or both may be influenced by the current, but in opposite directions. When there is no current, the balances vibrate at the normal speed, and the said pulley has no motion on its axis; but when the current is passing, the balance under its influence being accelerated or retarded, the pulley has a differential motion, which may be indicated by a train of wheels and dials. The winding up of the said weight may be automatically effected by a remontoir. The balance to be influenced is of iron, (or it may be of non-magnetic metal, having attached to it concentrically an iron core,) beneath, above, or around which is placed concentrically with it one or more fixed solenoids with or without iron cores. When the current passes through the solenoid or solenoids, it influences the balance or its iron core and increases or shortens the period of oscillation. If desired, the position of the fixed solenoid or solenoids and the iron core of the balance may be reversed, the former being placed on the balance and the latter fixed above or beneath it; or a solenoid or solenoids with or without iron cores may replace the iron core in either position. In the latter case the instrument becomes a "Watt meter" if the fixed solenoids indicate the "ampères" and the other indicate the electro-motive force or "volts," or vice versa. The iron core may be replaced by a bar-magnet or needle placed diametrically on the balance itself or on the torsion spring-wire or other suspender, and oscillating under the influence of a solenoid or solenoids, either with or without iron cores, so adjusted that the period of oscillation shall be proportionately varied by the current. Such solenoid may be of cylindrical, rectangular, elliptical, or other section. The two escapements and wheels hereinbefore referred to may be driven by the same mainspring or weight.

The above being the nature and object of our invention, the following is a complete description of same, reference being had to the accompanying drawings, forming a part of this specification, in which—

Figure 1 shows a simple form of torsion-balance with the solenoid therefor. Figs. 2 and 3 are front and side elevations, respectively, of two torsion-balances and a single spring-drum for driving them both. Figs. 4 and 5 show the manner of arranging two torsion-balances to be driven by a single weight. Fig. 6 illustrates a dial with indexes for securing a great range of indications. Figs. 7 and 8 are views of modified means for influencing the torsion-balance.

Fig. 1 shows a "torsion-balance" consisting of a cylindrical balance or weight 1, combined with an elastic torsion ribbon or suspender 2, of any suitable material, preferably of steel. Said weight is suspended by the ribbon 2 from its support 3, attached to the framework of a train of clock-work, from which it receives its impulse through the fork or crutch 4, which embraces a pin 5, affixed to the torsion-ribbon 2. The pallet 6 is fixed to the pallet-arbor 7, which carries the crutch 4, and

receives its impulse from the escapement-wheel 8. The regulation of the balance or weight 1 is effected by the right and left hand screw 9, which, when turned on its axis, moves the regulating-weights 10 10 nearer to or farther from the axis of the balance 1, on which they rest.

The action of the device is as follows: When the balance is rotated round its axis, the torsion of the ribbon 2 tends to bring it back to its position of rest, or zero, and in doing so will cause it to rotate or oscillate to and fro like the balance of a watch. Its rotation may be maintained and recorded by an ordinary train of clock-work. Beneath the balance (which in this case is of iron,) is placed a solenoid 21, through which is passed the current to be measured, so that when the current of electricity is passing the magnetic influence of the solenoid will alter the speed of the balance. The clock-work is set to register normal time when no current is passing, so that when the current is turned on the variation from normal time caused by the same will be a measure of the current consumed within certain limits. The solenoid 21 may have an iron core, either fixed or attached to and rotating with the balance, and the said solenoid may be placed either above or beneath the balance.

Figs. 2 and 3 show in front and side elevation, respectively, a method of driving two torsion-balances 1 1^a by one and the same spring, by which their periods of rotation or oscillation can be more easily and effectually synchronized. The spring inclosed in the spring-box 22 has one end attached to said box, which is fixed to the main wheel 18 and drives one escapement-wheel 8 through the intervening train of wheels *a*, *b*, *c*, *d*, *e*, 28, *f*, *g*, and *h*. The other end of the spring in the box 22 is fixed to the main wheel-arbor 23 and drives the other escapement-wheel 8^a through a ratchet-wheel 24, maintaining power-wheel 25, main wheel 18^a, and the intervening train of wheels a', b', c', d', e', 28^a, f', g', and h'. A dial 26, with a hollow arbor 27, is driven by a wheel or pinion *i*, which is fixed to said arbor, said wheel *i* gearing into the train-wheel 28^a. This arbor 27 rides loosely on the arbor 29, which carries the index 30. The arbor 29 (with the index 30) is driven from a wheel 28^y on the arbor of the train-wheel 28 through a wheel 28^x, which engages therewith. The said wheel 28^y is inserted to cause the index to revolve in the same direction as the dial. When the balances are rotating at their normal speed, the speed of the dial and that of the index are identical; but when the current influences one of the balances (or both balances in opposite directions) a difference is set up in the speed of the dial and index, which thus causes the amount of current consumed to be registered.

Figs. 4 and 5 show a mode of driving the two torsion-balances by means of one and the same weight, (in place of the spring, as hereinbefore described.) In this case the driving-weight 11 is suspended by an endless chain 13, passing over the pulleys 12 12^a 12^b, and is kept in tension by a counter-weight 14, attached to the pulley 12^c. The counter-weight has a handle by which it may be drawn down for the purpose of winding. The pulleys 12^a 12^b are loose on the arbor 23, which also carries loosely upon it the ratchet-wheels 16 16^a, the maintaining-wheels 17 17^a, (with which engage pawls 17^b 17^c,) and the main wheels 18 18^a, through which the driving-power is communicated to the escapement and balances, as before described, with reference to Figs. 2 and 3. The arbor of the pulley 12 carries an index 19, which shows on a dial 20, fixed to the weight 11, the difference between the motion of the pulleys 12^a 12^b as controlled by the balances. When the balances are rotating at their normal rate, the pulleys 12^a 12^b will revolve at the same speed; but when one of the balances is influenced by the current or when both balances are influenced in opposite directions a difference of speed is set up, which is recorded on the dial, such difference being a measure of the current of electricity consumed, (within certain limits.)

Instead of an endless chain we may use an endless cord or ribbon or its equivalent. It will be manifest that the employment of one and the same weight or one and the same spring, or the equivalent of either, is also applicable to the driving of two balances of any kind, or two pendulums when applied to the measuring and registering of electric currents in a manner equivalent to that herein indicated with regard to torsion-balances.

In Fig. 6 is shown a method of registering higher numbers than can be recorded with the single index and dial shown in Figs. 4 and 5. The arbor 29, which carries the index 30, also carries the pinion 31. The latter gears into a wheel 32, (with teeth in the ratio of ten to one,) riding on a stud fixed on the dial. This wheel carries a pinion 33, driving a wheel 34, (with teeth in the ratio of ten to one,) said wheel being affixed to a hollow arbor, which carries the index 35. It will be seen that the index 30 will register up to one hundred for one travel round the dial, while the index 35 can register up to ten thousand. The balance or balances may be influenced in the manner shown in plan in Fig. 7 in place of that shown in Figs. 1, 2, and 3. In this case the permanent magnet 36 is placed diametrically across the balance 1, which in this case is of non-magnetic material, and the current to be measured passes through the solenoids 21 21, which may be with or without iron cores, and which are placed so that their axes shall coincide, or nearly so, with the axis of the magnet 36 when the balance is at the "dead-point." It will be evident that the solenoids 21 21 may be enlarged, and may be brought nearer the axis of the balance, which may rotate wholly or in part within them.

When the poles of the solenoids and the position of their axes are as shown in the drawings, the effect of a current passing through the solenoids 21 21 will be to quicken the rotations or oscillations of the balance; but if their polarity be reversed the current will have the opposite effect.

Fig. 8 is the front elevation of a form of Watt meter according to our invention. In or on the balance (of non-magnetic metal) is placed diametrically a solenoid or coil 37, of high resistance and indicating the volts. Two solenoids 21 21, to carry the current to be measured, are placed with their axes coinciding with the axis of the volt solenoid or coil. Beneath the balance are placed mercury-cups 38 39, through which the volt-coil is connected as a shunt with the supply-circuit by wires 40 41 42 43. The effects of the current passing through the solenoids 21 21 are the same as described in reference to Fig. 7. It will be evident that the magnet 36 in Fig. 7 and the volt-coil 37 in Fig. 8 might as well be suspended on the torsion-spring 2; also, that in regard to Fig. 7, a solenoid may be placed on the balance, (receiving its current through mercury-cups, as in Fig. 8,) and the permanet magnet or magnets may take the place of the solenoids 21 21. In regard to Fig. 8 it will be seen that the solenoids 21 21 may be volt-coils, and the solenoid 37 may carry the current to be measured. In some cases it may be convenient to make the permanent magnet 36, Fig. 7, or the volt-coil, Fig. 8, of sufficient weight to constitute the balance.

What we claim, and desire to secure by Letters Patent, is—

1. In an electric meter, the combination, with two balances or pendulums driven through a train of clock-work by one and the same weight or by one and the same spring, of solenoids arranged to influence the movement of said balance, and a dial and index, both driven in the same direction, the difference in speed set up between which will indicate the amount of current consumed, substantially as described.

2. In electric meters, the combination, with two balances or pendulums driven through a train of clock-work by one and the same weight, (or its equivalent,) and suitable indicating apparatus, of solenoids arranged to influence the movement of said balance or pendulum, the current to be measured being passed through said solenoids, substantially as described.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

JOSEPH OULTON.
JOSEPH EDMONDSON.

Witnesses:
WALTER BRIERLEY,
J. BRIERLEY HOWARD.