(No Model.) 2 Sheets—Sheet 1.

M. L. M. HUSSEY.

ELECTRIC PENDULUM DRIVEN CLOCK.

No. 413,281. Patented Oct. 22, 1889.

Fig. 1.

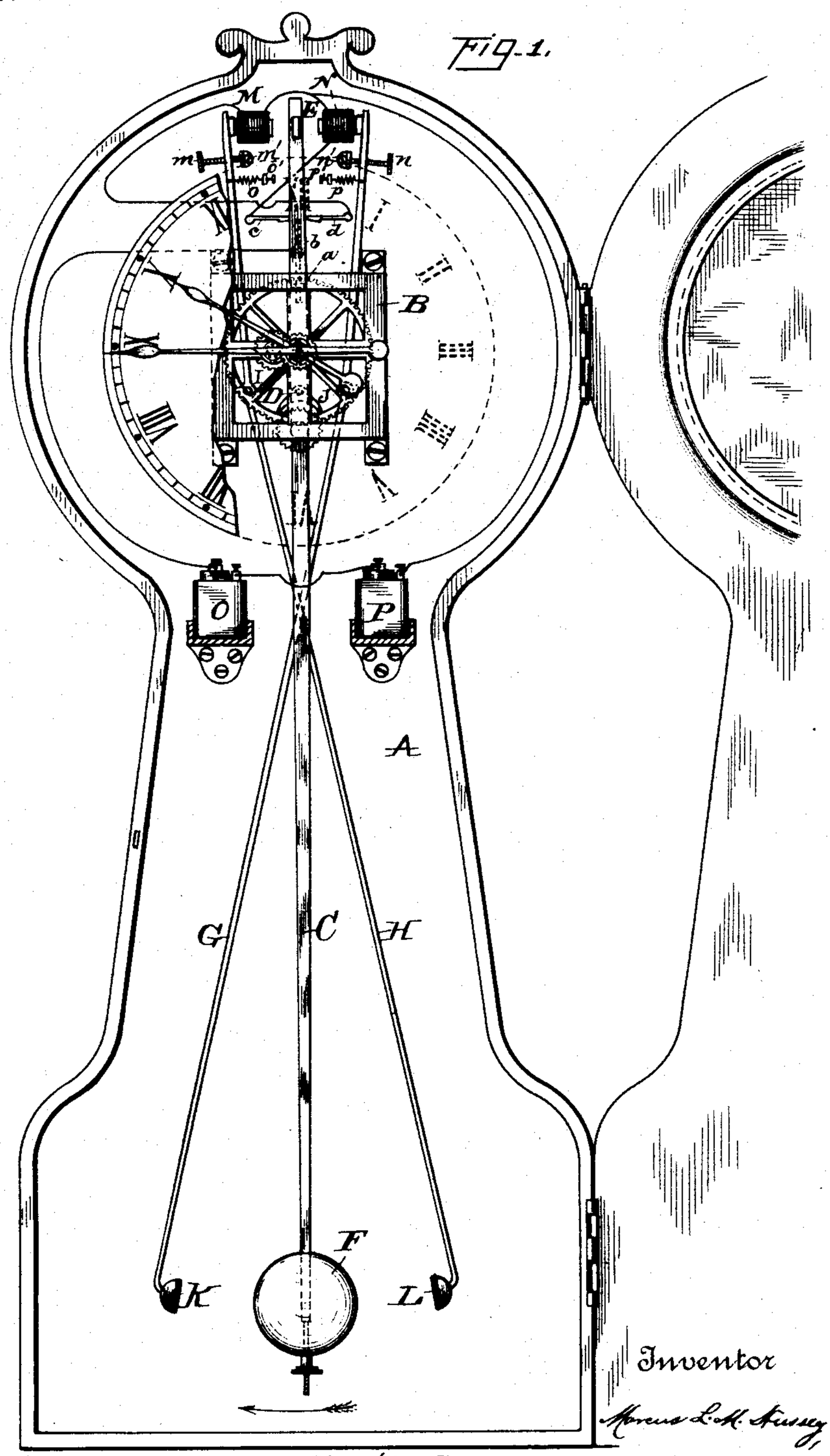
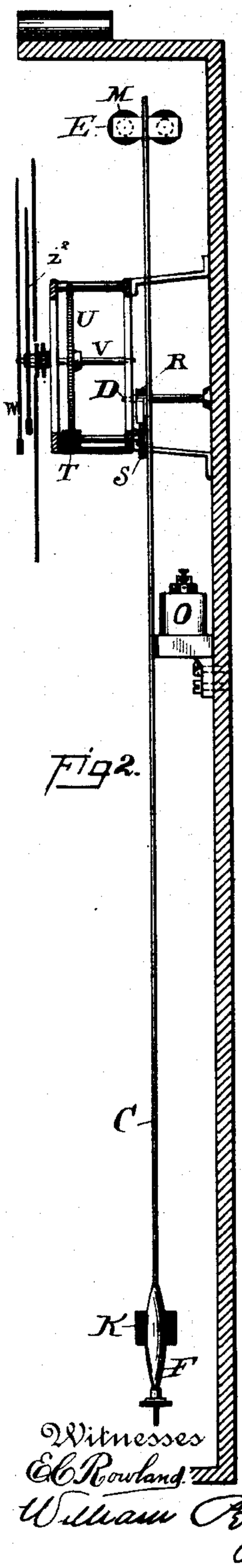


Fig 2.



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 7

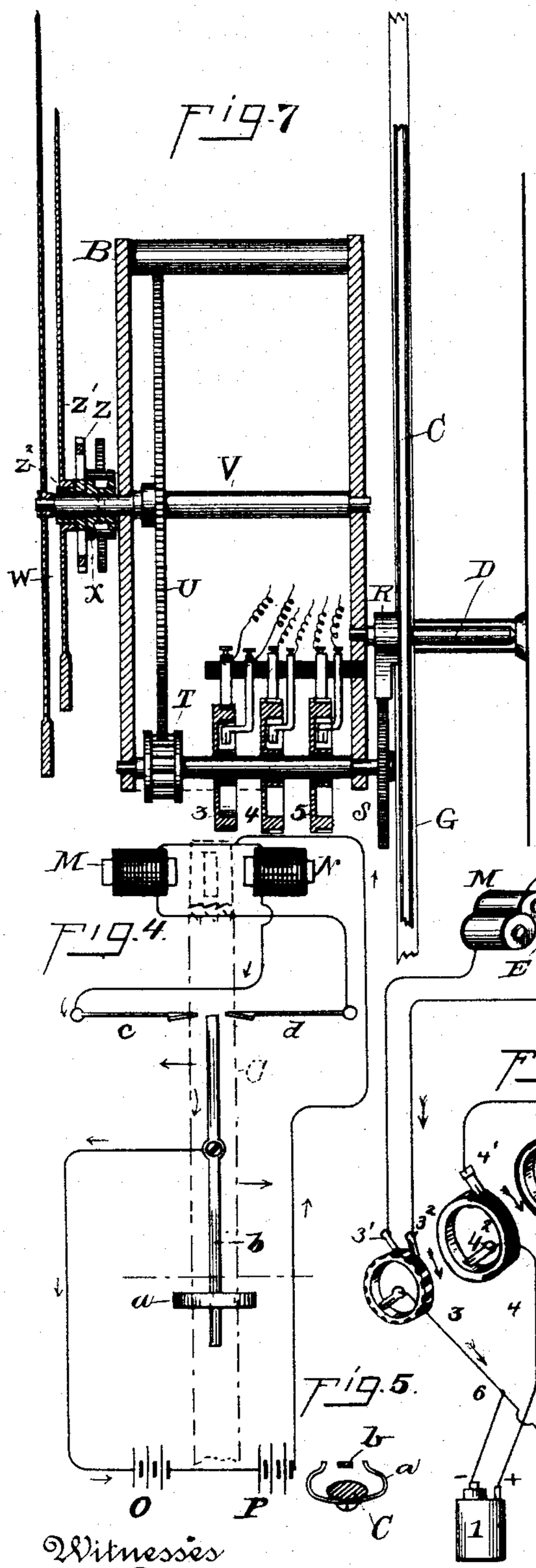


Fig. 4.

Fig. 6.

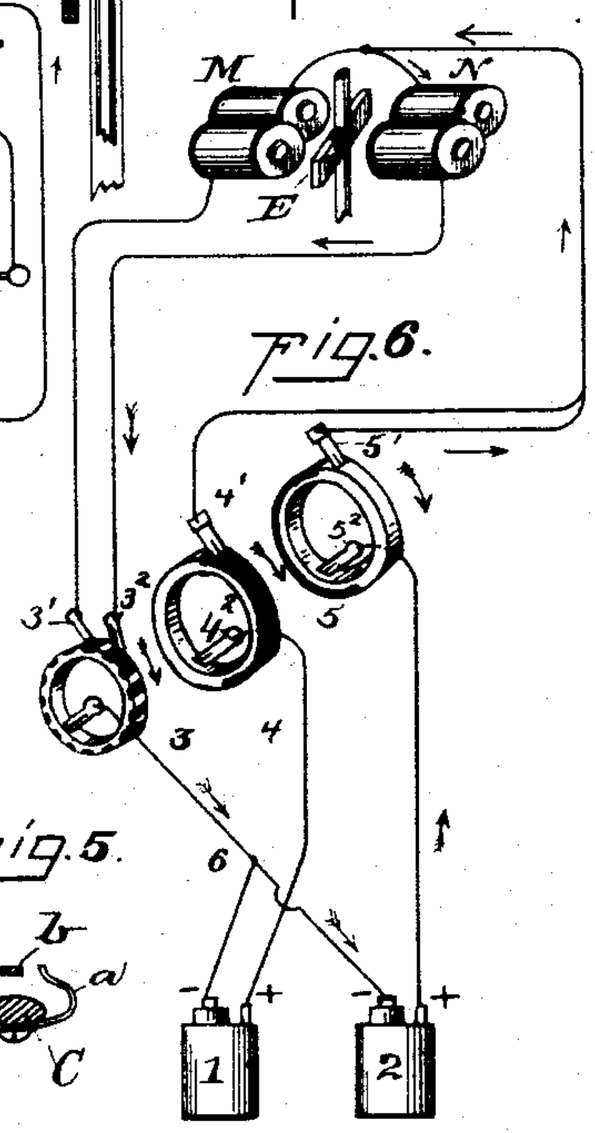
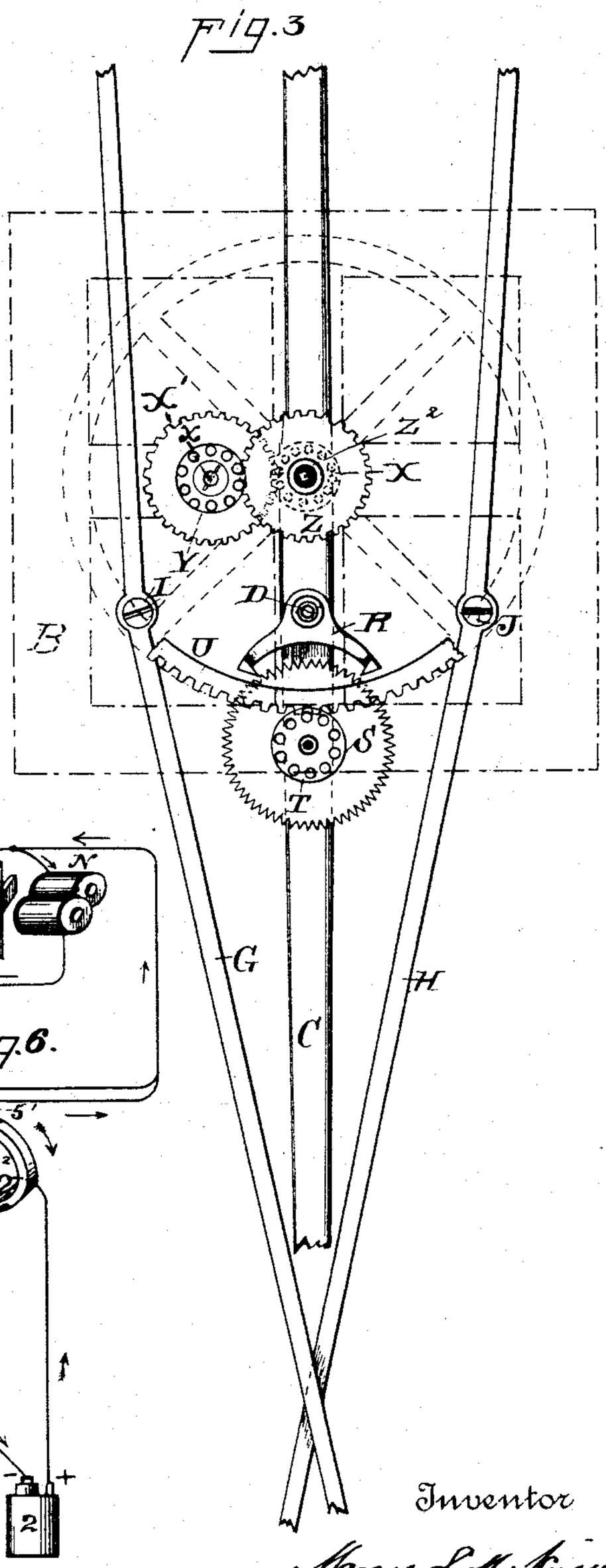


Fig. 5.

Fig. 3



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UNITED STATES PATENT OFFICE.

MARCUS L. M. HUSSEY, OF MENLO PARK, NEW JERSEY.

ELECTRIC PENDULUM-DRIVEN CLOCK.

SPECIFICATION forming part of Letters Patent No. 413,281, dated October 22, 1889.

Application filed August 27, 1888. Serial No. 283,842. (No model.)

To all whom it may concern:

Be it known that I, MARCUS L. M. HUSSEY, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a certain new and useful Improvement in Electric Clocks, of which the following is a specification.

The object of my invention is to produce a clock in which electricity is used to impel the pendulum and turn the hands, so that periodical winding of a spring or weight is dispensed with, and which shall keep perfect time.

In my clock the motive power is supplied by current from an electric battery located within or without the case, or from some other source of electrical energy, and which operates on the mechanism of the clock through electro-magnets placed in circuit with the battery, the pendulum in its oscillations making and breaking an electric circuit, which alternately magnetizes and demagnetizes the magnets.

In electric clocks heretofore made for various reasons the current would sometimes fail, and they would then cease to register, and on the resumption of the current would start with the error accumulated during its cessation. In my clock, however, the current can never fail, and by means of a suitable battery-controller or circuit-breaker, which forms part of my invention and will be hereinafter explained, the electro-motive force of the current is maintained constant; also, by means of a suitable device, the arc through which the pendulum travels is always maintained at the same length, and hence the oscillations of the pendulum are all of the same duration.

In the accompanying drawings, forming a part of my specification, Figure 1 is a front view of the clock, the door being open and a portion of the dial removed, revealing the works. Fig. 2 is a side elevation of the same with part of the case and frame supporting the works removed. Fig. 3 is a detail showing the location and arrangement of the escapement, hour and minute hand pinions, pendulum-rod, and magnet-levers with relation to each other. Fig. 4 is a view of the circuit-changing device shown in Fig. 1. Fig. 5 is a detail of finger on pendulum-rod for operating the circuit-changing device. Fig. 6 is a view showing a combined circuit-changing and depolarizing device; and Fig. 7 is a view in side elevation of the clock-works, showing circuit-changers and depolarizing device in position.

A is a clock-case having located in its upper portion a metallic frame B, in which is arranged the time-keeping mechanism, escapement, hour and minute hand wheels, &c. Pivoted at D on the same shaft as the escapement-pallet is the pendulum-rod C, having at its upper end an armature E and at its lower end an adjustable weight or bob F. As is shown in the drawings, the pendulum is hung or pivoted at a point between its middle and upper end, which is a method different from the hanging of pendulums in other clocks, in which the arc pendulum is hung from the extreme upper end, and which constitutes a feature of my invention.

Arranged on either side of the pendulum-rod C are magnet-levers G H, preferably of steel, secured to the clock-case by screws I J, which also serve as their fulcrums. These levers cross each other below their fulcrums and terminate at their lower ends in buffers K L, while upon their upper ends are secured the adjustable electro-magnets M N, of low resistance, arranged in circuit with the battery-cells O P through the circuit-changing device. (Shown in detail in Fig. 4.)

Through the magnet-levers G H, just below the magnets M N, pass adjusting-screws *m n*, (see Fig. 1,) their points resting against the stops *m' n'*, secured to the clock-frame, against which the points of the adjusting-screws *m n* are pressed by springs *o p*, which are secured at one end to the magnet-levers G H and at the other end to their adjusting-screws *o' p'*, located in retaining-pieces secured to the clock-frame. The purpose of the screws *m n* is to adjust the distance apart of the magnets M N, between which the armature E on pendulum C vibrates, and when the proper distance is once obtained, according to the strength of the magnets, it is maintained by springs *o p* and buffers K L, between which the pendulum oscillates, and the arc through which the pendulum travels

can never be longer than the distance between the buffers K L.

The circuit-changing device (shown in Figs. 4 and 5) consists of a spring-finger *a*, secured to the pendulum-rod C above its pivotal point, a lever *b*, attached to the clock-case in the rear of the pendulum, and also above its pivotal point D, and contact-terminals *c* and *d*, in circuit with the batteries O P and magnets M N, said contact-terminals being preferably strips of metal secured to the clock-case in such proximity or manner as to make contact with lever *b*, as shown in Fig. 4. As the lower end of the pendulum is swung, say, to the left, the upper end is swung to the right, and as spring-finger *a* is on the upper end of the pendulum, it will also move to the right, striking the lower end of lever *b*, swinging it (the lower end) also to the right and causing the upper end of lever *b* to swing to the left. Therefore, when the pendulum-bob F is swung in the direction of the arrow beneath it to start the clock spring-finger *a* (see Fig. 5) engages with the lower end of lever *b* of the circuit-changing device, (see Fig. 4,) moving it in the direction of the arrow thereon and causing its upper end to be thrown over, so as to make contact with terminal *c* and close the battery-circuit through the magnet N, as shown by the small arrows in Fig. 4, which attracts the armature E at the upper end of pendulum-rod C as it approaches said magnet until the armature makes actual or almost actual contact with the poles of magnet N, from which it is instantly released either by the force of the fall of the pendulum-bob F in making its return movement should the bob not strike the buffer K, or by the pendulum-bob F striking against the buffer K at the opposite end of the magnet-lever G, upon which the magnet N is located. At the same instant, starting on its return oscillation, the pendulum causes lever *b* to be released from contact *c*, and thus breaks the circuit through the magnet N and immediately makes or closes the circuit through the contact-terminal *d* and the magnet M, enabling the latter by its attraction to assist the oscillation of the pendulum until the armature E is released from the poles of the magnet M, as above described, and the pendulum starts on its return oscillation, and, as before, causes lever *b* to be released from contact *d*, and thus breaks the circuit through magnet M and closes the circuit to magnet N through lever *b* and contact-terminal *c*, and so on. When the pendulum-bob F strikes, say, buffer K on lever G, it strains spring *p* and gives to the pendulum a slightly-accelerated movement as it leaves the buffer. It also throws back slightly out of adjustment the magnet N on the upper end of lever G, which, however, is at once returned in place by the contraction of the spring *p*. Thus it will be seen that after the clock is started the vibration of the pendulum would cease altogether were it not that in its vibrations it makes and breaks an electric circuit, which alternately magnetizes and demagnetizes either magnet M or N, which in its active condition attracts armature E, such attraction being just sufficient to give the pendulum an adequate impulse to maintain its motion and cause it to travel through the same arc during each oscillation. It will also be seen that magnets M and N assist the oscillations of the pendulum in its upward stroke by attracting the armature E as the pendulum approaches the extremity of oscillation, and levers G H, buffers K L, and springs *o p* assist the oscillations of the pendulum in its downward or return stroke. Though the armature E on the pendulum might make actual contact with either magnet M or N, yet this contact does not hold the armature and retard the vibrations of the pendulum, and thus put the clock out of regulation for the striking of bob F against buffer K or L, and the fall of bob F by its own weight and the almost simultaneous breaking of the circuit through spring-finger *a*, lever *b*, and contact-terminals *c* or *d*, which demagnetizes the magnet, releases the armature E almost at the instant it makes contact.

The motion of the pendulum is transmitted to the hands of the clock by means of the pallet R, secured to the pendulum-rod at its pivotal point D, engaging with and rotating the escapement or impulse wheel S upon the same shaft with which is mounted the lantern-wheel T, which in turn engages with and rotates the wheel U. Wheel U is secured to a shaft V, to which is also secured the minute-hand W and the lantern-wheel X, the latter engaging with pinion X′ upon a shaft *x*, fixed to the clock-frame B, said pinion X′ having secured to and rotating with it the lantern-wheel Y, which engages with the pinion Z, located with the hour-hand Z′ upon a sleeve Z^2, located on the shaft V just in the rear of the minute-hand.

In the drawings, Figs. 1 to 5, is shown (and the description thus far relates to) one battery O P (of two cells connected up in series) and a circuit-changer (shown in Figs. 4 and 5) to throw in and out of circuit the magnets M or N; but it is well known that a battery-cell after a certain length of time in constant use becomes polarized, thus varying, reducing, or entirely stopping the flow of current until a sufficient interval of rest has restored the power of the cell. To prevent such an occurrence and to maintain the electro-motive force of the current constant, and at the same time to maintain the oscillations of the pendulum of uniform duration and strength, and to prevent a sudden acceleration or retardation, owing to different degrees of strength of the battery-current, I have invented a device which is represented in Figs. 6 and 7.

M and N are the magnets; 1 and 2, two battery-cells.

3 is a circuit-changer, which changes the circuit from the battery to either magnet,

and 4 and 5 are circuit-breakers, which make and break the circuit from either battery 1 or 2.

As shown in Fig. 7, circuit-changer 3 and circuit-breakers 4 and 5 are arranged on the same shaft with each other and with the escapement or impulse wheel S for convenience of illustration. Circuit-changer 3 is composed of a metallic ring having a series of strips of insulation upon its periphery, and having two brushes $3'$ 3^2 resting one on metal and the other on insulation. Circuit-breakers 4 and 5 are exactly alike—*i. e.*, of the same size, &c.—and are composed of a metallic ring having one-half of its periphery metal and the other half insulation, and each provided with two brushes $4'$ 4^2 and $5'$ 5^2, one of each resting on metal and the other on insulation.

Suppose the current to be passing from the positive pole of cell 2 in the direction of the arrows. It will pass to the circuit-breaker 5, to brush $5'$, to magnet N, (as brush 3^2 is resting on metal on circuit-changer 3,) back to the minus pole of cell 2; or should brush $3'$ (on circuit-changer 3) be on metal and brush 3^2 on insulation, then the current would flow to magnet M and back to cell 2. Thus cell 2 is now in use and cell 1 at rest. If the brush $4'$ be on metal and the brush $5'$ on insulation, then the current would pass from cell 1 to line through both magnets alternately, according as to which brush on circuit-changer 3 is on metal and which on insulation, and back to the minus pole of cell 1. Thus cell 1 would be in use and cell 2 at rest. The current passing, say, to circuit-breaker 5 from cell 2 passes away to line through the brush $5'$ on its periphery, and, owing to the fact that the outer brush upon circuit-breaker 4 is upon the insulation, the current cannot return to either battery, but must pass on to the junction of the wires passing around the magnets. Its course here is determined by the position of the brushes $3'$ and 3^2 on circuit-changer 3. The brush 3^2 being on metal, the current will pass through the magnet N to the circuit-breaker 3, and thence along the line back to cell 2. At the point 6, where the minus wire from cell 1 comes to line or forms a junction with the minus wire from cell 2, the current would pass from the line through cell 1 but for the fact that the circuit through that cell is broken at circuit-breaker 4. As the circuit-breakers are continually revolving, it is obvious that the circuit is broken in first one and then the other, and as a consequence the battery-cells are alternately in and out of circuit, thus giving each an interval of rest of longer or shorter duration, according to the diameter of these circuit-breakers and the manner in which they are arranged or geared in relation to the other parts of the clock. At the same time circuit-changer 3 is causing the current to pass through first one and then the other of the magnets M N at each vibration of the pendulum and revolution of the shaft on which the escapement or impulse wheel, circuit-changer 3, and circuit-breakers 4 and 5 are all located.

In Fig. 7 circuit-changer 3 and the circuit-breakers 4 and 5 are shown arranged on one and the same shaft with each other and with the escapement or impulse wheel S, as above stated; but while circuit-changer 3 would probably be always thus arranged, the circuit-breakers 4 and 5 may be arranged upon a separate shaft and timed by suitable gearing to operate at any desired interval of time to throw into and out of circuit cell 1 while cell 2 is resting, and vice versa, thus enabling each cell to recover itself, and this interval of rest may be measured in hours, days, or weeks, &c.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod, electro-magnets between which said armature vibrates with the oscillations of the pendulum, a battery cell or cells or other source of electrical energy, and a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, substantially as hereinbefore described.

2. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod, electro-magnets between which said armature vibrates with the oscillations of the pendulum, a battery cell or cells, a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, and a battery-controller or circuit-changer, also operated by the oscillations of the pendulum, which operates to alternately throw into and out of circuit first one battery and then another, substantially as hereinbefore described.

3. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod located between the pivotal point and its upper end, electro-magnets between which said armature vibrates with the oscillations of the pendulum, a battery cell or cells or other source of electrical energy, and a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, substantially as hereinbefore described.

4. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod located between the pivotal point and its upper end, electro-magnets between which said armature vibrates with the oscillations of the pendulum, a battery cell or cells, a circuit-changing device operated by the oscillations of the pendulum, which de-

vice operates to alternately magnetize and demagnetize the electro-magnets, and a battery-controller or circuit-changer, also operated by the oscillations of the pendulum, which operates to alternately throw into and out of circuit first one battery and then another, substantially as hereinbefore described.

5. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, a battery cell or cells or other source of electrical energy, and a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, substantially as hereinbefore described.

6. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, a battery cell or cells, a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, and a battery-controller or circuit-changer, also operated by the oscillations of the pendulum, which operates to alternately throw into and out of circuit first one battery and then another, substantially as hereinbefore described.

7. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers having buffers on their lower ends and supporting said electro-magnets on their upper ends, a battery cell or cells or other source of electrical energy, and a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, substantially as hereinbefore described.

8. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers having buffers on their lower ends and supporting said electro-magnets on their upper ends, a battery cell or cells, a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, and a battery-controller or circuit-changer, also operated by the oscillations of the pendulum, which operates to alternately throw into and out of circuit first one battery and then another, substantially as hereinbefore described.

9. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets on their upper ends, a battery cell or cells or other source of electrical energy, and a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, substantially as hereinbefore described.

10. In a clock, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets on their upper ends, a battery cell or cells, a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, and a battery-controller or circuit-changer, also operated by the oscillations of the pendulum, which operates to alternately throw into and out of circuit first one battery and then another, substantially as hereinbefore described.

11. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets on their upper ends, a battery cell or cells or other source of electrical energy, and a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, substantially as hereinbefore described.

12. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum,

levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets on their upper ends, a battery cell or cells, a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, and a battery-controller or circuit-changer, also operated by the oscillations of the pendulum, which operates to alternately throw into and out of circuit first one battery and then another, substantially as hereinbefore described.

13. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets M N on their upper ends, adjusting-screws *m n* and springs *o p*, a battery cell or cells or other source of electrical energy, and a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, substantially as hereinbefore described.

14. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets M N on their upper ends, adjusting-screws *m n* and springs *o p*, a battery cell or cells, a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, and a battery-controller or circuit-changer, also operated by the oscillations of the pendulum, which operates to alternately throw into and out of circuit first one battery and then another, substantially as hereinbefore described.

15. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillation of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets M N on their upper ends, adjusting-screws *m n* and springs *o p*, a battery cell or cells or other source of electrical energy, and a circuit-changing device consisting of a spring-finger *a*, lever *b*, and contact-terminals *c* and *d*, which device is operated by the oscillations of the pendulum and itself operates to alternately magnetize and demagnetize the electro-magnets, substantially as hereinbefore described.

16. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets M N on their upper ends, adjusting-screws *m n* and springs *o p*, a battery cell or cells, a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, and a battery-controller or circuit-changer consisting of a ring or rings made of metal and insulation, and a brush or contact on the metal and a brush or contact on the insulation, said brushes or contacts being connected with both the battery or batteries and the electro-magnets, which device operates to alternately throw into and out of circuit first one battery and then another, substantially as hereinbefore described.

17. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets M N on their upper ends, adjusting-screws *m n* and springs *o p*, a battery cell or cells, a circuit-changing device consisting of a spring-finger *a*, lever *b*, and contact-terminals *c* and *d*, which device is operated by the oscillations of the pendulum and itself operates to alternately magnetize and demagnetize the electro-magnets, and a battery-controller or circuit-changer consisting of a ring or rings made of metal and insulation, and a brush or contact on the metal and a brush or contact on the insulation, said brushes or contacts being connected with both the battery or batteries and the electro-magnets, which device operates to alternately throw into and out of circuit first one battery and then another, substantially as hereinbefore described.

18. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-

magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets M N on their upper ends, adjusting-screws *m n* and springs *o p*, a battery cell or cells or other source of electrical energy, a circuit-changing device consisting of a spring-finger *a*, lever *b*, and contact-terminals *c* and *d*, which device is operated by the oscillations of the pendulum and itself operates to alternately magnetize and demagnetize the electro-magnets, an escapement R S, lantern-wheel T, wheel U, lantern-wheel X, pinion X′, lantern-wheel Y, and pinion Z, substantially as hereinbefore described.

19. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets M N on their upper ends, adjusting-screws *m n* and springs *o p*, a battery cell or cells, a circuit-changing device operated by the oscillations of the pendulum, which device operates to alternately magnetize and demagnetize the electro-magnets, a battery-controller or circuit-changer consisting of a ring or rings made of metal and insulation, and a brush or contact on the metal and a brush or contact on the insulation, said brushes or contacts being connected with both the battery or batteries and the electro-magnets, which device operates to alternately throw into and out of circuit first one battery and then another, an escapement R S, lantern-wheel T, wheel U, lantern-wheel X, pinion X′, lantern-wheel Y, and pinion Z, substantially as hereinbefore described.

20. In a clock, the combination of the pendulum-rod C, hung or pivoted at a point D below its upper end on the same shaft with the escapement-pallet R, an armature on said pendulum-rod located between the pivotal point and its upper end, adjustable electro-magnets between which said armature vibrates with the oscillations of the pendulum, levers G H, which cross each other below their fulcrums, and having buffers on their lower ends and supporting said electro-magnets M N on their upper ends, adjusting-screws *m n* and springs *o p*, a battery cell or cells, a circuit-changing device consisting of a spring-finger *a*, lever *b*, and contact-terminals *c* and *d*, which device is operated by the oscillations of the pendulum and itself operates to alternately magnetize and demagnetize the electro-magnets, a battery-controller or circuit-changer consisting of a ring or rings made of metal and insulation and a brush or contact on the metal and a brush or contact on the insulation, said brushes or contacts being connected with both the battery or batteries and the electro-magnets, which device operates to alternately throw into and out of circuit first one battery and then another, an escapement R S, lantern-wheel T, wheel U, lantern-wheel X, pinion X′, lantern-wheel Y, and pinion Z, substantially as hereinbefore described.

21. In a clock, the combination, with the pendulum-rod, of buffers between which the pendulum oscillates and against which the pendulum-bob strikes, substantially as hereinbefore described.

22. In a clock or other measuring apparatus, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of buffers between which the pendulum oscillates and against which the pendulum-bob strikes, substantially as hereinbefore described.

23. In a clock or other measuring apparatus, the combination of the pendulum-rod hung or pivoted at a point below its upper end of levers having buffers on their lower ends between which the pendulum oscillates and against which the pendulum-bob strikes, substantially as hereinbefore described.

24. In a clock or other measuring apparatus, the combination, with the pendulum-rod hung or pivoted at a point below its upper end, of levers which cross each other below their fulcrums, and having buffers on their lower ends between which the pendulum oscillates and against which the pendulum-bob strikes, substantially as hereinbefore described.

This specification signed and witnessed this 22d day of August, 1888.

MARCUS L. M. HUSSEY.

Witnesses:
A. W. KIDDLE,
H. A. CURTIS.