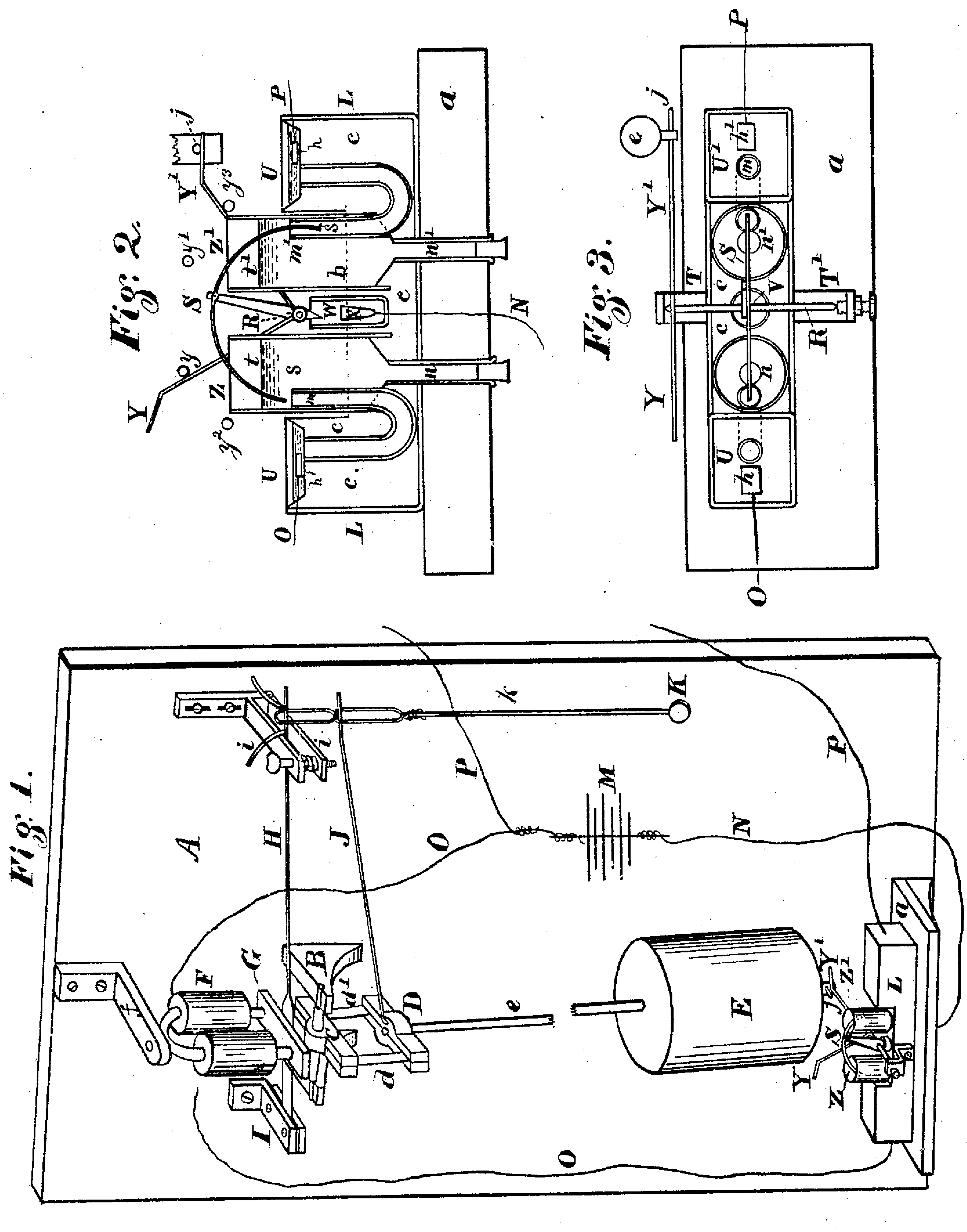
3 Sheets—Sheet 1.

W. M. DAVIS.

ELECTRO-MAGNETIC CLOCK.

No. 176,740. Patented May 2, 1876.



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3 Sheets—Sheet 2.

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ELECTRO-MAGNETIC CLOCK.

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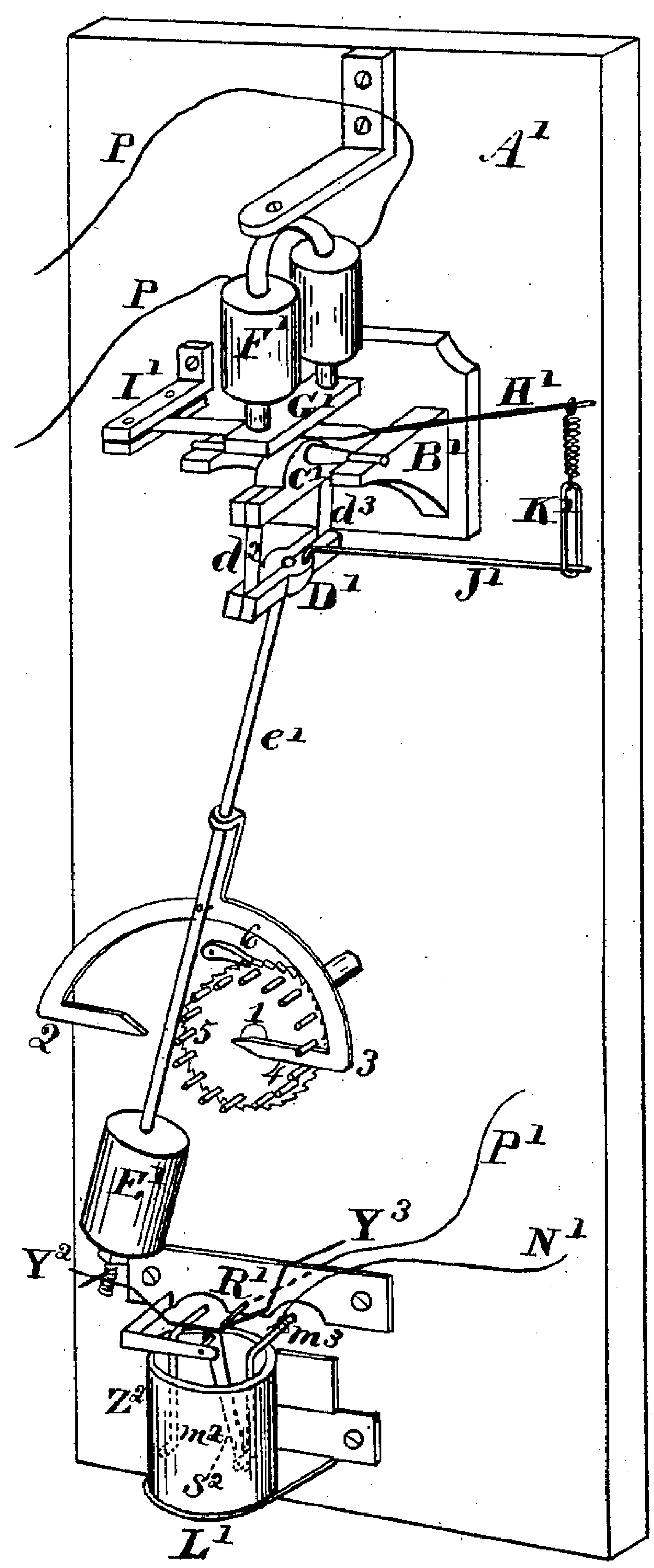
Fig. 4.



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Inventor.

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3 Sheets—Sheet 3.

W. M. DAVIS.

ELECTRO-MAGNETIC CLOCK.

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Fig. 5.

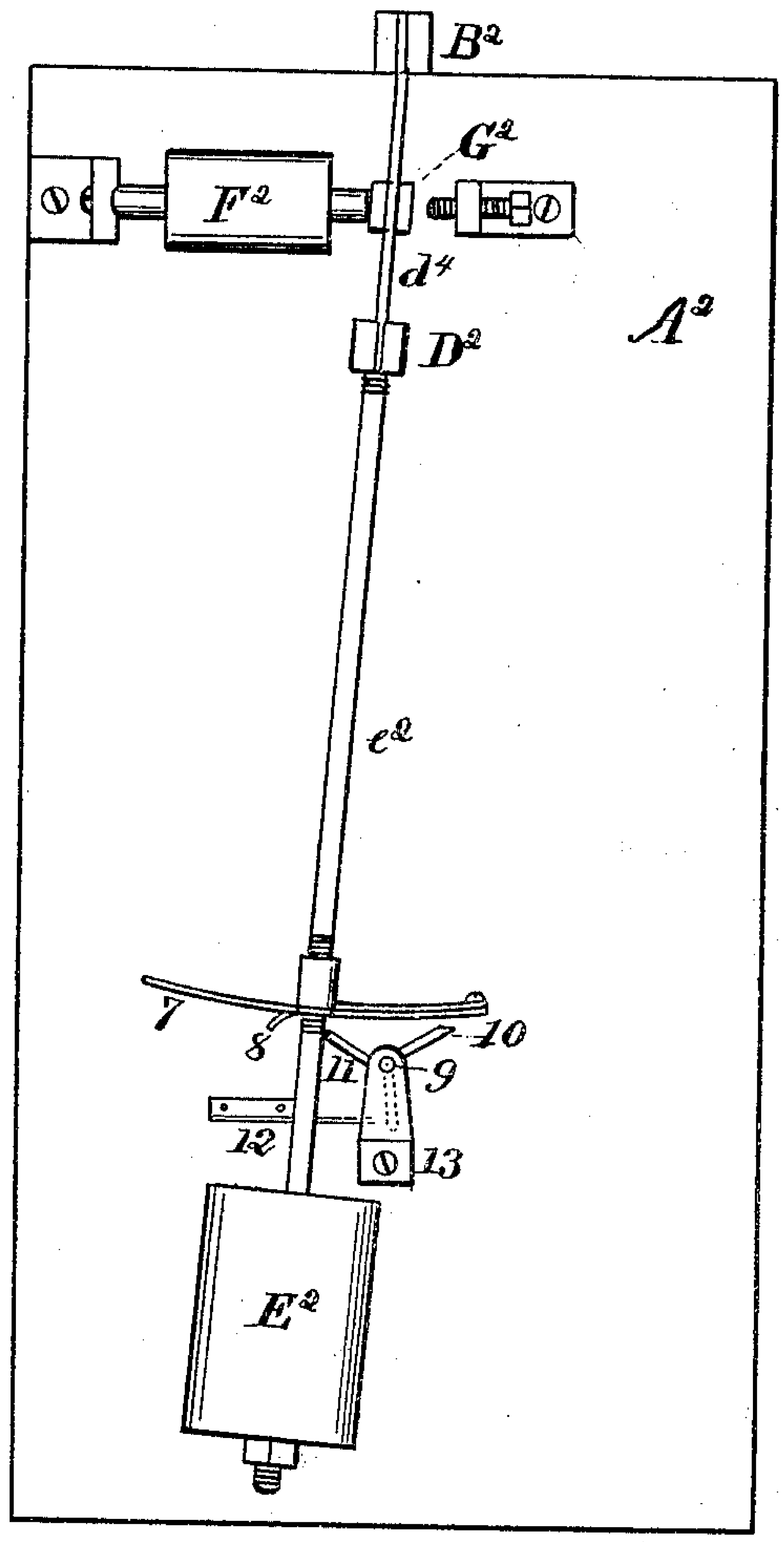
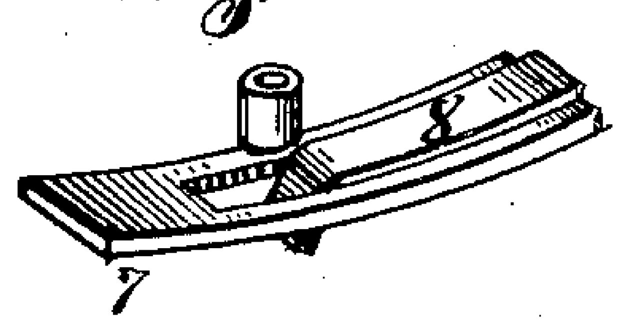


Fig. 6



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UNITED STATES PATENT OFFICE.

WILLIAM M. DAVIS, OF CLEVELAND, OHIO.

IMPROVEMENT IN ELECTRO-MAGNETIC CLOCKS.

Specification forming part of Letters Patent No. **176,740**, dated May 2, 1876; application filed April 19, 1875.

To all whom it may concern:

Be it known that I, WILLIAM M. DAVIS, of Cleveland, county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Electro-Magnetic Clocks; and declare the following to be a full, clear, and exact description thereof, reference being had to the drawings hereto annexed, which form part of this specification.

My invention relates to improvements in that class of electro-magnetic clocks wherein a primary or regulating pendulum or clock is made to propel and regulate any required number of secondary clocks by means of one or more secondary circuits.

The failure of electro-magnetic clocks to come into more general use is attributable, in a great measure, to the heretofore unavoidable deterioration of electrical contact in the impinging surfaces of the rheotome or other current-director necessarily used in connection with such clocks. To obviate this difficulty is the main object of my invention and discovery.

In immersing the impact-points in a liquid medium or immergent any suitable liquid may be employed; but I prefer kerosene, which I have found, by continued experiment, will effectually preserve and maintain these surfaces in that sensitive condition requisite for a prompt and reliable electric contact by the slight touch which the pendulum or chronometer-balance may be able to produce without sensibly affecting its time-keeping qualities.

Without discussing theories upon this question, whatever the difficulty may be which causes this deterioration of the contact-surface, the liquid immergent above mentioned successfully prevents its injurious consequences, either by preventing the production of the cause or by removing the cause as fast as produced.

Whenever one or more extended series of secondary clocks, governed and actuated by one or more secondary circuits issuing from one or more secondary batteries, are to be operated by a single primary pendulum, it is found necessary, in order to preserve the time-keeping qualities of said primary pendulum, to interpose between it and the said secondary circuits one or more intermediate or secondary magnets, which may or may not be provided with pendulums.

These secondary magnets I term auxiliary magnets, and their function is to open and close the secondary circuits by means of circuit-breakers. For this purpose the primary pendulum directs the electric flow from the primary battery alternately through its own impelling magnet and one of the auxiliary magnets, while this latter magnet directs the more intense secondary current or currents through one or more extended circuits of secondary clocks. By preference, the primary device and its auxiliaries are placed near together in a dry, warm chamber, or other place where the changes of temperature are slow and small.

To attach a clock-movement to a primary pendulum tends to impair its time-keeping qualities; therefore the movement is attached to a secondary pendulum, which may be driven by an auxiliary magnet, so as to enable the attendant to keep the entire system of clocks on true time simply by observing and regulating the time of said auxiliary clock.

In the drawings, Figure 1 represents a primary pendulum with a detached gravity-impellent and an oscillating mercurial current switch furnished with the necessary immergent-cups. Fig. 2 is a vertical longitudinal section of said switch, and Fig. 3 a plan view of same. Fig. 4 represents an auxiliary magnet as driving a pendulum and an auxiliary rheotome of hard metal (preferably constructed of platinum) with a suitable immergent-cup, together with a pin scape-wheel and long pallets for driving any preferred clock-movement. The object of this auxiliary magnet and rheotome, or other current-director operated by it, is to relieve the primary pendulum or other regulator from the extra work otherwise required when a number of secondary clocks are to be operated and regulated by a single primary or regulating clock. Fig. 5 represents a secondary pendulum with its impelling-magnet and movable "cock," by the to-and-fro motion of which the pendulum is kept swinging together with its combined feed-hand and detent, operating the spur time-wheel of a secondary clock. Fig. 6 is a view of the curved detent and the attached feed-hand separated from the rod.

In Fig. 1, A is any suitable base for the attachment of the operative parts of the primary pendulum. B is the pendulum-bracket; and

C is a gimbal-bar which rests upon it and clamps the upper ends of one, two, or more suspension-springs, *d d'*. D is a divided clamp-bar for clasping the lower ends of springs *d d'* and the upper end of the pendulum-rod *e*. E is the pendulum-bob. F is an electro-magnet; and G its armature attached to the lifting-lever H, which lever is secured, by a spring, to the adjustable bracket I. *i i'* are adjustable stop-posts to limit the movement of lever H.

This feature of my invention I regard as an improvement over the impellent as shown in a former patent of the United States granted to me October 24, 1871, No. 120,185. In connection with this feature of my invention, I am also aware of a certain invention of V. Himmer, patented June 4, 1872, No. 127,483. I regard the function of my adjustable stop-post as an improvement over the inventions just alluded to, inasmuch as by limiting the movement of the lever H a uniform result is obtained by the action of the magnet, whereas, by the stronger or weaker action of said magnet, the movement of lever H heretofore has been correspondingly affected, thereby materially injuring the time-keeping qualities of the mechanism.

By the adjustable character of my stop-posts *i i'* I am enabled to govern the throw of the lever H exactly to its proper limits, and to control it within the same.

J is a horizontal impulse-arm to give moving impulse to the pendulum, and is secured to the bar D in the plane of the pendulum's swing, but inclined a little upward, as hereinafter shown. K is an impelling-weight attached to the slender wire *k*, which wire has two loops near its upper end, as shown in the drawings. K *k* together constitute a detached gravity-impulse. An attached gravity-impulse may be used in its stead upon this same horizontal arm, provided its spring or pivot attachment coincides very closely with the center of motion of the pendulum. When the pendulum is at rest that portion of the arm J where the impulse-weight impinges should be on a level with the center of motion of the pendulum. *j* is a tappet-pin in the lower end of rods *e* for operating the current-switch L.

The current-switch L is shown in detail in Figs. 2 and 3. M may represent any suitable battery to act as a primary battery, and N a conductor from one of its poles to the central cup of the switch L. O and P are two other conductors, which lead from opposite extremities of switch L to the primary and auxiliary magnets, respectively, and from thence to the other pole of the battery M.

In Figs. 2 and 3, *a* is the base to which the case of current-switch L is attached. This case L is to hold the operative parts of the current-switch, including a suitable cement, *c*, as a support for containing-tubes, as will hereinafter more fully appear. The middle portion of this case is lower than the two end portions thereof, and is represented by the dotted lines *b*, Fig. 2. R is a rock-shaft, to which are secured the arc S, impulse-horns Y Y^1, and the platinum plate W, the shaft being held in position by the double-kneed brackets T T. N, O, and P are continuations of the same conductors shown in Fig. 1 by the same letters. Q is the central glass tube, held in position by cement *c*, and is filled with mercury, to secure a constant and reliable electrical connection between the conductor N and the rock-shaft R, by means of a submerged platinum plate, X, (which is attached to wire N,) and the oscillating plate W, upon the rock-shaft R. $y\ y^1\ y^2\ y^3$ are four stop-posts, to limit the movement of the rock-shaft R. $m\ m^1$ are siphon-shaped tubes, to hold the mercury which is to form electrical contacts with arc S. Z Z^1 are two immergent-cups, which surround, respectively, the longer ends of the tubes m m^1, which are designed to hold the liquid immergent, so as to cover the surfaces of the mercury contained in those tubes. It is this contained liquid which preserves these metallic surfaces in that sensitive and desired condition to electric contacts which is so essential to that prompt and certain electrical connection required for successful operation of electric clocks. This liquid (preferably kerosene) should be a so-called non-conducting medium, but one which will, at the same time, preserve unimpaired the active and conducting power of the contact-surfaces of the current-director to which it is applied, and which it surrounds. The upper surface of this liquid is shown at lines *t t'*, Fig. 2. *n n'* are waste-pipes, to draw off the liquid immergent from cups Z Z^1 whenever it may be necessary. The liquid known as kerosene or coal-oil, also other hydrocarbons, have been used for the purpose just mentioned with satisfactory results. Moreover, many other liquids have been used, but none of them, so far as I am aware, have as yet been subjected to that long and crucial test these liquids (hydrocarbon) have been.

The mercury may be placed in the bottom of immergent-cup Z, and the kerosene or other suitable liquid poured over it with good effect; but the form of vessel herein described, or some equivalent thereof, is preferred, because the liquid immergent with the deflagrated mercury can then be drawn off and new liquid supplied without disturbing the surface of the mercury in the least.

U U' are two reservoirs for mercury, which are bedded in cement *c*, and which communicate with tubes $m\ m^1$, to furnish them with a constant supply of mercury, inasmuch as a minute portion of mercury is deflagrated by the electric spark at every break of either circuit. The mercury in the reservoir U U' and tubes $m\ m^1$ also serves to secure electrical connection between the reservoir U U' and the mercury in the tubes *m m'*, respectively. *h h'* are platinum plates at or near the bottom of said reservoir, to secure constant electrical connection between the contained mercury and the conductors O P. The arc S is made sufficiently long, so that its point s, by the rocking shaft R, is immersed in mercury m before the point s' is withdrawn from the mercury in m^1, and vice versa. By this means the deflagrating effect of the electric spark is materially diminished.

In Fig. 4, which represents the auxiliary magnet and its adjuncts, the letters A^1 to K', inclusive, refer to parts of the auxiliary magnet and its pendulum, corresponding to parts of the primary pendulum in Fig. 1, which are indicated by similar letters. This pendulum is propelled by the elastic force of the spring K', attached by the lever H' to the armature of the auxiliary magnet F^1. L^1 is the rheotome with its immergent-cup Z^2, which is so arranged as to make and break a secondary circuit, which includes the magnets of a number of secondary clocks to be operated by the primary pendulum. P P are continuations of conductor P, as shown in Fig. 1. 1 is a pin scape-wheel for driving any suitable clock-movement, if desired. 2 and 3 are impelling-pallets attached to the rod e^1, to give motion to the wheel.

Rheotome L^1 is constituted as follows: R' is a rock-shaft, to which are attached the pendant vibrating contact-point S^2 and the impulse-horns Y^2 Y^3. The rock-shaft R' is put into electrical connection with conductor P' (which issues from a secondary battery) by any of the ordinary methods. m^2 m^3 are two stationary contact-surfaces, formed of any suitable metal, and so placed and insulated from shaft R' and from each other that each may receive contacts from the lower end of movable point S^2 when that point is actuated by rod e^1. To the upper end of strip m^3 is attached a conductor, N', including the magnets of a number of secondary clocks, and connected with the other pole of the aforesaid battery. Another like wire may be attached to the strip m^2, and so forming another circuit of secondary clocks from the same battery, may run another like number of secondary clocks. Z^2 is an immergent-cup of suitable form, so placed that its contained liquid immergent will completely surround the contact-points m^2 m^3 S^2, so that no part of the cup will interfere with their proper performances.

I do not confine myself, however, to this particular arrangement of parts, as the cup may be placed at a distance from the contact-points and the contained liquid be automatically supplied to them at intervals of more or less frequency, especially if the contacts are made by the friction of the points; or the fixed point may be placed outside of the cup, and the movable point so arranged as to dip into the liquid in the act of breaking the electric circuit. In both cases the advantage of the liquid is secured without making the contacts beneath its surface. This rheotome may be operated directly by the armature of the magnet without the intervention of a secondary pendulum, unless it be desired to operate the clock-movement by said pendulum, so that the entire system of clocks may be kept on time by observing and regulating the time of this one. In Fig. 5 the letters A^2 to F^2 inclusive and E^1 refer to parts of the secondary pendulum corresponding to those of the primary pendulum in Fig. 1, which are indicated by similar letters. G^2 is the armature of the magnet F^2, and at the same time constitutes the movable cock for driving the pendulum e^2. 7 is a curved metallic plate secured to the rod e^2 at the required height, and is designed to perform the functions of a detent. 8 is a feed-hand in the form of a thin metallic spring secured by one end to the upper side of plate 7. The free end of said spring is bent downward through a suitable opening near the center of the plate, as seen in Fig. 6. 9 is a spur time-wheel of not less than three teeth, and is designed to give motion to the secondary clock. 10 and 11 are two teeth of said wheel. 12 is a click, to prevent a backward motion of the wheel 9. 13 is a bracket, to support the outer end of the shaft. In a working machine the spur-wheel and its adjuncts, in order to drive the clock, are placed in front of the pendulum and in connection with a clock, instead of behind it, as shown in the drawings.

Operation: The combined operation of the primary pendulum and current switch L, Figs. 1, 2, and 3, and their effect on the auxiliary magnet and its adjuncts, is as follows: The batteries being charged and all the necessary connections made, the primary pendulum is put in motion by hand. As this pendulum swings to and fro, it tilts the arc S alternately to right and left by the action of pin j in the horns Y Y^1. By this action of the arc S the electric current which flows from the primary battery M, through wire N, to the arc S is directed alternately through the primary magnet F and auxiliary magnet F^1; thence to the other pole of the primary battery.

The effect of these changes in the direction of the current on the primary pendulum may be briefly stated as follows: As represented in the drawing, the pendulum is at the right extremity of its swing, having tilted the arc S to the right, thus closing the circuit through cup Z^1 and breaking it in cup Z. By this action of arc S the entire current is directed through wire P and auxiliary magnet F^1, Fig. 4, while magnet F remains uncharged. Just before this movement of arc S took place, however, arm J had reached the upper end of its loop in wire k, and had lifted that wire quietly from lever H, after which said lever dropped to its lowest point upon the stop-post i', because the magnet F was then discharged.

As the pendulum E e swings to the left, the wire K descends on the arm J, thus imparting motion to the pendulum until the upper loop in the wire K reaches the lever H, when the arm J is relieved from its further pressure. When this relief shall have fully occurred arc S will be tilted to the left, and magnet F, being thereby charged, lifts wire K to its highest point, until the lever H impinges against the stop-post i, and holds it firmly there, until the pendulum nears the right-hand limit of its swing again, when it will be taken gently up by the arm J just before the magnet F is discharged, to be ready to give the pendulum another impulse. These impulses recurring at the proper intervals of time, and being constant in amount, owing, as heretofore stated, to my arrangement of adjustable posts i i', produce a uniform amplitude of swinging of the pendulum. As rod E swings to the right the pin j strikes the horn Y^1, and thrusts the end s' of the arc S into mercury m^1 before the point s of the arc S is withdrawn from the mercury in m, as before shown.

By this arrangement of parts the electric current is at no time entirely arrested, but begins to flow through the mercury in m^1 before it ceases to flow through the mercury in m; hence the name "current-switch" has been given to this portion of my device.

While the arc S remains in the position shown in Fig. 1 the electric current flows through the magnet F^1, Fig. 4, holding up the lever H′, thus giving an impulse to the pendulum E^1 e^1. During this interval the lever H, Fig. 1, is resting on its lower stop-post, and will remain there until the wire K has been deposited upon it by the downward swing of the arm J, after which, by the return swing of rod e, magnet F will be recharged, lifting the weight K to its highest point, preparatory to giving the pendulum another impulse.

This current-switch may be used in connection with a clock which is run by a weight or spring. In this way it may be actuated by the clock-movement instead of the pendulum, as here shown.

The operation of the auxiliary magnet and its adjuncts is as follows: In order that the pendulum, which is driven by this auxiliary magnet, may perform its functions properly, it must first be so adjusted that its natural beat shall coincide closely in time with those of its regulator. When so adjusted, and the necessary connections are made with the primary clock and its battery, the operation proceeds as follows: When the magnet is charged by the action of the primary clock, the armature G^1 is drawn to its poles and firmly held there until the tension thus produced in the spring K′ is expended in giving motion to the pendulum. When this pendulum has reached the normal amplitude of its swing, and begins to move again to the left, the point of pallet 3 strikes the upper side of pin 4 and presses it downward just as point 2 recedes from the upper side of pin 5. On the return swing of the pendulum the point of the pallet 2 strikes the under side of pin 5, and presses it upward just as pallet 3 is withdrawn from the pins opposite, while click or pawl 6 prevents any backward movement of the wheel. By the successive impulses thus given to it this wheel is caused to drive any desired clock-movement to serve the purposes of a secondary clock.

In a working machine the pin-wheel and pallets are placed before the pendulum, and in connection with a clock-movement, instead of behind it, as shown in the drawings. While this pendulum is swinging to and fro the operation of the rheotome L^1 will obviously be as follows: As rod e^1 swings to the left and strikes the horn Y^2, point S^2 impinges and rests against the strip m^3, thus closing the secondary circuit through the wires P′ N′, and secondary magnet F^2, Fig. 5. As rod e^1 swings to the left again, and strikes the other horn of the rock-shaft R′, this circuit will be broken. The making and breaking of the secondary circuit by the operation of the magnet G^1 keeps up a corresponding motion in each of the secondary clocks connected with this secondary circuit, thus insuring their perfect concert of action.

It will be seen that these contacts are made by percussion. By a slight change in the form of slips m^2 m^3, the contacts may be made by friction.

The operation of each of the secondary clocks in Fig. 5 will be as follows: This secondary pendulum E^2 e^2, like others, must be so adjusted that its natural beats will coincide closely with those of its regulator. When so adjusted, and the necessary connections are made between its magnet, the secondary battery, and the rheotome L^1, the action of the several parts will be as follows: The magnet F^2 being charged, the armature G^2 is drawn to its poles, which gives an impulse to the pendulum E^2 e^2 to swing to the left. Just as the pendulum reaches the limit of its leftward swing, the armature G^2 is released from the magnet, thus allowing both the pendulum and armature to swing to the right again. As the pendulum nears the right extremity of its swing, the armature is attracted to the magnet again, thus giving a new and increased impulse to the pendulum to swing to the left. These impulses being repeated at the proper intervals of time soon give to the pendulum its required amplitude of swing, with power sufficient to drive the clock. This operation will now be described. As the pendulum swings to the right, feed-hand 8 slips over the end of tooth 10, and falls down behind it, and as the pendulum swings to the left again, the feed-hand catches tooth 10, and pushes it up in front of it through the opening in plate 7, when, by the onward swing of the pendulum, this tooth is immediately withdrawn again from the said opening just as the next tooth reaches the under side of plate 7, and is there detained by it from further motion. At this point of the operation tooth 11 falls in front of pawl 12, which prevents any backward motion of the wheel, and no forward motion can take place, as the detent never swings entirely beyond the teeth of the wheel. By this arrangement of the parts one tooth, and one only, can be moved forward by each return swing of the pendulum.

What I claim is—

1. The combination, in an electric clock, of the magnet F, armature G, lever H, stop-post *i i'*, and gravity-impellent K K, with the horizontal arm J of a common clock-pendulum, substantially as shown, and for the purpose described.

2. In combination with the contact-points of a rheotome or other director of an electric clock, the immergent-cup Z, constructed substantially as and for the purpose described.

3. The horizontal lever H secured at stud I, thence passing under and beyond the magnet, its further extremity being provided with the gravity-impellent K, and its vertical movement limited by the stop-bars *i i*, substantially as and for the purpose described.

4. The combination of the primary magnet F, primary pendulum E *e*, current-switch L, secondary or auxiliary magnet F^1, with or without a pendulum, E^1 e^1, auxiliary rheotome L^1, secondary or auxiliary battery, and one, two, or more clock-movements, constructed and operated substantially as shown and described.

WILLIAM M. DAVIS.

Witnesses:
J. H. HESSIN,
G. W. STOCKLY.