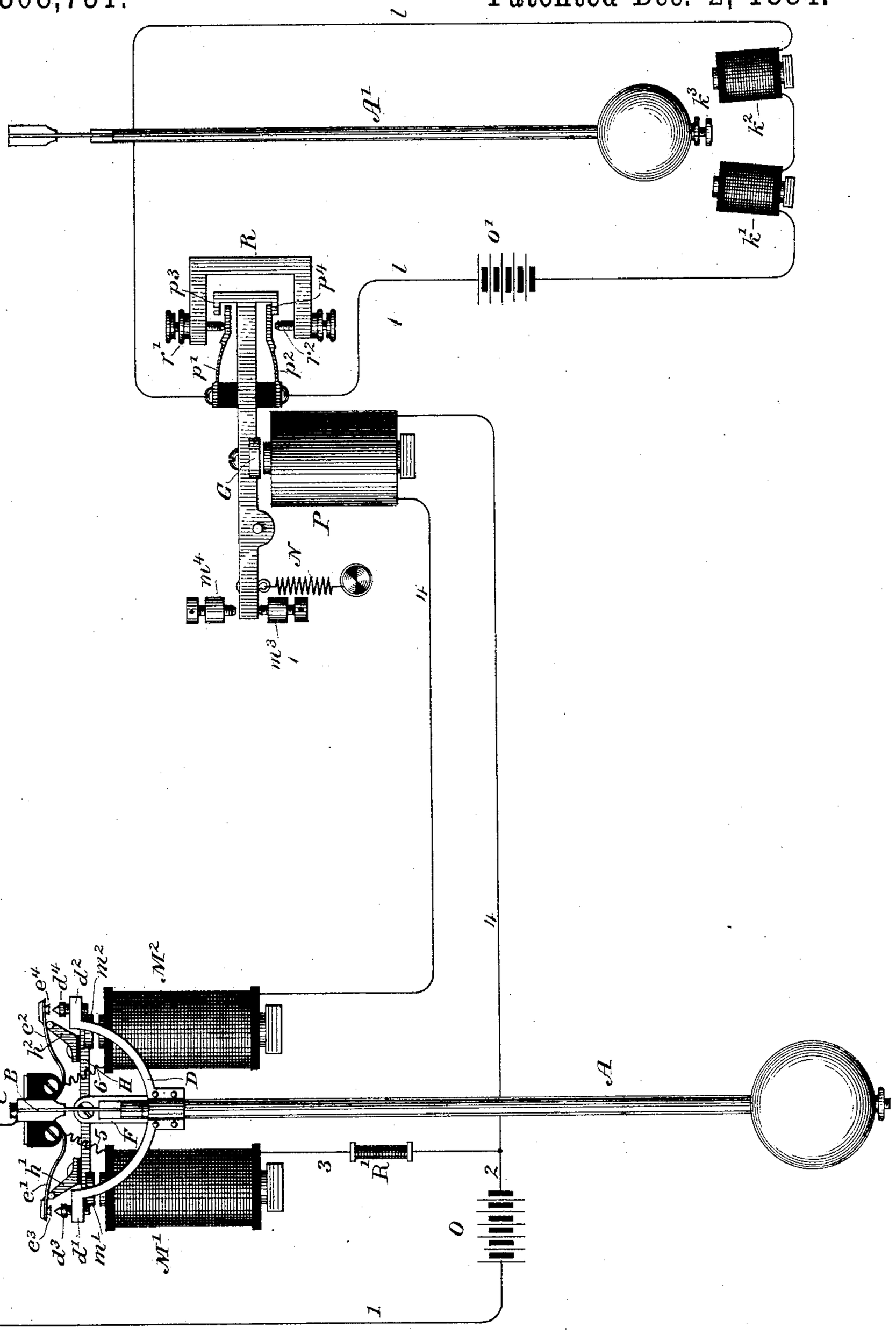
(No Model.)

H. L. BAILEY.

ELECTRIC DEVICE FOR SYNCHRONIZING CLOCK PENDULUMS.

No. 308,731. Patented Dec. 2, 1884.



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ELECTRIC DEVICE FOR SYNCHRONIZING CLOCK-PENDULUMS.

SPECIFICATION forming part of Letters Patent No. 308,731, dated December 2, 1884.

Application filed February 2, 1884. (No model.)

To all whom it may concern:

Be it known that I, HENRY L. BAILEY, a citizen of the United States, and a resident of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Devices for Synchronizing Electric Clocks by Electricity, of which the following is a specification.

My invention relates to the class of apparatus employed for maintaining the vibrating pendulums of a series of clocks in unison with each other.

The object of the invention is to provide means for deriving from prolonged electric impulses—such, for instance, as are obtained by the movements of the pendulum of an electrically-actuated regulator—momentary electric impulses, and to employ these impulses for vitalizing one or more electro-magnets which are designed to act upon one or more vibrating pendulums in the proper manner and at the proper intervals to maintain them in unison with the primary pendulum.

The invention consists in applying to an electric circuit the connections of which are completed and interrupted with the proper frequency an electro-magnet the armature of which causes a second or local circuit to be momentarily closed at each completion and each interruption of the primary circuit.

In carrying out the invention I prefer to provide the armature with two flexible contact-springs and two resting-stops, against which they are normally pressed by their resilience. The two contact-springs constitute the terminals of the secondary circuit. Two contact-stops in electrical connection with each other are respectively applied to the two springs, and against these they are alternately caused to impinge by the movements of the armature-lever. When, however, the armature is in either of its positions of rest—that is to say, either in proximity to or remote from the electro-magnet—one or the other of the springs is forced away from its contact-stop by means of the corresponding resting-stop. At the central point of its vibration, however, both the contact-springs rest against their respective contact-stops and complete the connections of an electric circuit in which are included one or more electro-magnets for synchronizing the pendulums. These electro-magnets are so located with reference to the respective pendulums to which they are applied that they are vitalized by the currents traversing the same at the precise moment an armature carried upon the pendulum is passing its vibration across the field of force of one of the magnets. If, however, any pendulum has been thrown out of unison and swings slightly in advance or behind the primary pendulum, the vitalization of the electro-magnet will occur either immediately after or immediately before the pendulum has passed the electro-magnet. The force thus exerted upon the armature of the pendulum by the electro-magnet will then act either to retard or to accelerate the movement of the pendulum as required, and a unison of the same with the movements of the primary pendulum will eventually be secured.

In the accompanying drawing, which illustrates my invention, I have represented in diagram the organization of circuits and apparatus which I prefer to employ.

Referring to this drawing, A represents the primary pendulum of an electric clock, and A′ represents the pendulum of the secondary electric clock which it is designed to synchronize. The pendulum A is supported in any suitable manner, preferably by a flexible strip of metal, B, secured to the frame or support C. Upon the pendulum A is fixed a bracket, D, having two arms, d' and d^2, respectively projecting from opposite sides of the same. The contact-points d^3 and d^4 are respectively carried at the extremities of the arms d' and d^2.

Above the arms d' and d^2 extend two resilient arms or springs, e' and e^2, secured to, but insulated from, the support C. The contact-points e^3 and e^4 are respectively carried at the extremities of these arms, and they are designed to make contact with the corresponding points, d^3 and d^4, near the respective limits of the vibration of the pendulum A.

Secured to the frame of the mechanism is a bracket, F, upon which is pivoted a table or rocking support, H, having its center of oscillation in the same vertical plane with the support of the pendulum A, but preferably in a lower horizontal plane.

Near the respective extremities of the table H are carried two upwardly-projecting arms, h' and h^2, respectively designed to raise the corresponding spring, e' or e^2, whenever the corresponding end of the table is raised.

In the drawing the table is represented as in a horizontal position, both springs being slightly raised by the arms h' and h^2. If, however, the left-hand end of the table, for instance, be depressed, the spring e^2 will be still further raised, while the spring e' will be allowed to fall, which it will do by virtue of its resilience. The table H is designed to be so operated that the springs or resilient arms e' and e^2 will in this manner be alternately raised by means of the corresponding arms, h', and h^2, when the pendulum is near one limit or the other of its vibration. The remaining spring will at the same time be released, and it will impart an impulse to the pendulum by virtue of the pressure exerted through the contact-points. Two electro-magnets, M′ and M², are provided for tilting the table H alternately in one direction or the other by acting upon two armatures, m' and m^2, respectively attached to the opposite extremities of the table. One pole of a battery, O, is connected through a conductor, 1, with the support C, and thus with the bracket D and contact-points d^3 and d^4. The opposite pole of the battery O is connected through conductors 2, 3, and 4 with the outer terminals of the coils of the electro-magnets M′ and M², respectively, while the inner terminals of these coils are connected through conductors 5 and 6 with the resilient arms e' and e^2, and thus with the contact-points e^3 and e^4, respectively. It will be understood, therefore, that when the contact-point d^3, for instance, is carried by the movement of the pendulum toward the left hand against the contact-point e^3 the circuit of the battery O will be completed through conductors 2 and 3, the coils of the electro-magnet M′, conductor 5, resilient arm e', contact-points e^3 and d^3, bracket D, supporting-spring B, support C, and conductor 1. The electro-magnet M′ will thus be vitalized and the left-hand end of the table H will be drawn downward, thereby releasing the resilient arm e'; hence the arm e' will exert a pressure upon the arm d' through the contacts e^3 and d^3, and the pendulum will be caused to swing toward the right hand, not only by the action of gravity, but also under the influence of the additional force exerted by the spring e'. The resilient arm or spring e' will continue to exert the pressure until it is arrested by striking against the arm h'. The further movement of the pendulum by virtue of its acquired momentum will cause the separation of the contact-points e^3 and d^3, thus interrupting the circuit of the battery O through the electro-magnet M′. The point d^4 will, however, be carried into contact with the point e^4, thereby completing the circuit of the battery O through the conductors 2 and 4, the electro-magnet M², conductor 6, contact-points e^4 and d^4, bracket D, and conductor 1. The electro-magnet M² will thereby be vitalized, and the right-hand end of the table H will be drawn downward, releasing the spring e^2, which will add an impulse to the pendulum A, tending to again vibrate it toward the left hand. This operation will be repeated for each semi-vibration of the pendulum. It is evident that the circuit through one electro-magnet will be completed either immediately before that through the other is interrupted or immediately thereafter, or the completion of one may be simultaneous with the interruption of the other circuit. In practice, however, it is preferable, for use in this organization, that the latter arrangement be employed. Any suitable means may be employed in connection with the contact-points for preventing the occurrence of sparks thereat.

By considering the operation of the instrument thus described it will be seen that the circuit of the battery O is completed one-half the time—say for periods of one second at a time—through the electro-magnet M′, and for equal periods through the electro-magnet M², and that while the circuit is complete through one electro-magnet the circuit through the other is interrupted. An electric current will therefore traverse the conductor 3 for one second, and then the conductor 4 for a like period. It is the purpose of this invention to employ the currents thus obtained for occasioning impulses of short duration, which are caused to traverse the coils of electro-magnets k' and k^2, which are applied to the pendulum A′. For this purpose an electro-magnet, P, is included in the circuit of the battery O by being interposed in one of the conductors leading through the electro-magnet M. In the drawings I have shown this electro-magnet as included in the conductor 4, and an artificial resistance, R′, is preferably placed in the conductor 3, for the purpose of rendering the resistance of the two circuits approximately equal. If desired, however, a duplicate of the electro-magnet P may be substituted for the resistance R′. This electro-magnet is provided with an armature, G, which, so long as the electro-magnet is not vitalized, is withdrawn from its poles by means of a retractile spring, N′. When, however, the circuit of the battery O is completed through the conductor 4, this armature is attracted into its forward position.

Upon the armature G are carried two insulated contact-springs, p' and p^2, which respectively extend beneath two resting-contacts, p^3 and p^4, carried upon opposite sides of the armature. The contact-springs p' and p^2 are respectively provided with adjustable contact-stops r' and r^2. The contact-springs are respectively connected with two terminals of an electric conductor, l, in which is included a battery, o'. The positions of the stops r' and r^2 are so adjusted that at a single point in the vibration of the armature G the two springs p' and p^2 will rest against the respective con-

tact-stops r' and r^2, thereby completing the connections of the battery o' through the springs and the contact-stops and their conducting-support R. When, however, the armature passes beyond this intermediate point, either in its movement toward or away from the electro-magnet P, one of the springs will be carried by the corresponding stop, p^3 or p^4, out of contact with its contact-stop r' or r^2, thereby interrupting the circuit-connections of the battery o'. It will be seen, therefore, that during the movement of the armature the circuit-connections will be completed only for an instant, whether the movement be toward or away from the magnet P. The impulses thus obtained are employed for vitalizing one or more of the electro-magnets k' k^2, which are applied to the pendulum to be synchronized. In the drawing I have represented two electro-magnets, k, as applied to a single pendulum, A', and these are placed near the respective limits of its vibration.

Upon the pendulum A' is carried an armature, k^3, which is designed to be acted upon by the electro-magnets when in proximity thereto. It will be seen that the connections of the battery o' will be completed twice during each complete vibration of the pendulum A. The pendulum A' is therefore, for example, adjusted to vibrate so that it will pass the electro-magnet k' in its outward swing at the instant the circuit of the battery o' is completed by the movement of the armature G away from the electro-magnet P. Likewise the pendulum A' will pass the pole of the magnet k^2 on its outward movement the instant of the completion of the circuit of the battery e' by the movement of the armature G toward the electro-magnet P. So long, therefore, as the pendulums swing in unison the resultant effect of the magnets upon the armature, and thus upon the pendulum A', will be of no value, and the pendulum will continue to vibrate without being affected thereby. If, however, the pendulum A' be in advance of the pendulum A, the armature k^3 will have passed the center of the field of force of the magnet k', for instance, during the outward movement immediately before the correlative completion of the circuit of the battery o' occurs. The action of the magnet k' will therefore be to retard the pendulum upon its outward movement. The action of the magnet k^2 will be the same, and eventually the pendulum A' will be brought into unison with the pendulum A. The action of the electro-magnets upon the pendulum, when the latter has fallen behind the primary pendulum A, is the reverse of that described—that is, they will act to impel the same with greater rapidity, adding an accelerating impulse each time the circuit of the battery o' is completed. When the secondary or synchronized pendulums have once been brought into unison with the pendulum A, they will remain so, provided they are adjusted so that they will naturally swing in approximately the same periods.

It is evident that one electro-magnet, k' or k^2, might be employed alone in connection with each pendulum; or the latter might be constructed to beat with twice the rapidity of the pendulum A—that is to say, their periods might be one half the length of the period of the pendulum A. It is evident, moreover, that various other forms of primary circuit-closing devices may be employed for completing the primary circuit.

The limiting-stops m^3 and m^4 are preferably applied to the armature G, and these are rendered adjustable. By adjusting the positions of these stops with reference to the contact-stops r' and r^2, the position occupied by the armature G at the moment the circuit of the battery e' is completed may be readily adjusted. This feature is of value when it is desired to modify the position of the armature in which it shall act to complete the secondary circuit.

It is evident that there are various other methods of deriving the momentary impulses from the periodic impulses; but it is not deemed necessary to further illustrate the invention.

I claim as my invention—

1. The combination, substantially as hereinbefore set forth, with a clock-pendulum and an electric battery the circuit-connections of which are completed and interrupted through the action of said pendulum, of one or more secondary pendulums, one or more synchronizing electro-magnets applied to said secondary pendulums, and an electro-magnet included in the circuit of said battery and acting to momentarily complete the connections of an electric circuit through the coils of said synchronizing-magnets each time the connections of the first-named circuit are completed or interrupted.

2. The combination, substantially as hereinbefore set forth, with a regulating-pendulum, a circuit-closer actuated thereby, and an electric circuit the connections of which are periodically completed and interrupted by the action of said circuit-closer, of a secondary electric circuit the connections of which are momentarily completed at each completion and interruption of the first-named circuit, and one or more electro-magnets included in said secondary circuit.

3. The combination, substantially as hereinbefore set forth, with a regulating-pendulum, a circuit-closer actuated thereby, a battery, and a circuit for said battery, the connections of which are periodically completed and interrupted by the action of said circuit-closer, of a second battery, one or more electro-magnets included in the circuit of the same, an electro-magnet vitalized by the first-named battery, an armature applied to the last-named electro-magnet, contact-springs applied to said armature and constituting terminals of the circuit of said second battery, contact-points for said springs, which points are in electrical connection with each other, with which points said springs are respect-

ively in momentary contact during the movement of said armature toward or away from its electro-magnet, whereby the circuit-connections of the second battery are caused to be both completed through the first-named electro-magnets and interrupted during each movement of the last-named armature.

4. The combination, substantially as hereinbefore set forth, of a pendulum, a circuit-closer actuated thereby, a battery, a circuit for the same, a second battery the connections of which are completed by said circuit-closer, an electro-magnet included in said circuit, an armature and armature-lever applied thereto, and contacts, substantially such as described, serving to momentarily complete the connections of said second battery during each movement of said armature either toward or away from its electro-magnet at an intermediate point in its excursion.

5. The combination, substantially as hereinbefore set forth, with an electro-magnet and means, substantially such as described, for periodically vitalizing the same, of a battery the circuit of which is completed each time said magnet is magnetized or demagnetized, one or more clock-pendulums, and one or more electro-magnets included in the circuit of said battery applied to said pendulums, substantially as described.

6. The combination, substantially as hereinbefore set forth, with an electro-magnet and its armature, and means, substantially such as described, for periodically vitalizing the same, of two contact-stops in electric connection with each other, applied to said armature, two contact-springs carried upon said armature, and caused by the movements of the same to alternately impinge against their respective contact-stops, an electric circuit the terminals of which are respectively connected with said contact-springs, and means, substantially such as described, for causing one of said contact-springs to impinge against the contact-stop before the other spring has been carried away from its stop.

7. The combination, substantially as hereinbefore set forth, of a pendulum, a circuit-closer actuated thereby, a battery, a circuit for the same, a second battery the connections of which are completed by said circuit-closer, an electro-magnet included in said circuit, an armature and armature-lever applied thereto, contacts, substantially such as described, serving to momentarily complete the connections of said second battery during each movement of said armature either toward or away from its electro-magnet at an intermediate point in its excursion, and means, substantially such as described, for modifying the length of time during which said second circuit shall be thus completed.

In testimony whereof I have hereunto subscribed my name this 31st day of January, A. D. 1884.

HENRY L. BAILEY.

Witnesses:
DANL. W. EDGECOMB,
CHARLES A. TERRY.