H. E. WARREN.

ELECTRIC APPARATUS FOR DRIVING CLOCKS OR SIMILAR MECHANISM.

APPLICATION FILED DEC. 23, 1909.

1,089,886.

Patented Mar. 10, 1914.

5 SHEETS—SHEET 1.

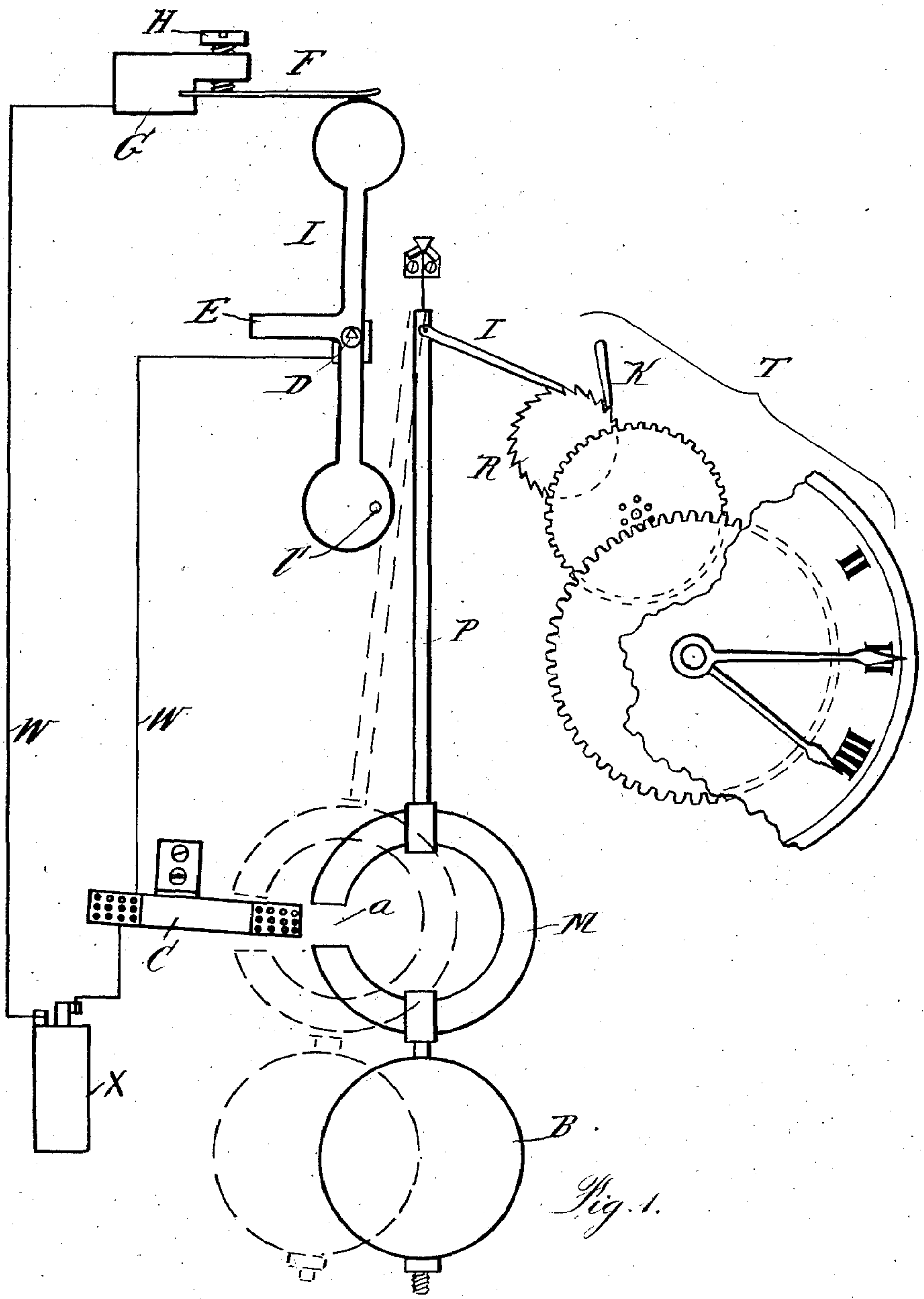

Fig. 1.

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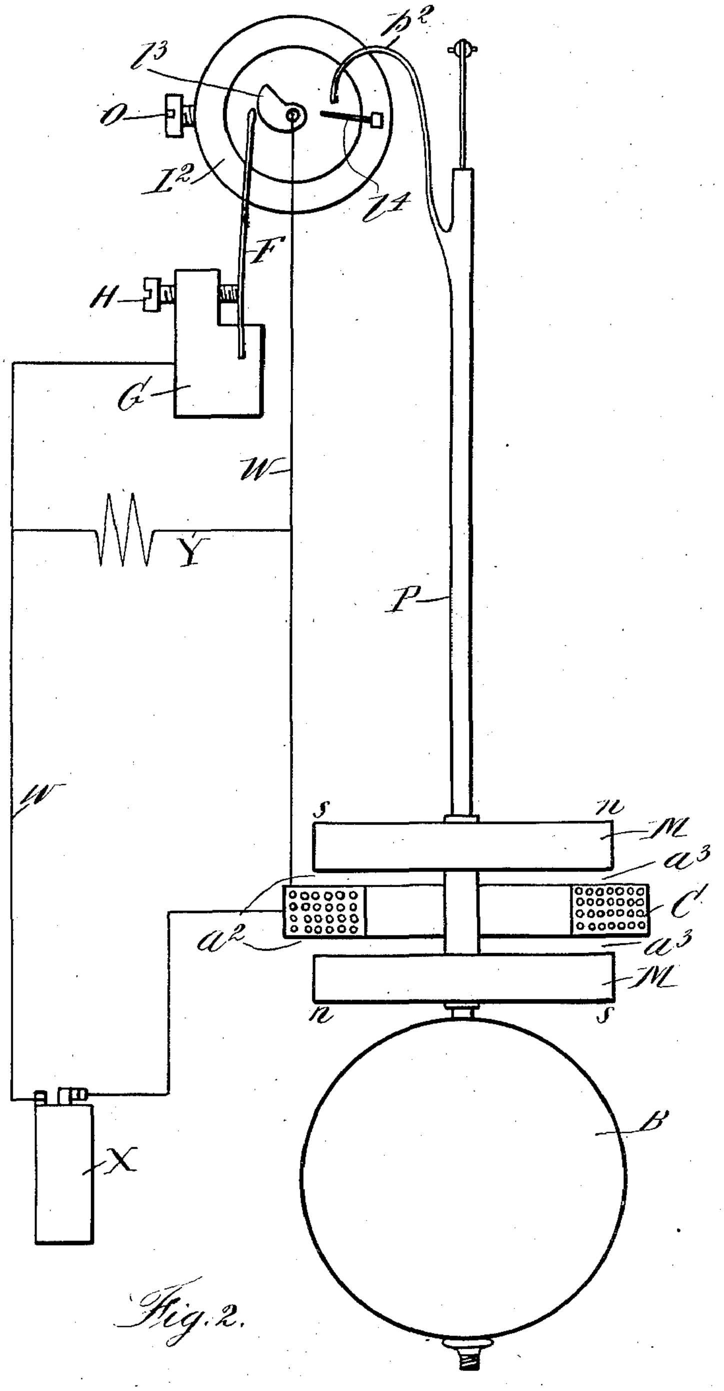

Fig. 2.

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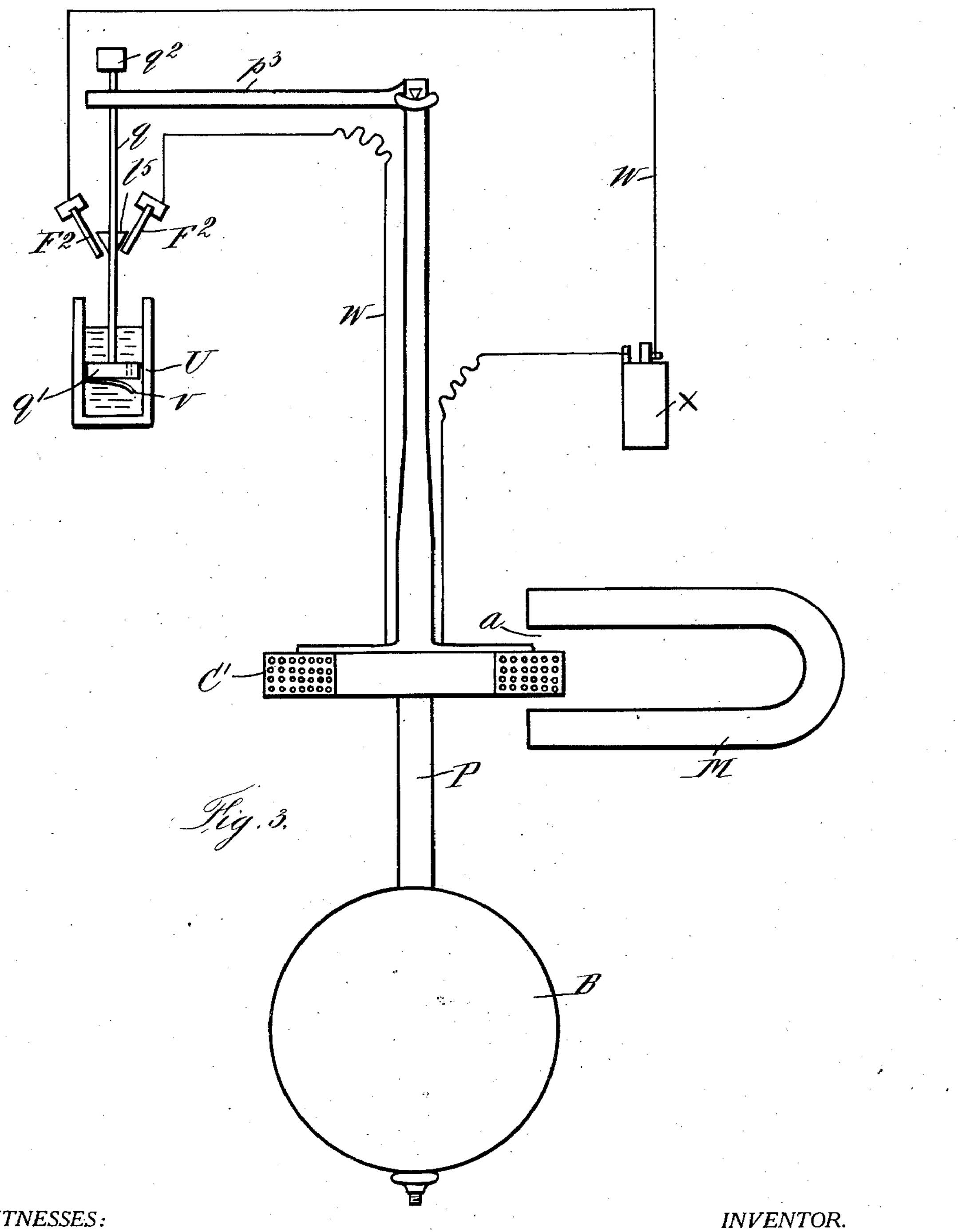

Fig. 3.

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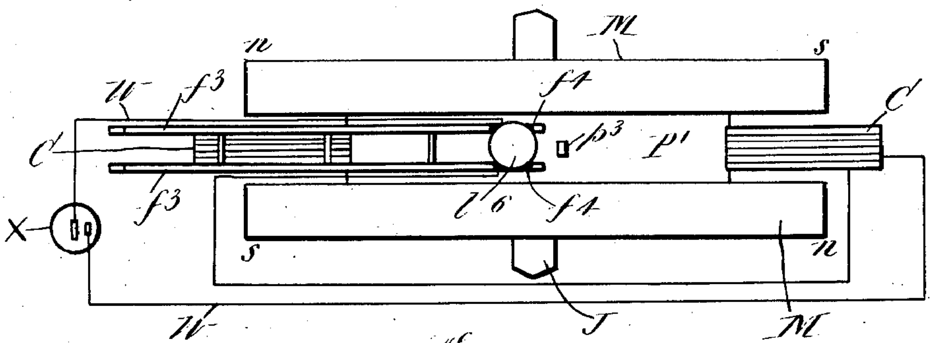

Fig. 5.

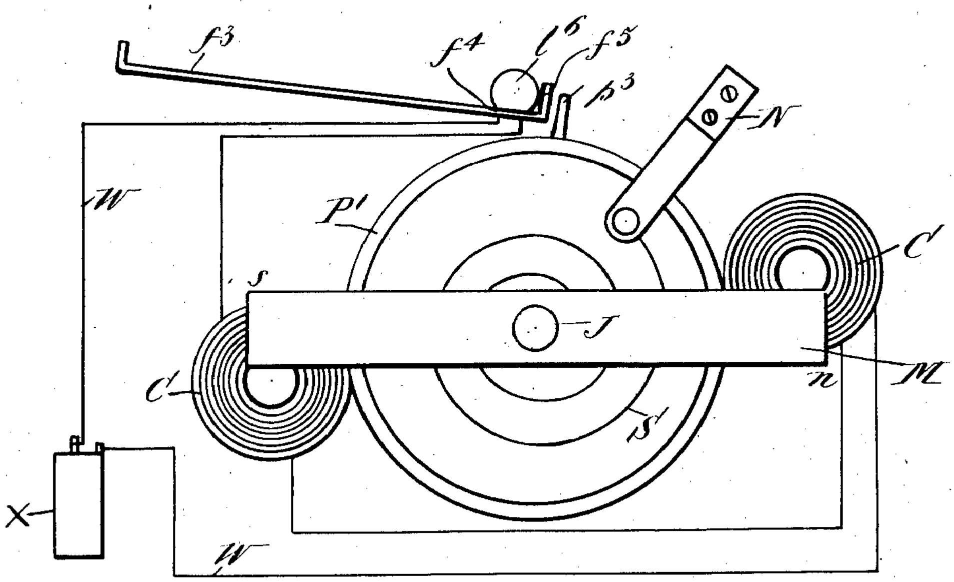

Fig. 4.

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5 SHEETS—SHEET 5.

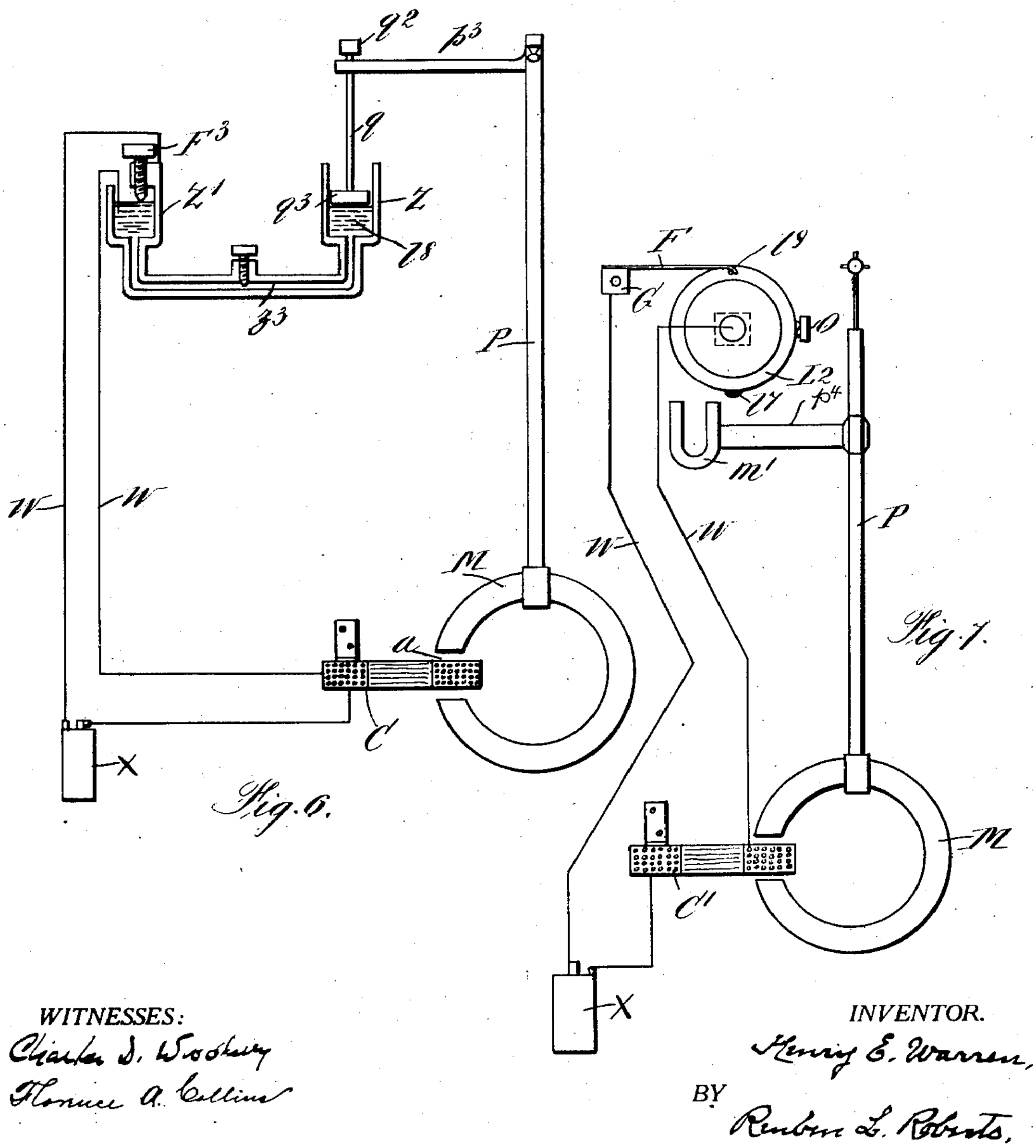

Fig. 6.

Fig. 7.

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UNITED STATES PATENT OFFICE.

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ELECTRIC APPARATUS FOR DRIVING CLOCKS OR SIMILAR MECHANISM.

1,089,886. Specification of Letters Patent. **Patented Mar. 10, 1914.**

Application filed December 23, 1909. Serial No. 534,686.

To all whom it may concern:

Be it known that I, Henry E. Warren, a citizen of the United States of America, and resident of Ashland, in the county of Middlesex and Commonwealth of Massachusetts, have invented Improvements in Electric Apparatus for Driving Clocks or Similar Mechanism, of which the following is a specification.

The invention relates to electrical apparatus for propelling clocks and similar apparatus, and is an improvement upon that shown and described in my Letters Patent No. 927,907 dated July 13, 1909.

It consists in an improved form of electrical contacts in the circuit, which are periodically separated by the oscillating device, and of the electrical devices by which the pendulum or other oscillating device is given periodic added impulses while in oscillation.

In my said prior patent the electrical contacts are constructed of resilient material and supported so that when they came together after separation they would repeatedly rebound until the resilient energy due to their impact is dissipated. In this improved construction the electrical contacts of the make-and-break device are constructed and arranged in such manner that when they have been separated by the action of the oscillating device they come together again after a time interval with a dead beat movement, and there is no rebounding action as in said prior patented construction. The improved electrical devices for giving the oscillating device added impulses while oscillating, consist of one or more permanent magnets having air-gaps across which is a permanent magnetic field, and an electric conductor adapted periodically to cut the lines of force in said field, so that when current is passing through the conductor there will be mutual attraction or repulsion, and in consequence a tendency to cause relative motion between the magnet and electric conductor, either of which may be stationary and the other caused to move in relation thereto. Thus far I have found that the preferable arrangement is to attach the permanent magnet to the oscillating device, and in such position that the lines of force across the air-gap will in the case of a pendulum be chiefly, approximately radial to the axis of oscillation, and to hold the electric conductor, which preferably may consist of a coil of many turns of fine wire, in such a fixed position that when the oscillating device with the attached magnet is in motion the electrical conductor will enter the air-gap and cut the lines of force in the permanent field, at each recurrent swing of the oscillating device, and if the circuit is closed at the make-and-break device, and current is passing through the electrical conductor, the magnet upon the pendulum will, for example, be attracted, and thus given an added impulse which will increase the amplitude of its swing. This will occur whenever the swing of the oscillating device is not sufficiently great to cause it to strike the movable electrical contact before it has come to a state of rest. The period of movement of this contact will vary with the force by which it is struck by the oscillating device, which depends upon the amplitude of its oscillation; the minimum time interval for an out and return movement of the electrical contact should be approximately the same as a single swing of the pendulum, although the mechanism will operate if the time of such movement of the contact is less; while the maximum time interval for such a movement of the contact, when struck with greater force by the pendulum due to an increased amplitude of swing, should at least be equal to the double period of swing of the pendulum, or one period of oscillation.

In the drawings forming a part of this specification,—Figure 1 is a front elevation of one form of the improved electrical devices with a detached portion of a clock mechanism and with the magnet attached to an oscillating pendulum; Fig. 2 is a front elevation of another form of electrical devices with an oscillating wheel as a means for breaking and making contact, instead of a pivoted lever; Fig. 3 is another form in which an arm on the swinging pendulum raises a rod carrying a device which breaks contact at two points, and its return is controlled by a dashpot; Figs. 4 and 5 are an elevation and plan of still another form in which an oscillating balance wheel is employed in place of a pendulum and a ball upon an inclined plane as the make-and-break device. Fig. 6 shows another form of make-and-break device in which are two vessels connected by a restricted passage and containing an electrical conducting liquid, a piston or float resting upon the liquid in one vessel and adapted to be raised by the swing of the pendulum, and an adjustable contact in the other vessel by which the vertical movement of the float in one vessel changes the level of the liquid in the other vessel, and makes or breaks the circuit through the adjustable contact therein; Fig. 7 illustrates one means by which the make-and-break device is operated by magnetic means controlled by the oscillating device.

Designating the several parts of the mechanism by reference letters and using the same letter for the same or similar part in the several figures, referring first to Fig. 1, P is a pendulum rod and B the bob, adjustable on the rod in the usual manner; M is a permanent magnet attached to the rod P, and provided with an air-gap a, so located that the magnetic lines of force will pass across such gap in a direction substantially radial to the axis of oscillation of the pendulum.

C is a coil of fine wire fixed in such position in relation to the magnet M that when the pendulum swings, all of the conductors in one half section of the coil C pass through the air-gap a and cut the magnetic lines of force therein. The coil C is connected in circuit with a source of electrical supply, for instance, a battery X. The make-and-break device also in the same circuit consists of a lever L hung upon a pivot D and provided with a counterbalance E. The upper end of the lever L serves as the movable contact and a spring F held in a fixed support G at one end and its free end projecting into a position to bear upon the upper end of the lever L, serves as the other contact. A screw H extends through a portion of the support G, and bears upon the spring F; thus its degree of pressure upon the contact L may be regulated. On the lower end of the lever L is a projecting pin l' against which the pendulum rod P will strike at each return swing, unless its amplitude falls below the prescribed minimum. When the pendulum rod strikes the pin on the lower end of the lever L, its upper end is moved to the right and its contact with the spring F is broken, and the circuit W from the battery X through the coil C and lever L, is opened. The time interval between the breaking of this contact and the return of the lever to contact with the spring F is determined by the force of the blow of the pendulum rod against the pin l'. While the pendulum is swinging in the opposite direction and returning, the counterweight E acts upon the lever L and swings its upper end back into contact with the spring F, which as it slides over the end of the lever creates sufficient friction to arrest its movement and bring it to a state of rest without any rebounding action.

T indicates a part of a clock train, operated by a pawl I pivoted to the pendulum rod P, and engaging a ratchet wheel R.

K is a pawl to prevent retrograde movement of the ratchet wheel. Assuming that the current through the coil C is such as to cause it to attract the magnet M, whenever the blow of the pendulum rod P upon the pin l' is not sufficient to cause the lever L and spring F to remain out of contact for a longer interval of time than that required for the pendulum to swing out and back, or a complete period of oscillation, the contacts F and L will have come together, the circuit through the coil C will have been closed, and the magnet M will receive an additional pull as it approaches the coil and the pendulum will receive an added impulse to its oscillation.

In Fig. 2, instead of a counterbalanced lever as the make-and-break device, a counterbalanced wheel L^2 is shown, provided with a cam surface l^3 about its axis and with relation to which the spring F is located so as to make contact when the cam is turned. This wheel is caused to oscillate by the action of the pendulum when it swings, by means of a spring arm p^2 thereon, which strikes a projecting flexible pin l^4 upon the wheel L^2, and thus gives it a rotary movement sufficiently great in the direction of the hands of a watch to break contact between the spring F and the cam l^3, and open the circuit W, W. In the arrangement here shown a shunt circuit Y is provided between the wires W, W, so that when the circuit is broken between F and l^3 a small current will still flow through the shunt circuit, and thus lessen the tendency to spark when the said contacts separate. A condenser may be substituted for the shunt Y. In this construction, also, the conducting wire coil C is held in a position so as to surround the pendulum rod P and stand between two magnets M, M, fixed upon that rod; thus the coil cuts the lines of force in two air-gaps a^2, a^3, between the respective ends of the two permanent magnets, they being arranged with ends of opposite polarity upon opposite sides of the respective air-gaps. As in the arrangement shown in Fig. 1, after the contacts F and l^3

have been separated by the rotary movement of the wheel L^2, the wheel will be returned slowly to its former position by the action of a counterweight at the screw O, and the spring F will strike the cam surface l^3 with a sliding frictional contact, and immediately bring it to a state of rest, and close the circuit W, W, that is, the circuit will be closed and the pendulum P given an added impulse upon its return swing, provided the contacts F and l^3 have come together before the pendulum arrives at the limit of its return swing.

Fig. 3 illustrates a still further modification, in which the coil C of conducting wire is attached to the pendulum rod P, and the circuit wires W, W, lead therefrom to two separate contact terminals F^2, F^2; one branch of this circuit is through the battery X. Herein the permanent magnet M is of horseshoe form and is fixed in such a position that as the pendulum swings the coil C will pass into the air-gap between the poles of the magnet M and cut the lines of force which extend across the gap. The means for closing the circuit at the terminals F^2, consists of a contact piece l^5 shown as wedge-shaped, and attached to a rod q which extends up between the said terminals, the lower end of the rod being provided with a loosely fitting piston q' within a vessel of liquid U, thus acting as a dashpot. The piston has a hole through it controlled by a clack-valve v upon the under side so that the liquid will readily pass through when the piston is raised, and the valve will close when the piston is lowered by force of its weight, the liquid slowly passing between the periphery of the piston and the interior surface of the vessel. An arm p^3 which extends from the pendulum rod P is adjusted so as to engage the rod q below the block q^2, which is made adjustable vertically thereon; and when the pendulum swings to the left the arm p^3 will engage the block q^2 on the rod q and raise it with the piston q', and at the same time separate the contact piece l^5 from the terminals F^2, F^2, and open the circuit W, W, at two points. By means of the dashpot U the contacts l^5, F^2 will be caused to move slowly together again, while the pendulum is swinging to the right and back to the left, when it will again raise the rod q and open the circuit W, W.

In Figs. 4 and 5 another modification is shown, wherein the oscillating device consists of a wheel P′ supported upon a journal J secured to which upon opposite sides of the wheel P′ are permanent magnets M arranged in parallel position, with their ends of opposite polarity opposite one another, as indicated by letters n, s, and in the air-gaps between the respective ends of the permanent magnets, coils of fine wire C are located, but in the normal position of the magnets the center of the cores of the respective coils C are out of the longitudinal median line of the magnets and upon opposite sides thereof, so that when current is passing through the coils they will act upon the magnets and attached wheel P′ and give it an added impulse at each return oscillation. In this form the means for making and breaking the circuit through the coils C consists of a track f^3 of insulating material, inclined upward from the wheel P′; at the lower end of each side of this track is a small section f^4 of electrical conducting material, each section being connected with one of the wires of the circuit W, W. Upon this track is a metallic ball l^6 which normally rests upon two metallic sections f^4 of the track, and thus electrically connects the two and closes the circuit W, W. A stop is provided at either end of the track f^3 to prevent the ball l^6 from accidentally running off, the stop at the lower end being provided with non-resilient material a piece of felt f^5, for instance to prevent rebounding of the ball. As illustrated, the track f^3 is placed at right angles to the journal of the wheel P′ and with its lower end substantially over the vertical diameter of the wheel, upon the periphery of which is a radially projecting finger p^3, in line with the space between the two sides of the track, so that as the wheel oscillates the finger p^3 will, when moving to the left, strike the ball l^6, remove it from the metallic contacts f^4, and send it up the inclined track a greater or less distance, depending upon the force with which it is struck by the finger p^3, and thus determine the length of time that the circuit W, W, will remain open. The oscillation of the wheel P′ is against the stress of a helical spring S, the inner end of which is secured to the wheel and the outer end to a fixed bracket N.

Referring to Fig. 6, the make-and-break device consists of two vessels Z, Z′, connected by a passage z^3. These contain a suitable amount of electrical conducting liquid l^8, such as mercury. Within vessel Z is a piston or float q^3, which rests upon the liquid therein and has an attached rod q provided with a block q^2 at its upper end. As in Fig. 3, an arm p^3 extends out from the pendulum rod P so as to engage the vertically adjustable block q^2 and lift the rod q and piston q^3 when the pendulum swings to the left. The raising of the piston q^3 causes the liquid previously displaced thereby to flow into the vessel Z from the vessel Z′, thus lowering the level of the liquid in the latter and withdrawing it from the adjustable contact F^3, which is connected with one of the circuit wires W and thus the circuit is opened. When the pendulum swings to the right, the piston p^3 presses down upon the liquid in the vessel Z again, and slowly forces back to the vessel Z′ through the passage z^3 an amount of liquid equal to the weight of the piston and its rod, thus raising the level of the liquid in Z′ until it comes into contact with the screw F^3 and closes the circuit W, W. By means of a screw z^4 the size of the passage z^3 may be varied, and the time that the circuit shall remain open, regulated. Also as the swing of the pendulum varies it will hold up the piston q^3 for different intervals of time, so that a varying amount of liquid will flow into the vessel Z and thus regulate the interval of time that the circuit remains open. In practical operation the piston q^3 is not separated from the liquid.

Fig. 7 illustrates means by which the make-and-break device is operated magnetically, wherein the wheel L^2 is provided upon its periphery with a soft iron strip l^7; and upon an arm p^4, which extends from the pendulum rod P, is a magnet m', and this is caused to attract the strip l^7 as it passes at each swing of the pendulum, thereby turning the wheel L^2 to the left and separating the contact pin l^8 on the wheel from the spring contact F, thus opening the circuit W, W. As in Fig. 2, the counterweight O slowly turns back the wheel L^2 and puts F and l^8 again into contact.

In the construction and arrangement of the electrical devices for impelling the oscillating device herein described, the air-gaps in the permanent magnets may be sufficiently large and so located with respect to the conducting coil as to give free and unobstructed movement of the oscillating device in all directions within practical limits, and no interference will occur from the collection of dust upon the parts or the lack of perpendicularity of the mechanism.

As previously stated, when an arrangement such as shown in Fig. 2 with a shunt resistance in the circuit is used, current is never completely interrupted therein, and the oscillating device will continue to receive small impulses of the same frequency as the swing of the device.

The attraction or repulsion of electrical or magnetic means may be employed to operate the make-and-break devices instead of the direct push of the oscillating device, as shown in Fig. 7, and also instead of gravity, a spring or a magnet may be employed to return these devices to contact after separation. The purpose of this invention is to provide means which receive motion from an oscillating device, and, with the introduction of a time lag in such movement, operated by single electrical impulses to impart added kinetic impulses to the oscillating device at the proper time and of such varying magnitude as to maintain a practically constant amplitude of swing, and to eliminiate the multiple electrical impulses of greater frequency generated in the construction set forth in my said prior patent, all of which impulses excepting those of the same frequency as the oscillations of the oscillating device are unnecesary, tend to injure the contact surfaces by frequent making and breaking of the circuit, and also cause a needless consumption of electric energy.

I claim:—

1. The combination of an oscillating device, electrical means to give it added impulse when oscillating, mechanism to open the electric circuit operated by the oscillating device, and operated by other means to close the circuit, with a dead-beat contact after time intervals, the extent of which are determined by the amplitude of swing of the oscillating device.

2. The combination of an oscillating device, electrical means to give it added impulse when oscillating, a contact maker operated by the oscillating device to open the impulse giving circuit, other means as a counterweight to act upon the contact-maker to close the circuit, and means to arrest the kinetic force of such contact and prevent resilient action when closing the circuit.

3. The combination of an oscillating device, electrical means to give it added impulse when oscillating, a make-and-break device in the electric circuit which is operated by the oscillating device to open the circuit and automatically to close the circuit, one member of the make-and-break device having resilient frictional contact to cause the kinetic energy of the movable member to polish the contact surfaces and to prevent resilient action.

4. The combination of a pendulum, a permanent magnet having an air-gap, and so placed that its magnetic lines of force across the gap are chiefly in a direction approximately radial to the axis of oscillation of the pendulum, and an electric conductor, in the form of a coil with its axis substantially parallel to the lines of force across the air gap of the magnet which lines will be cut by the electric conductor when the pendulum oscillates, and means to supply current to the conductor intermittently.

5. Means to impart energy to an oscillating device consisting of a permanent magnet having a relatively short air gap in which the lines of force are concentrated and approximately parallel, and an elec-

tric conductor in the form of a flat coil, the planes of the convolutions of which are perpendicular to the lines of force across said air gap, one of said means being mounted in such position upon the oscillating device that the magnetic lines of the magnet will cut across the convolutions of the conductor when the device is oscillating, and means to supply current to the conductor intermittently.

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