H. E. WARREN.

ELECTRIC APPARATUS FOR DRIVING CLOCKS OR SIMILAR MECHANISM.

APPLICATION FILED JAN. 27, 1911.

1,186,459. Patented June 6, 1916.

2 SHEETS—SHEET 1.

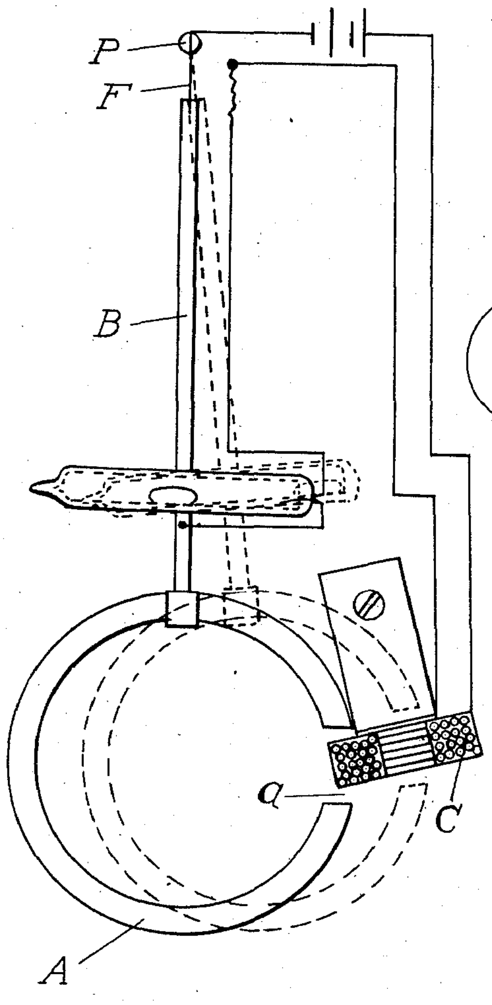

Fig. 1

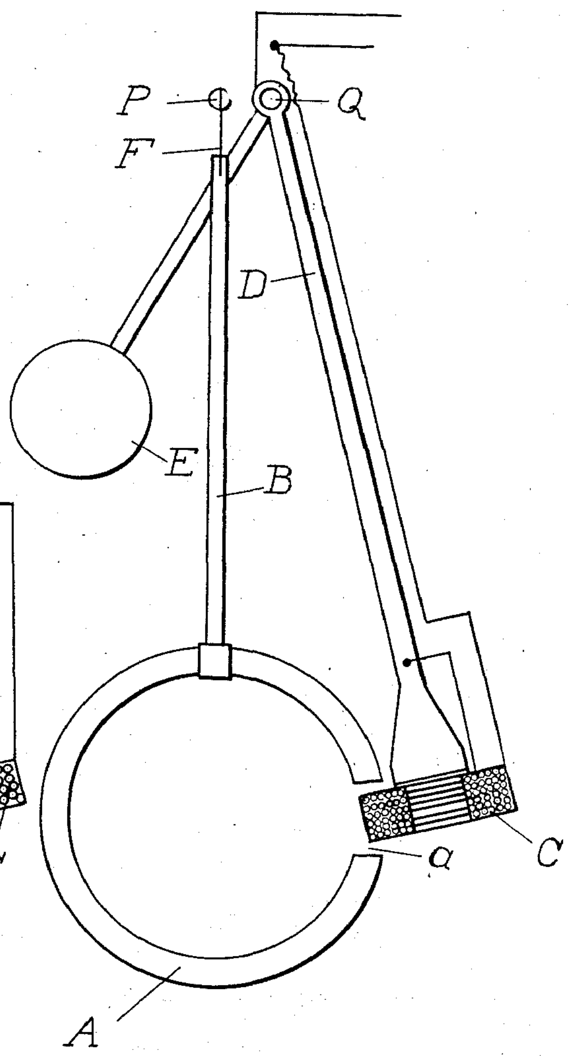

Fig. 2

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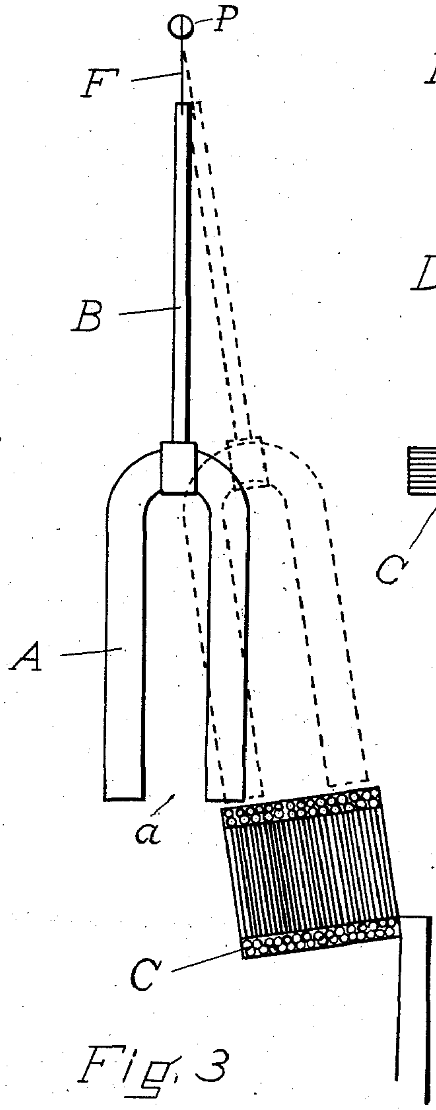

Fig. 3

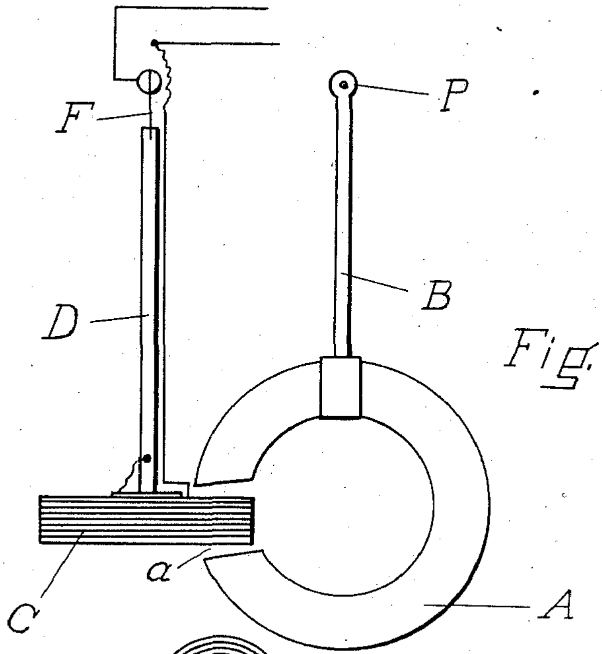

Fig. 4

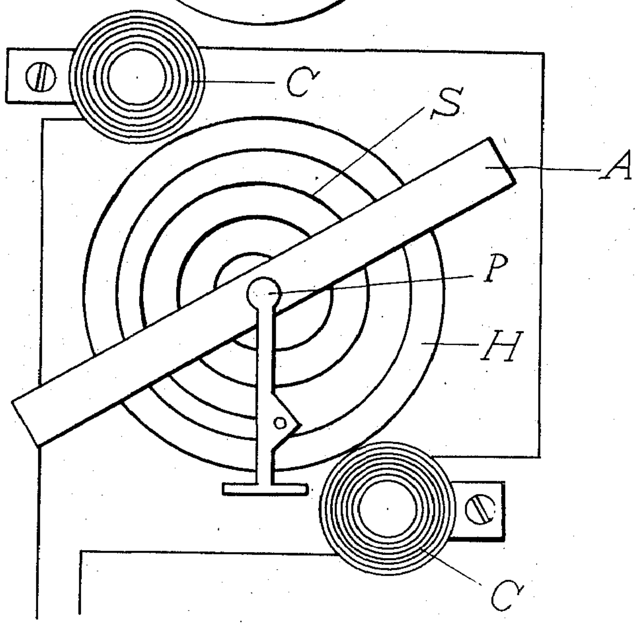

Fig. 5

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ELECTRIC APPARATUS FOR DRIVING CLOCKS OR SIMILAR MECHANISM.

1,186,459. Specification of Letters Patent. **Patented June 6, 1916.**

Application filed January 27, 1911. Serial No. 605,066.

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.

This invention relates to improved means for imparting energy to a swinging pendulum or vibrating balance-wheels, and is of particular service in connection with contact-making devices, such, for instance, as is referred to in my applications Serial No. 534,686, filed December 23, 1909 and Serial No. 574,092, filed July 27, 1910, and which I prefer to use; but this device may be utilized in connection with any electric circuit in which periodic impulses of current are available. For example, clocks equipped with pendulums or oscillating wheels of this form may be connected in circuit with a master clock, and thus be moved synchronously therewith.

This invention consists in the arrangement of mechanism by which use is made of both attraction and repulsion between a permanent magnet and a conductor carrying an electric current.

I am aware that prior to my applications above named, pendulums have been driven by means of either the attraction or repulsion between a permanent magnet and a conductor carrying an electric current, but these prior inventions have been defective in the following particulars:—

1. The driving effect was independent of amplitude of swing of the pendulum, being substantially constant whether a pendulum was swinging through a small or a large arc. In fact, sometimes the driving effect increased with the arc of swing of the pendulum. As a consequence, if the electric impulses were uniform and continually recurring there would be no special tendency for the pendulum to vibrate over a constant arc, except as the energy absorbed in friction etc. balanced the energy imparted.

2. So far as I am aware, no means have hitherto been used, in any electrically driven pendulum, to compensate for variations from a vertical position of the support for the pivot of the pendulum, without interfering with the amplitude of its swing.

In order to accomplish the improved results, I arrange the conductor carrying the current in such a manner with respect to the permanent magnet that for periodic impulses there will be a positive driving effect owing to the attraction or repulsion between the magnet and the conductor when the pendulum or balance-wheel is swinging through its normal arc even though the outside frictional effects are variable.

Variations in the said vertical position of the support for the pendulum are compensated for in the specific form of devices illustrated, by mounting both the permanent magnet and the repelling or attracting conductor on separate supports, upon one of which the oscillating device can swing freely. The other device, however, is mounted so that it can swing in response to variations from a vertical position of the support for its pivot and thus preserve a practically constant relation to the freely swinging device; but is preferably subject to sufficient friction or other restraining effect to prevent it from swinging in response to the electro-magnetic impulses. This improvement does not necessarily involve the use of a permanent magnet, although I prefer it. The conductor may be utilized through an electro-magnet, to induce magnetism in soft iron or steel, and thereby produce a similar effect.

In the drawings forming a part of this specification,—Figure 1 is a front elevation of the prior arrangement shown in my said application No. 534,686 of permanent magnet and electrical coil, the latter being held in a fixed position, the circuit closing device being a small mass of mercury in an exhausted tube; Fig. 2 is a front elevation of the improved manner of supporting the two oscillating devices; Fig. 3 shows another arrangement of the oscillating magnet and electrical coil, by which the electric current in the coil retards the swing of the oscillating device when above normal and the two poles of the magnet are over different portions of the coil; Fig. 4 is a modification of the manner of supporting the magnet and coil; Fig. 5 is an elevation showing the oscillating device in the form of a spring balanced wheel.

Referring to the drawings, A is a permanent magnet mounted upon a pendulum-rod B, or other oscillating device.

In Figs. 1, 2 and 4 the air-gap *a* of the magnet is preferably arranged so that the lines of force are approximately radial to the pivotal support P, and the conductor is arranged in the form of a flat coil C having its axis practically radial to the pivotal support P. Thus the oscillating device can swing freely in all directions without interfering with the coil.

In Fig. 1 the coil is shown fixed in position and as thus arranged it would be utilized in connection with clocks permanently fastened in position, such as wall-clocks. The normal limit of swing of the pendulum toward the right is shown by the dotted lines and is the minimum permitted for the operation of the escapement devices. In the dotted position the air-gap of the magnet has passed through the left hand section of the coil and has received energy from so doing. Any farther swing would cause the air-gap to cut across the section of the coil to the right of its axis, and in doing so energy would be subtracted from the pendulum for the reason that the conductors in the section to the right of the axis are carrying current which in relation to the magnet A is moving in the opposite direction from that in the left hand position.

In Fig. 2 the permanent magnet A is mounted upon the pendulum-rod B and the coil C is mounted upon another pendulum-rod D with a counterweight E. The rod B is supported by a flexible strip F, while the rod D is mounted upon a pivot Q which is made to offer appreciable frictional resistance to the free swinging of the pendulum-rod D. The friction of Q, however, is not sufficient to prevent the center of gravity of the system composed of C, D and E from assuming a perpendicular position below Q, but the friction at pivot Q is sufficient to prevent any objectionable movement of C on account of the electro-magnetic impulses which are sufficient to maintain the swing of pendulum-rod B, and so far as affecting the proper operation of the mechanism is concerned any movement of C, if thus produced, is negligible. A clock equipped with this device will maintain a constant arc of swing of its pendulum, even though the supporting frame-work of the clock is out of level.

In Fig. 3 is shown another arrangement for maintaining a constant arc of swing. In this case, however, the reversed direction of the lines of magnetic force passing out of one pole of a horse-shoe magnet and into another pole, is employed to limit the swing across electric conductors through which current is flowing in a single direction in relation to the magnet. When the magnet A is in the position shown in the solid lines, there is a tendency to cause it to move toward the right, across the upper surface of coil C which is shown in section with its axis substantially parallel with the arc of swing of the magnet A. As the pendulum swings farther to the right, however, into the position shown by the dotted lines, the reversed magnetic lines of the left-hand pole of magnet A, cut across the conductors of coil C and thereby tend to prevent farther swing.

Fig. 4 is substantially the same as Fig. 2, except that the pendulum D on which the coil C is mounted is arranged to swing freely, and the magnet A mounted on its pendulum B is made to swing less freely, as by friction at its supporting pivot P.

In Fig. 5, a balance-wheel H is shown which receives impulses from the repulsion or attraction between the permanent magnet A and the coils C, C′. The same reasons for maintaining a constant arc of vibration exist in this arrangement as with the pendulums; when the magnet A swings over the coils upon one side of their centers, it is attracted by the current flowing through the coils upon that side, and when the magnet swings past the center of the coil it is repelled by the current passing through that side. The wheel H is counterbalanced by a spring S.

I claim:—

Means for imparting energy to an oscillating device, consisting of a restrained pendulum and a freely swinging pendulum, a permanent magnet and a coiled electrical conductor, one of which latter is mounted on the respective pendulums, so that the movement of the swinging pendulum will cause the magnetic lines of force of the magnet to cut across the convolutions of the conductor, the restraint upon the first named pendulum being sufficient to prevent the effect of the mutual magnetic force between the magnet and the energized conductor from producing other than negligible vibrations of such restrained pendulum.

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