July 10, 1934. C. BATTEGAY 1,965,762

SELF OSCILLATING ELECTRIC CLOCK

Filed Jan. 15, 1930 2 Sheets-Sheet 1

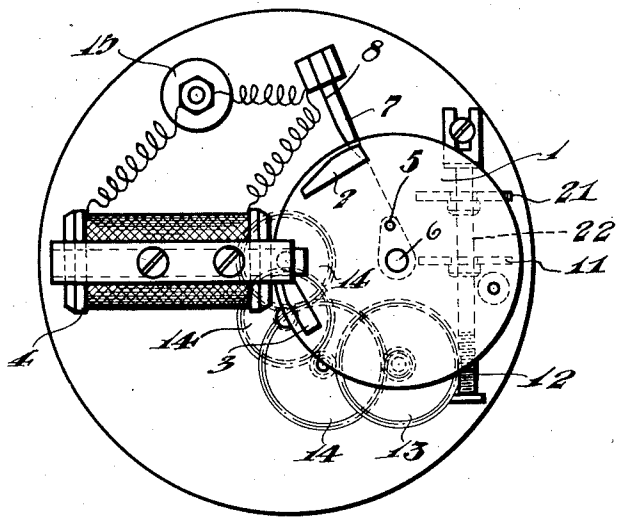


Fig. 1

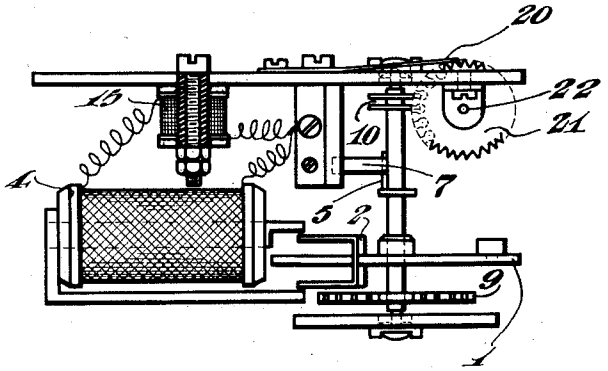


Fig. 2.

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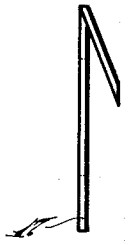


Fig. 3.

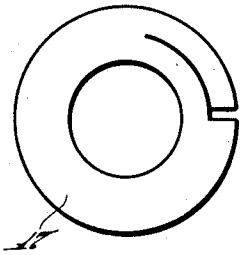


Fig. 4.



Fig. 5.

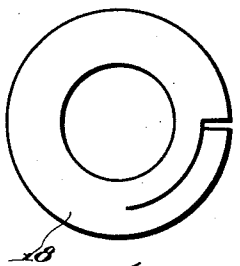


Fig. 6.

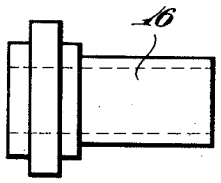


Fig. 7.

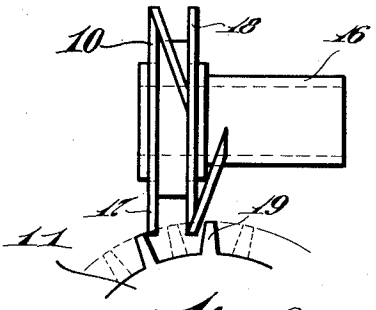


Fig. 8.

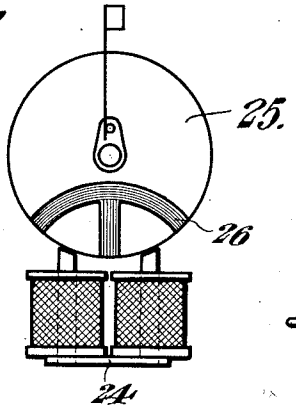


Fig. 9.

Fig. 10.

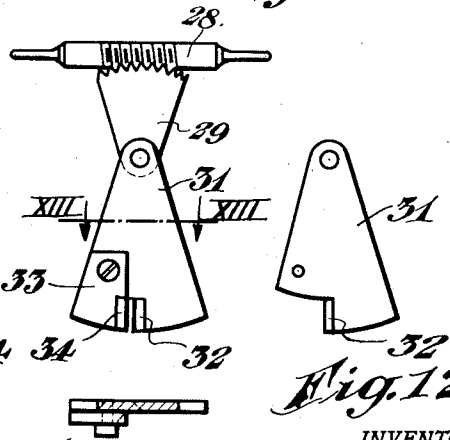


Fig. 11.

Fig. 12.

Fig. 13.

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UNITED STATES PATENT OFFICE

1,965,762

SELF-OSCILLATING ELECTRIC CLOCK

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Application January 15, 1930, Serial No. 420,956
In France January 18, 1929

15 Claims. (Cl. 58—28)

My invention relates to improvements in clocks provided with electric self-oscillating balance means, and chiefly to clocks in which the whole or part of the balance forms the armature of an electromagnet.

The present application is closely related to my copending application Serial No. 284,297, filed June 11, 1928, Patent No. 1,826,719, Oct. 13, 1931, and of which the present application is a continuation-in-part.

My said invention has for its object a particularly simple and economical construction of clocks of the said type and it ensures an improved electromagnetic efficiency for such apparatuses.

My invention chiefly consists in controlling the self-oscillating contact in said clocks through the movement of the balance in such manner that the contact will always be closed when the clock is stopped.

It further consists in various improvements and methods of manufacture concerning such clocks, as will be hereafter specified.

In the appended drawings, given by way of example:

Figure 1 is an elevational view of the mechanism of an electric clock in accordance with my invention, the balance and the contact carried thereby being near one of the extreme positions in their paths of movement;

Fig. 2 is a top plan view of the mechanism of Fig. 1;

Figs. 3 and 4 are, respectively, edge and side elevational views of a ring member of the escapement mechanism;

Figs. 5 and 6 are similar views of a second ring member of the escapement mechanism;

Fig. 7 is a side elevational view of a tubular member for supporting the ring members of Figs. 3 to 6;

Fig. 8 is a similar view of the assembled escapement mechanism;

Fig. 9 is an elevational view of a modification of the electromagnet and its associated armature;

Fig. 10 is an assembled view of a modified form of driving mechanism;

Figs. 11 and 12 are side elevational views of two cam members; and

Fig. 13 is a sectional view taken on line XIII—XIII of Fig. 10.

It is a matter of common practice to maintain the self-oscillating movement of a balance through the agency of an electromagnet; for example, this is the case of clocks having a circular balance, in which the said balance wholly or partially forms the armature of an electromagnet. However, this type of clock offers a low electromagnetic efficiency, and for the self-oscillating contact it is necessary to use external means for giving the first impulse to the balance. Such clocks further show certain defects which I propose to reduce or to entirely obviate.

In the drawings, an electric clock of the self-oscillation type comprises a balance 1 of brass or other non-magnetic material upon which are mounted two angularly spaced iron members 2 and 3 of U-shape. The latter members constitute the armature of an electro-magnet 4 and operate by their movements toward and from the electromagnet to maintain the oscillation of the balance 1.

The circuit of the electromagnet 4 is controlled by a movable contact 5 mounted on the shaft 6 of the balance 1 and extending parallel to the shaft 6. The contact 5 coacts with a stationary contact spring blade 7 having a second spring blade 8 bearing against it to damp its natural oscillations.

A hairspring 9, Fig. 2, returns the balance 1 toward its central position after the end of each oscillatory movement.

The oscillation of the balance 1 drives through its shaft 6 and a double driving ring 10, a gear mechanism comprising a drive wheel 11, a worm 12, worm gear 13 and reduction gear mechanism 14 in the form of a train of gears and pinions.

The usual mechanism for operating the minute hand of the clock is omitted as being unnecessary to an understanding of the present invention.

A protective high resistance 15 is connected across the terminals of the winding of the electromagnet 4 and comprises in part a material such as carbon. As shown, the resistance material may be in tubular form.

The double driving ring 10 shown in detail in Figs. 3 to 7 and assembled in Fig. 8 comprises a flanged tubular member 16, upon which are mounted two rings 17 and 18 each having a segment bent at an angle thereto to operate as a cam to actuate the teeth 19 of the drive wheel 11.

The drive wheel is maintained in its successive positions by a pawl 20 and a ratchet wheel 21 on the shaft 22 of the drive wheel 11.

Electrical energy for operating the clock may be supplied by a small battery (not shown), such as are used in flash lights. One terminal of the battery is connected to the outer terminal of the resistance 15 which, as shown in Fig. 2, is insulated from its support and, as shown in Figs. 1 and 2, is connected to a terminal of the electro-

magnet 4. The other terminal of the battery is connected to the base plate for supporting the mechanism and which is connected to the balance shaft 6 through the bearing of the latter.

The circuit when completed extends from the shaft 6 through the contact 5 thereon, the spring blade 7 and its support, which is insulated from the base plate, to the other terminals of the electromagnet and the resistance 15. The resistance 15 is permanently connected across the coil controlled by the contacts 5 and 7.

In the operation of the clock, it may be assumed that the balance is stationary. In the stationary position, the balance is displaced from the central position with the armature members 2 and 3 positioned at unequal distances from the electromagnet 4. This condition is caused by the fact that the movable contact 5 is always on the one side or the other of the spring blade 7 which prevents the hairspring 9 from returning the armature to its exact central position.

When the circuit of the electromagnet 4 is connected to a small battery as a source of power, the electromagnet is energized in the stationary position of the balance since the contacts 5 and 7 are engaged. One of the armature members is attracted by the greater force since it is closest to the electromagnet and the balance 1 moves accordingly. Ordinarily this movement is in such direction as to separate the contact 5 from the contact 7. When such separation occurs, the balance 1 and the contact 5 are returned by the hairspring 9 to again complete the circuit. If the inertia of the balance is not sufficient to carry it beyond its central position, the balance will again move in its initial direction but with greater amplitude because of the resilience of the spring contact blade.

When the contact 5 again engages the spring contact 7 upon its return movement, the circuit of the electromagnet is again completed slightly before the balance reaches its central position. Inertia of the balance carries it across the central position. Also, the time-constant of the circuit which is a function of the inductance of the circuit is relatively high whereby the maximum force of the electromagnet is delayed after the engagement of the contacts 5 and 7 until after the balance has passed through the central position. The balance continues as before until the contacts are again separated to open the circuit.

In Fig. 1, the balance 1 is moving in a clockwise direction near one of its extreme positions and the contacts 5 and 7 are about to disengage to open the circuit of the electromagnet.

These oscillations continue in the manner above described, the electromagnet operating to actuate the balance alternately in opposite directions. The oscillations of the shaft 6 and the double ring 10 thereon cause the cams of the latter to alternately engage the teeth 19 and thus actuate the wheel 11 and its connected mechanism in a single direction.

The resistance 15 affords a circuit for the discharge of energy stored in the iron of the electromagnet on the interruption of the circuit. Instead of being dissipated in the form of a spark across the contacts 5 and 7, it traverses the circuit including the resistance 15 and performs useful work in that it causes the armature to increase the amplitude of its oscillations beyond that obtaining without the use of the discharge circuit. The amplitude of the armature's oscillations is about 90° or 45° from its central position.

Fig. 9 illustrates a modification of the electromagnet and its armature. A bipolar magnet 24 operates a balance 25 comprising a brass disc carrying an iron armature 26 of approximately trident shape. The balance 25 is shown in its position of rest.

When the electromagnet 24 is energized and the armature is even slightly unbalanced, the armature oscillates toward a position in which the central arm of the member 26 and an outer arm thereof coincide with the pole-pieces of the electromagnet. When the circuit is broken, as previously described, the armature oscillates in the opposite direction toward a similar and symmetrical position.

The modified driving mechanism of Figs. 10 to 13 comprises a shaft 28 adapted to be oscillated as by an armature of either of the above types. It has worm threads for rocking a segment 29 about its pivot pin 30.

The pin 30 carries an arm 31 having a cam face 32. A plate 33 secured to the arm 31 has a cam face 34. These cam faces alternately actuate teeth of an escapement wheel as the arm 31 is oscillated about the pin 30.

The characteristic features of the invention are clearly specified in the foregoing description, but it is understood that while the said features may be advantageously employed as a whole, such features may be also employed only partially without departing from the principle of my invention:

These features may be summarized as follows:

1. The electromagnet is of reduced size with reference to the balance and to the remainder of the clockwork whereby I obtain small-sized clocks or watches, particularly adapted for use on automobile dashboards.

2. The balance carries iron armatures adapted to close the magnetic circuit of the electromagnet so as to form an electromagnet having a rotary armature.

3. With a view to reduce as much as possible the magnetic connection between the balance and the electro-magnet in those moments where no impulse is required, the armatures form only a small part of the balance, the remainder of which is made of a non-magnetic material such as brass.

4. The iron armatures are disposed on the balance in a manner such that the attraction exerted by the pole-pieces of the electro-magnet is substantially zero for the position of equilibrium of the balance, the attraction increasing as soon as the balance moves away from this position of equilibrium in one direction or the other.

5. The contact adapted to keep up the oscillations is closed and opened by the movement of the balance in its two directions of motion, for positions of said balance which may be symmetrical or not with reference to its position of equilibrium.

6. The contact is disposed in a manner such that it is always closed when the movement stops, the stop position of the balance being very near its position of equilibrium without coinciding therewith. This condition is absolutely necessary for allowing an automatic starting of the balance oscillations because, as stated in paragraph 4 hereinabove, the attraction exerted by the electromagnet is substantially zero for the position of equilibrium of the balance. This is accomplished through the action of the above mentioned contact comprising a yielding element urging the hairspring away from its position of equilibrium.

7. The half-time constant of the electric circuit is given a high value for keeping up the oscillations of the balance with an increased action of its positive impulses with reference to that of its negative impulses. This half-time constant is important in particular for ensuring the permanency of the oscillations for the case where the arcs corresponding to the impulses are symmetrical with reference to the position of equilibrium of the balance. The keeping up of the oscillations is nevertheless still possible in this case. The current does not instantaneously reach its normal value and consequently is smaller during the negative impulse than during the subsequent more important positive impulse. This is still more true in the usual practical cases where the arc corresponding to the positive impulse is greater than that corresponding to the negative impulse.

8. A non-inductive resistance is connected with the terminals of the electromagnet with a view to reduce the sparking at the contact and to increase the amplitude of the oscillations through the partial use of the electromagnetic energy contained in the iron of the electromagnet at the moment of the breaking of the circuit. This resistance consists for instance in a part of specially treated graphite.

My invention is obviously not limited to the applications disclosed as to the forms of execution described by way of example. It covers all modifications thereof and in particular those wherein the parts are constructed in a different manner, while serving purposes similar to those disclosed hereinabove. As already stated the different features of the invention need not of necessity be used all together.

What I claim is:

1. A system of clockwork mechanism with electric sustained oscillation, comprising in combination an electromagnet having a winding, an oscillatable armature constituting a balance and mounted for oscillation in the field of said electromagnet, two coacting contact members controlled by the motion of the balance and normally closed in the position of equilibrium of said balance, and means, operable upon the opening of said contact members, for permitting current to flow through a circuit comprising said winding whereby there is utilized in the performance of useful work a portion of the energy stored in said electromagnet while the contact is closed, said means comprising a resistance without self-induction connected to the terminals of the electromagnet.

2. An electric clockwork comprising a balance of non-magnetic material, a stationary electromagnet, iron members carried by the balance and forming the armature of the electromagnet, said iron members being substantially equally spaced on opposite sides of said electromagnet in the position of equilibrium of said balance whereby the resultant attraction of the balance in either direction of oscillation by the electromagnet is substantially zero and increases as the balance passes in either direction away from this position, an electric circuit having contact terminals controlled directly by the balance and closed whenever the balance passes through its position of equilibrium and a gearwork controlled by the balance.

3. An electric clockwork comprising an oscillating balance of non-magnetic material, a stationary electromagnet, two iron members carried by the balance and forming the armature of the electromagnet, said balance having a position of equilibrium in which said electromagnet is substantially equidistant from said iron members whereby the resultant attraction of the balance in either direction of oscillation by the electromagnet is substantially zero and increases as the balance passes in either direction away from this position, an electric circuit adapted to be controlled directly by the balance and comprising a movable contact secured to the balance and a stationary spring blade directed parallel to the plane of oscillation of the balance and a gearwork controlled by the balance.

4. An electric clockwork comprising a balance of non-magnetic material, a stationary electromagnet, spaced iron members carried by the balance and forming the armature of the electromagnet, said balance having a central position in which said electromagnet is equidistant from said iron members whereby the resultant attraction of the balance in either direction of oscillation by the electromagnet is substantially zero and increases as the balance passes in either direction away from this position, an electric contact adapted to be controlled directly by the balance and to be closed whenever the balance passes through its central position, an electrical circuit for the electromagnet, a resistance connecting the terminals of the winding of the electromagnet for permitting current to flow therethrough for the performance of useful work when the contact is open by the balance, and a gearwork controlled by the balance.

5. An actuating mechanism for electric clocks comprising a bipolar electromagnet, an armature therefor, comprising a disk of non-magnetic material and a member of magnetic material carried by said disk and having three spaced portions for coaction with the poles of said electromagnet, the spaces between the respective portions being substantially equal to that between the poles of the electromagnet whereby two of said portions may be simultaneously adjacent the respective poles of said electromagnet and contact controlled by said disk for controlling the circuit of said electromagnet.

6. An electric clock comprising an electromagnet, an armature therefor comprising two spaced iron members that are magnetically separate and a rotatable member for carrying said iron members within the field of said electromagnet, said armature having a central position in which the electromagnet is midway between said iron members, means movable with said armature for controlling the circuit of said electromagnet, and gear mechanism actuated by said armature.

7. An electric clock comprising an electromagnet, an armature therefor comprising two magnetically separate members of magnetic material that are mounted for rotation within the field of said electromagnet and are spaced apart by an angle of substantially 90°, said armature having a central position in which the electromagnet is midway between said iron members, means movable with said armature for controlling the circuit of said electromagnet, and gear mechanism actuated by said armature.

8. In an electric clock, a shaft mounted to oscillate, a balance element fixed on said shaft, a magnet having poles at one and the same side of the shaft and spaced apart axially of the shaft, arcuately spaced apart armature members movable with the shaft and adapted to be attracted by said electromagnet to actuate the balance element alternately in opposite directions, said ar-

mature members being operable through the gap between the poles of the magnet, a contact member movable with the shaft, a relatively fixed contact member adapted to cooperate with the contact member of the shaft, and an electric circuit including both contact members and the electromagnet.

9. In an electric clock, a shaft mounted to oscillate, a balance element fixed on said shaft, a magnet having poles at one and the same side of the shaft and spaced apart axially of the shaft, arcuately spaced apart armature members movable with the shaft and adapted to be attracted by said electromagnet to actuate the balance element alternately in opposite directions, said armature members being operable through the gap between the poles of the magnet, said armature members being of an axial dimension to substantially fill said gap when positioned therein, a contact member movable with the shaft, a relatively fixed contact member adapted to cooperate with the contact member of the shaft, and an electric circuit including both contact members and the electromagnet.

10. In an electric clock, a shaft mounted to oscillate, a balance element fixed on said shaft, a magnet having poles at one and the same side of the shaft and spaced apart axially of the shaft, arcuately spaced apart forked armature members movable with the shaft and adapted to be attracted by said electromagnet to actuate the balance element alternately in opposite directions, said armature members being operable through the gap between the poles, said forked armatures being of sufficient axial dimension to position the tines of the forks in close spaced relation to the respective poles when in said gap, a contact member movable with the shaft, a relatively fixed contact member adapted to cooperate with the contact member of the shaft, and an electrical circuit including both contact members and the electromagnet.

11. In an electric clock, a shaft mounted to oscillate, a balance element of non-magnetic material fixed on the shaft, an electromagnet having poles at one and the same side of the shaft and spaced apart axially of the shaft, magnetic armature members mounted on the non-magnetic balance and arcuately spaced apart thereon, said armature members being adapted to be attracted by said electromagnet to actuate the balance element alternately in opposite directions and to operate through the gap between the axially spaced poles of the magnet, a circuit including the magnet, and a switch included in said circuit, said switch being operable through oscillation of the balance to periodically make and break said circuit.

12. In an electric clock, a shaft mounted to oscillate, a balance element fixed on the shaft, a magnet having poles positioned laterally of the shaft and spaced apart axially of the shaft, arcuately spaced apart armature members movable with the shaft and adapted to be attracted by said electromagnet to actuate the balance element alternately in opposite directions, said armature members being operable through the gap between the poles of the magnet, a circuit including the magnet, and a switch included in said circuit and operable by oscillation of the shaft to alternately make and break the circuit through the magnet.

13. In an electric clock, a shaft mounted to oscillate, a balance element fixed on said shaft, a magnet having poles at one and the same side of the shaft and spaced apart axially of the shaft, arcuately spaced apart forked armature members movable with the shaft and adapted to be attracted by said electromagnet to actuate the balance element in opposite directions, and the tines of which forked armature members are adapted to cooperate with the respective poles of the magnet, a circuit including the magnet, and a switch included in said circuit, said switch being operable through oscillation of the balance to periodically make and break the circuit.

14. An electric clockwork comprising a stationary electromagnet, a balance of non-magnetic material having spaced iron members carried thereby and forming the armature of said electromagnet, said balance having a central position in which said spaced iron members are equidistant from said electromagnet, a resilient contact member directly controlled by said balance and closing a circuit when engaged by said balance, said balance having a stationary position of equilibrium upon the one or the other side of said central position as determined by its engagement with said contact member, whereby, when the circuit of said electromagnet is energized while the balance is stationary in a position of equilibrium, the attraction of said electromagnet for one of said iron members is greater than that for the other and said balance will move from its stationary position.

15. An electric clockwork comprising a stationary electromagnet, a balance of non-magnetic material having spaced iron members carried thereby and forming the armature of said electromagnet, a spring for actuating said balance toward a central position in which said electromagnet is midway between said spaced iron members, means for controlling the circuit of said electromagnet comprising a resilient contact member adapted to be engaged by said balance when the latter is adjacent its central position, said balance having a stationary position of equilibrium upon the one or the other side of said central position as determined by its engagement with said contact member, whereby, when the electromagnet is energized while the balance is stationary in a position of equilibrium, the attraction of said electromagnet for one of said iron members is greater than that for the other of said members and said balance will move from its stationary position in the direction of the greater attraction.

CONSTANT BATTEGAY.