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VIBRATORY MOTOR FOR AN ELECTRIC WATCH

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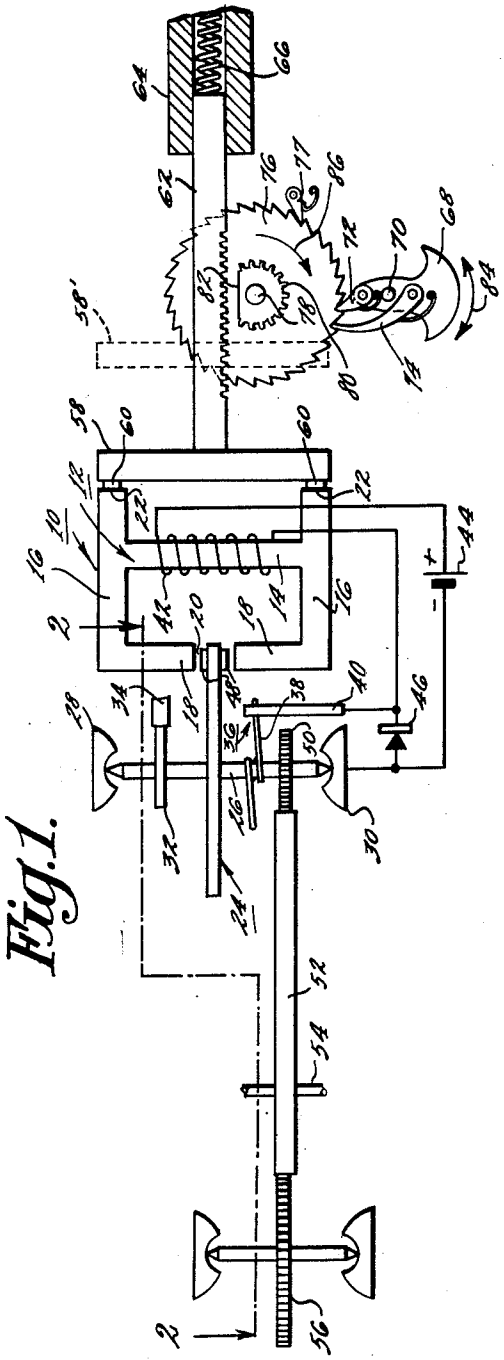


Fig. 1.

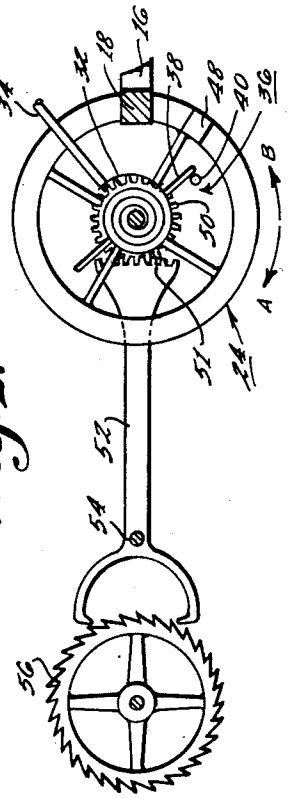


Fig. 2.

INVENTOR.
Loren F. Jones
BY Morrish Lebkin
ATTORNEY

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VIBRATORY MOTOR FOR AN ELECTRIC WATCH

Loren F. Jones, Philadelphia, Pa., assignor to Radio Corporation of America, a corporation of Delaware

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This invention relates generally to improvements in electric watches, and more particularly but not exclusively to means, in combination with the electromagnetic driving mechanism of a battery-powered wrist watch to maintain the battery in a charged condition.

In recently developed battery-powered wrist watches, a small battery, mounted within the case or on the wrist watch band, is used to operate the watch. Instead of using a main spring to provide the motive power for the oscillatory motion of the spring-loaded balance wheel, as in a conventional watch, an electroamagnet is used to attract periodically a metallic portion cooperating with any oscillatory component of the electric watch, and thereby causes it to oscillate. A switch, in series with the coil of the electromagnet, periodically opened and closed by the spring-loaded balance wheel, serves to provide the periodic magnetic force necessary to maintain the watch in normal operation.

Electric wrist watches of the type described, and known in the art, have lacked popular acceptance because of certain disadvantages. For example, the battery necessary to operate an electric wrist watch of the type described for any appreciable length of time is relatively large and bulky in comparison to the other components of the watch. These batteries are usually of the primary type and have to be discarded when they have become discharged. In accordance with the objects of the present invention, the high cost and inconvenience of frequent battery changes are obviated.

It is a principal object of the present invention to provide improved means in a battery-powered electric watch of the type described for charging the battery used to operate the watch.

It is a further object of the present invention to provide, in a battery-powered electric watch of the type described, the novel combination of charging means, cooperatively associated with the electromagnetic means, to charge the battery.

It is still a further object of the present invention to provide, in an electric watch powered by a secondary battery, the novel combination of unique means to convert mechanical energy due to the random motion of a person's wrist into electrical energy, and to utilize the derived electrical energy for charging the secondary battery, wherein the converting means and the means to provide the periodic magnetic force to drive the spring-loaded balance wheel have parts in common.

Another object of the present invention is to provide in an electric watch of the type described, improved means for utilizing energy available from body motion to charge the battery used to operate the watch, through the electromagnetic winding in a manner which is basically simple in operation and construction, and which is sufficiently practical in use.

These and further objects of the present invention are attained in an electric watch using a battery energized electromagnet to drive a spring-loaded balance wheel. A circuit including a switch, opened and closed by the spring-loaded balance wheel, provides pulses of current through the coil of the electromagnet. A permanent magnet is adjustably mounted adjacent the core

of the electromagnet and forms a magnetic circuit therewith. When the electric watch is worn on a person's wrist, mechanical means responsive to the random motion of the person's wrist is used to vary the distance between the magnet and the electromagnet core at a differential rate to induce a voltage across the coil of the electromagnet. This induced voltage is used to provide a charging current for the battery which, in accordance with the present invention, is of the secondary, or chargeable type. A small dry-type rectifier is connected across the balance wheel-operated switch in order to allow only the charging current to flow into the battery even when the switch is opened.

The novel features of the invention as well as the invention itself, both as to its organization and the method of operation, will be understood in detail from the following description when considered in connection with the accompanying drawing, in which similar elements have similar reference numerals, and in which:

Fig. 1 is an exaggerated side elevational view, partly diagrammatic, of the driving portion of an electric watch, showing the electromagnetic and the battery charging means, in accordance with the present invention, and

Fig. 2 is a top plan view of a portion of the watch shown in Fig. 1, taken along the line 2—2 thereof.

Referring now to Fig. 1, there is shown the driving portion of a battery-operated wrist watch comprising an electromagnet 10. The electromagnet 10 comprises a core 12 of soft iron, having an elongated central portion 14, similar elongated, side portions 16 extending at substantially right angles from both ends of the central portion 14 to either side thereof, and similar, elongated, aligned portions 18 extending towards each other from one end of each of the side portions 16, and separated from each other by an air gap 20. The other ends of the side portions 16 of the core 12 terminate in aligned surfaces 22. The core 12 is mounted within a wrist watch case (not shown) by any suitable means. A spring-loaded balance wheel 24 is mounted for oscillatory rotation within the watch case. The balance wheel 24 is fixed to an arbor 26, the ends of which are mounted in bearings 28 and 30, fixed to the watch case in any suitable manner. A hair spring 32 has its inner end fixed to the arbor 26 and its outer end fixed to a fixed member 34, within the watch case. The hair spring 32 biases the balance wheel 24 in one direction; namely, in the direction indicated by the arrow A in Fig. 2. A switch 36 has one metallic portion 38 fixed to the arbor 26, for rotation therewith, and another metallic portion 40, at right angles to the portion 38, fixed to the watch case, in any suitable manner.

A coil 42 is wound around the central portion 14 of the core 12 of the electromagnet 10. One end of the coil 42 is connected to the positive terminal of a secondary battery 44. The negative terminal of the battery 44 is connected to the movable portion 38 of the switch 36, through the bearing 30 and the metallic arbor 26. It is assumed that the bearing 30 is electrically conductive. Where electrically non-conductive bearings are used in a watch, the battery 44 may be placed in series with the switch 36 by means of a brush, or by any other suitable means well known in the art. The fixed portion 40 of the switch 36 is electrically connected to the other end of the coil 42. A rectifier 46, of the small dry-type, is connected across the switch 36 in a manner which would permit current under the influence of a charging voltage, to flow into the battery when the switch 36 is opened.

The balance wheel 24 may be made of brass or any other non-magnetic material. Fixed to the upper and lower surfaces of the balance wheel 24, adjacent the periphery thereof, in any suitable manner, are two small pieces 48 of soft iron. The pieces 48 of soft iron are

positioned, with respect to the air gap 20 of the core 12, in a manner such that they will be attracted into the gap 20 by the magnetic force produced as a result of the current flow in the coil 42.

Oscillatory motion of the balance wheel 24 is produced in the following manner: The hair-spring 32 biases the balance wheel 24 in one direction, for example clockwise, looking at Fig. 2. As a result, the switch 36 is closed by the portion 38 contacting the portion 40 thereof. Current will now flow from the positive terminal of the battery 44 through the coil 42, the switch 36 and back to the negative terminal of the battery 44. Because of the magnetic field produced in the gap 20, as a result of the current through the coil 42, the pieces 48 of soft iron bias the balance wheel 24 in an opposite direction to the normal biasing action of the hair-spring 32; that is, in a counterclockwise direction, as indicated by the arrow B in Fig. 2. As a result of the electromagnetic biasing, the portion 38 of the switch 36 breaks contact with the portion 40 thereof, and current ceases to flow in the coil 42. The balance wheel 24 is now under the biasing action of the hair-spring 32 which will return it to a position where the portions 38 and 40 of the switch 36 will contact each other again. The electromagnetic biasing means will again urge the spring in a counterclockwise direction, whereby the oscillatory motion of the balance wheel will be maintained.

A pinion 50 fixed to the arbor 26 engages a segment 51 of ratchet teeth of a bifurcated member 52, pivoted to the watch case by a pivot 54, in any suitable manner. It will now be understood that as the spring-loaded balance wheel 24 oscillates, the bifurcated member 52, because of its engagement with the pinion 50, will also oscillate about its pivot 54. The bifurcated member 52 may be made to rotate a gear 56 in a manner well known in the watch art. In other words, the spring-loaded balance wheel may be made to drive a train of watch gears and thereby operate a timepiece.

The secondary battery 44 may be of the alkaline type, or any other type of the chargeable variety. Since the battery 44 is necessarily small, it will become discharged in a relatively short time unless it is constantly recharged. In accordance with the present invention, charging means are combined with the electromagnet 10 to charge the secondary battery 44. To this end, a permanent magnet 58 is adjustably mounted adjacent the aligned surfaces 22 of the side portions 16 of the core 12. The magnet 58 is spaced from the aligned surfaces 22 of the core 12 by non-metallic spacers 60, which may be secured to the aligned surfaces 22 by any suitable means. The magnet 58 is fixed to a ratchet bar 62. The bar 62 is slidable within a guide or tube 64, fixed within the watch case in any suitable manner. A spring 66 biases the bar 62 toward the core 12 of the electromagnet 10.

Means are provided to move the magnet 58 away from the core 12 at a relatively slow rate to a predetermined distance, as indicated by the dashed outline of the magnet 58'; and then to move the magnet 58 toward the core 12 at a relatively faster rate. To this end, there is provided a weighted pendulum 68 of the type used in self-winding wrist watches. The pendulum 68 is pivoted for oscillatory movement around a pivot 70 fixed to the watch case by any suitable means. Spring biased pawls 72 and 74 pivoted to the pendulum 68 on opposite sides of the pivot 70 engage teeth in a ratchet wheel 76, pivoted for rotation about a pivot 78, fixed to the watch case in any suitable manner. A spring-loaded pawl 77 pivoted to the watch case and engaging the ratchet wheel 76 allows the ratchet wheel to rotate in only one direction. A small gear 80 also pivots about the pivot 78 and is adapted to move with the ratchet wheel 76. The gear 80 has teeth which mesh with the teeth in the ratchet bar 62. The gear 80 also has a flat spot 82. It will now be understood that, as the wrist watch is worn on the wrist of a person, the random motion of the person's wrist will cause the pendulum 68 to swing in the directions indicated by the double headed arrow 84. This oscillatory motion will cause the pawls 72 and 74 to move the ratchet wheel 76 in the direction indicated by the arrow 86. Since the gear 80 rotates with the ratchet wheel 76, the teeth of the gear 80 engage the teeth of the ratchet bar 62 and cause it, and the magnet 58 fixed thereto, to move away from the core 12. The flux in the magnetic circuit caused by the permanent magnet 58 and the core 12 will now decrease. When the gear 80 has reached a position in which the flat spot 82 thereof comes adjacent to the teeth of the ratchet bar 62, the ratchet bar 62 is disengaged from the gear 80 and the spring 66 biases it and the magnet 58 suddenly toward the core 12. As a result of this sudden movement, the magnetic flux in the magnetic circuit, including the magnet 58 and the core 12, is suddenly increased. This results in a voltage being induced across the coil 42, and consequently current will flow in the closed circuit comprising the coil 42, the battery 44 and the rectifier 46. Thus, it is seen that the random motion of the wrist of the wearer of the watch will cause the magnet 58 to vary the flux within the magnetic circuit in the core periodically, a number of times per day, whereby charging current will be caused to flow into the battery 44, and thereby keep it in a charged condition.

There has been shown and described, in accordance with the present invention, a battery-operated wrist watch having electromagnetic driving means, and a combination therewith of means to charge the secondary battery used to operate the watch. The random motion of the wrist of the wearer of the watch causes a pendulum to swing and to move a magnet to a predetermined distance from the core of the electromagnet. The magnet is then suddenly released and biased toward the core in a manner to vary suddenly the magnetic flux in the magnetic circuit produced by the magnet and the core. The sudden change in flux through the coil of the electromagnet sends a charging current through the battery and a rectifier connected in a series circuit with the coil.

What is claimed is:

1. In an oscillatory electromagnetic motor of the type having an arbor, a spring-loaded balance wheel fixed to said arbor for rotation therewith, electromagnetic means comprising a core and a coil for imparting magnetic energy to said wheel, a secondary battery, and means including a switch having a portion thereof cooperatively engaged with said arbor for periodically connecting said battery in circuit with said coil; the combination therewith of an electric generator comprising a permanent magnet disposed adjacent said core of said electromagnetic means and in magnetic circuit therewith, mechanical means responsive to random motion to vary suddenly the distance of said magnet from said core and to induce a voltage across said coil, and a rectifier connected across said switch whereby to send current through said rectifier and said battery, to charge said battery.

2. In an oscillatory electromagnetic motor of the type having an arbor, a spring-loaded balance wheel fixed to said arbor for rotation therewith, electromagnetic means comprising a core and a coil for imparting magnetic energy to said wheel, a secondary battery, and means including a switch having a portion thereof cooperatively engaged with said arbor for periodically connecting said battery in circuit with said coil; the combination therewith of an electric generator comprising a permanent magnet adjustably mounted adjacent said core, means including said permanent magnet to vary the flux in said core, and a dry-type rectifier connected in series with said core and said battery, and in parallel with said switch, whereby to produce a charging current for said battery.

3. In an oscillatory electromagnetic motor of the type having an arbor, a spring-loaded balance wheel fixed to said arbor for rotation therewith, electromagnetic means

comprising a core and a coil for imparting magnetic energy to said wheel, a secondary battery, and means including a switch having a portion thereof cooperatively engaged with said arbor for periodically connecting said battery in circuit with said coil; the combination therewith of an electric generator comprising a permanent magnet adjustably mounted adjacent said core, mechanical means responsive to random motion to increase the distance between said core and said magnet to a predetermined length at a relatively slow rate, and to decrease the distance therebetween at a relatively fast rate after reaching said predetermined length, and a dry-type rectifier connected in series with said coil and said battery, and in parallel with said switch.

4. In an oscillatory electromagnetic motor of the type having an arbor, a spring-loaded balance wheel fixed to said arbor for rotation therewith, electromagnetic means comprising a core and a coil for imparting magnetic energy to said wheel, a secondary battery, and means including a switch having a portion thereof cooperatively engaged with said arbor for periodically connecting said battery in circuit with said coil; the combination therewith of an electric generator comprising a permanent magnet adjustably mounted adjacent said core and in magnetic circuit therewith, a pendulum pivoted to swing with random motion of said generator, linkage means linking said magnet and said pendulum to vary the distance of said magnet from said core whereby to induce a voltage across said coil, and a rectifier connected across said switch in a manner to permit current to flow into said battery.

5. In an oscillatory electromagnetic motor of the type having an arbor, a spring-loaded balance wheel fixed to said arbor for rotation therewith, electromagnetic means comprising a core and a coil for imparting magnetic energy to said wheel, a secondary battery, and means including a switch having a portion thereof cooperatively engaged with said arbor for periodically connecting said battery in circuit with said coil; the combination therewith of an electric generator comprising a permanent magnet adjustably mounted on said core and in magnetic circuit therewith, a pendulum pivoted to swing with random motion of said generator, means linking said pendulum and said magnet to increase the distance between said core and said magnet to a predetermined length at a relatively slow rate, and to decrease said distance at a relatively faster rate after reaching said predetermined distance, and a rectifier connected across said switch in a manner to permit current to flow into said battery.

6. In combination, an arbor, a spring-loaded balance wheel fixed to said arbor for oscillatory rotation therewith, an electromagnet comprising a core and a coil, a secondary battery, a switch having a portion thereof cooperatively engaged with said arbor and adapted to open and close with the oscillatory rotation of said arbor, means to connect said battery, said switch, and said coil in a series circuit, a rectifier connected across said switch, said core comprising an elongated central portion, a pair of elongated parallel side portions extending from the ends of said central portion, respectively, substantially at right angles thereto, inwardly aligned portions extending from one end of said side portions and forming a gap therebetween, the other ends of said side portions being substantially aligned surfaces, said coil being wound around said central portion whereby to produce a magnetic field across said gap when said switch is closed, magnetic material fixed to said balance wheel and disposed to be attracted by said magnetic field, a permanent magnet spaced from said aligned surfaces and in magnetic circuit with said core, means to vary the flux in said magnetic circuit whereby to produce a charging voltage across said coil.

7. In combination, an arbor, a spring-loaded balance wheel fixed to said arbor for oscillatory relation therewith, an electromagnet comprising a core and a coil,

a secondary battery, a switch having a portion thereof cooperatively engaged with said arbor and adapted to open and close with said oscillatory rotation of said arbor, means to connect said battery, said switch, and said coil in a series circuit, a rectifier connected across said switch, said core comprising an elongated central portion, a pair of elongated parallel side portions extending from the ends of said central portions, respectively, substantially at right angles thereto, inwardly aligned portions extending from one end of said side portions, respectively, and forming a gap therebetween, the other ends of said side portions being substantially aligned surfaces, said coil being wound around said central portion whereby to produce a magnetic field across said gap when said switch is closed, magnetic material fixed to said balance wheel and disposed to be attracted by said magnetic field, a permanent magnet adjustably mounted adjacent said aligned surfaces and in magnetic circuit with said core, and means responsive to random motion to move said magnet relative to said core at a varying rate whereby to induce a charging voltage across said coil.

8. In combination, an arbor, spring means biasing said arbor in one angular direction, electromagnetic means biasing said arbor in an opposite angular direction, said electromagnetic means comprising a core having a central portion, similar parallel side portions extending to both sides of said central portion from the ends thereof, similar aligned portions extending toward each other from one end of each of said side portions, respectively, and forming a gap therebetween, the other ends of said side portions being substantially aligned surfaces, and a coil wound around said central portion, a battery, switch means in circuit with said battery and said coil and cooperatively engaged with said arbor to intermittently open and close said switch means whereby to produce a magnetic field across said gap when said switch is closed, said electromagnetic means comprising magnetic material fixed to said balance wheel and disposed to be attracted by said magnetic field, a rectifier connected across said switch means, a permanent magnet in magnetic circuit with said core, and mechanical means to vary the magnetic flux in said magnetic circuit at a differential rate.

9. In combination, an arbor, spring means biasing said arbor in one angular direction, electromagnetic means biasing said arbor in an angular direction, said electromagnetic means comprising a core having a central portion, similar parallel side portions extending to both sides of said central portion from the ends thereof, similar aligned portions extending toward each other from one end of each said side portions, respectively, and forming a gap therebetween, the other ends of said side portions being substantially aligned surfaces, a coil wound around said central portion, a battery, switch means in circuit with said battery and said coil and cooperatively engaged with said arbor to intermittently open and close said switch means whereby to produce a magnetic field across said gap when said switch is closed, said electromagnetic means comprising magnetic material fixed to said balance wheel and disposed to be attracted by said magnetic field, a rectifier connected across said switch means, a permanent magnet adjustably mounted adjacent said aligned surfaces, and forming a magnetic circuit with said central portion of said core, mechanical means responsive to random motion to vary the distance between said aligned surfaces and said magnet in one direction at a first rate, and in an opposite direction at a second rate different from said first rate, and means to bias the movement of said magnet in one of said directions.

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