PATENT SPECIFICATION

Convention Date (France): July 6, 1927. **293,423**

Application Date (in United Kingdom): July 4, 1928. No. 19,434/28.

Complete Accepted: Oct. 3, 1929.

COMPLETE SPECIFICATION.

Improvements in Electric Time Pieces.

We, SOCIÉTÉ ANONYME DES ETABLISSEMENTS LEON HATOT, residing N° 23, rue de la Michodière, Paris, France, a company organized under the laws of the French Republic, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

Our invention has for its object improved electromagnetic time pieces chiefly watches of the type comprising an arc-shaped magnet over which a coil borne by a balance is adapted to revolve by more than 180°, said coil being controlled through contacts which are allowed to remain in engagement for a comparatively long period (e.g. 20°—30°) of the total period of the balance.

According to our invention the very light and small balance controls the clockwork and the contacts of the coil circuit through parts arranged closely adjacent to the axis of the balance so as to reduce the possible losses of energy through shock and friction.

Time-pieces according to our invention possess the following advantages:

(a) the single balance used which is very small and light so as to create no stresses on its jewel bearings rotates by nearly one revolution and does not engage any external part at the ends of its oscillation path.

(b) the electromagnetic force exerted is very small and acts during a comparatively considerable angular movement of the balance, whereby the electrical efficiency of the very small driving parts used is increased.

(c) the passive resistances due to the gear work and to the contacts are greatly reduced and act during a rather considerable fraction of the period of the balance.

Further our magnet is of a much simpler, cheaper and more efficient construction than heretofore used in time pieces of the type described as it is constituted merely by a single semi-circular part supported at one end by a narrow support and having no lateral extensions acting as pole-pieces.

The invention and its several forms will now be described with reference to the accompanying drawings in which:—

Figure 1 is a view of the clockwork adapted to work in all positions. The view is a cross section taken on a plane passing through the axis of the balance.

Figure 2 is a front view of said balance.

Figure 3 is an elevation of one form of electric contact for the clockwork shown in Figure 1.

Figures 4 and 5 show to an enlarged scale the parts controlling the clockwork, Figure 4 being a cross section through the axis of the balance and Figure 5 being a cross section in a plane perpendicular to said axis and passing through the ratchet wheel.

Figure 6 is a detail sectional view, the section being made by a plane passing through the pivoting axis of the pawl driving the ratchet wheel.

Figure 7 is a detail sectional view taken in a plane passing through the pivoting axis of the detent of the ratchet wheel.

The watch shown on Figures 1 to 7 comprises an equilibrated balance 1 associated with a spiral spring R which may be replaced by a number thereof. The arrangement of the parts is such that the watch works in all positions and may be moved without stopping the normal working of the balance and of the hands.

The improved construction provides a balance, the weight of which is not above that of an ordinary alarm clock. It is of great interest to fulfil this condition because, the balance being mounted on pivots and oscillating for several years without being oiled, it is necessary for the movable parts to be very light so as to reduce the friction to a minimum. This also reduces the detrimental effects of the inertia of the moving parts when the watch is submitted to severe shocks as is the case of automobile watches.

In order to obtain a proper working for the arrangement with very light driving parts, the mechanical power to be given out by the balance must be reduced to a minimum. This may be obtained through a ratchet wheel having very small teeth (preferably about 1 mm)

whilst the forces of inertia due to the switch and ratchet wheel, opposing the movement of the balance are reduced as much as possible.

To the balance 1 are secured a small coil 2 and two equilibrating weights 3 and 4. The balance oscillates on either side of its position of equilibrium shown on Figure 2. In this position, the coil surrounds the pole pieces of a small magnet 5 having the shape of a semicircle. There is a great advantage in using magnet steel having a high content of cobalt so as to provide an intense magnetizing. This magnet is secured to the main plate 6 of the clockwork through an angle iron 5^1 directly opposite the mean position of the coil; thus the balance may rotate by nearly 180° on either side of its position of equilibrium.

One end of the coil is earthed, the other end is secured to the insulated part 8 (Figure 1) on the balance, to which current is led through the spiral spring 9 secured to the insulated angle bar 10.

The balance thus described may be made to a very small scale and its weight may be reduced to 10 grammes. Good results have been obtained with a total weight of about 5 grammes.

The balance may drive a periodical switch and a clockwork. One form of such a switch is shown in Figure 3. It comprises an insulated part 8^1 on the balance to which part is secured a pin 13 parallel to the axis of the balance and at a distance therefrom preferably under 3 millimetres. Next to and parallel with this pin is disposed another pin 12 which pin is secured to the balance 1.

These pins cause a part 11 pivotally secured to a stationary part to reciprocate, for when the balance rotates in an anti-clockwise direction the pin 13 strikes against the one arm of the part 11, which has the shape of the fork of an anchor escapement, causing this part to move in a clockwise direction, the circuit being closed while the pin 13 is in contact with the said arm. The pin 12, however, misses this first arm of the part 11 as the balance continues to rotate to the end of its swing. On the return swing of the balance i.e. in a clockwise direction the pin 12 again misses the first arm but comes into contact with the second arm of the part 11, this arm having moved into the path of the pin 12 by the action of the pin 13 on the first arm as described above. The part 11 is thereby caused to move in an anti-clockwise direction, the first arm being then brought into the path of the pin 13 on the next swing of the balance in an anti-clockwise direction.

The movements of part 11 are mechanically damped. In order to send the current periodically through the coil 2, a known type of switch constituted by the pawl and ratchet driving device of the clockwork control mechanism may be used, the contact being provided by the detent which is lifted at each driving stroke.

Great difficulties are encountered in the construction of clockworks of this kind comprising a small balance rotating by nearly one revolution. These difficulties are due to the following reasons:

In order to reduce the intensity of the current used, it is desirable to keep the coil circuit closed whilst the balance rotates by a comparatively important angle (e.g. 20 to 30 degrees) otherwise the contact would be of too short a duration and the electro-magnetic force would be exerted on the balance during too short a travel, therefore it would be necessary to use a very intense current and the electric efficiency would be very low because of the small size of the driving parts.

Moreover it is advisable, with a view to reducing the mechanical power required, to use a small ratchet wheel the interval between two successive teeth of which is only about 1 mm. If the driving pawl is to actuate the tooth-work of the ratchet wheel whilst the balance is rotating by more than 20°, it is necessary for the end of the pawl to be very near the balance axis. Figure 5 shows this distance should be only about 1 to 2 mm. The usual arrangement used with clocks cannot therefore be used as the size of the pawl and of its pivots cannot be reduced too much if the parts are not to be too liable to be broken, and the oiling of the pivots on the other hand requires comparatively large lubricating chambers.

The enlarged figures 4, 5 and 6 show an arrangement for removing this difficulty. The pawl 14 for driving the clockwork pivots round the spindle 15 held in the support 16 secured to the spindle 17 of the balance. The end of the driving pawl bears a part 18 the free end of which engages the teeth of the ratchet wheel 19. The spindle 17, the part 18 and the wheel 19 have the shape shown on Figure 5 and only the parts disposed in the plane of the ratchet wheel are shown shaded on said Figure 5. This design thus allows the operative end of the part 18 of the driving pawl to be disposed very near the balance spindle as the driving pawl 14, its spindle and its support are not in the plane of the ratchet wheel. The said parts may be thereby comparatively large sized. The driving pawl is urged back into the position shown in

Figure 5 by a spring 20 constituted by a spiral spring blade connecting the spindle 15 with the pawl support 16. This spring is also outside the plane of the ratchet wheel whereby no part can prevent the balance from rotating by nearly one revolution.

A detent 21 pivoting round the spindle 22 may be used. The part of this detent acting on the ratchet wheel is constituted by a part 23 of tempered and polished steel or of precious stone. The shape of this part as shown on the drawing allows it to bear against the tooth D very near the line connecting the pivots 22 and 24 of the detent and of the ratchet wheel. The detent 21 is provided with a pin 25 of platinum disposed in front of a very yielding small spring 26. The end of this spring bears a gold tube 27 secured through a conical pin 28. The electric contact between 25 and 27 is provided for each driving stroke of the pendulum when the part 18 makes the ratchet wheel rotate by one tooth.

In order to provide a good electric contact with a very small contact pressure the following arrangement is preferred. The stationary support of the spring 26 is placed in a manner such that when the pin 25 raises the said spring, there is a small sliding motion of one of the contacting surfaces with reference to the other whereby the dust and oxides are swept away. A stop 30 disposed in front of the spring 26 limits the movement in that direction. On the other hand the ends of the spindle 22 form pivots adapted to rock in comparatively large recesses. A spring 31 bears against one of the ends of the spindle so as to hold the other pivot against a thrust plate 29 (Figure 7). A spiral spring 32 ends with a ferrule fitted over the spindle 22 and is adapted to lead the electric current to the pin 25. All the movable parts are mechanically equilibrated and the tension of the spiral spring 32 is adjusted so as to make the detent press slightly against the ratchet wheel 19 (Figure 5).

When the ratchet wheel rotates, the pivots of the spindle 22 move in their recesses due to the fact that the part 23 is displaced by a force which has a direction varying according to the moment of the drive considered. The result is a compound sliding motion of the pin 25 over the gold tube 27 which causes the circuit to be broken at a point where the occurrence of a slight friction cleans the contacting surfaces.

The spring 31 prevents any longitudinal sliding of the spindle 22. Experience shows this is of interest in order to avoid any dust due to the abovementioned friction from penetrating between the contacting parts.

It should be noted that in the above disclosed arrangements the contact pin is very near the balance spindle, whereby the resisting force due to the contact pressure is reduced to a minimum.

It may also be an advantage for maintaining the oscillations to use a current under conditions such that when the circuit is closed, the voltage between the contacting parts is greater than that used heretofore in time pieces of the same type which is generally below 1 volt; practice shows a proper contact may thus be ensured with pressures below those considered necessary up till now (about 0.5 to 1 gramme).

Though the abovedescribed improvements are particularly intended for watches and small clocks, they are of advantage in all time pieces for eliminating all causes of disturbance in the regular working of the time piece considered.

The driving parts and pawl devices described may be used not only with clocks and watches working independently but also with receiving time pieces of a time distributing system comprising a pendulum receiving periodical electromagnetic impulses the frequency of which is determined by a master-clock. In particular the arrangements comprising a spiral equilibrated balance which work properly even when the time piece is being moved are adapted for use in time distribution on board ships.

The above arrangement may also be used for actuating balance relays which are gradually started oscillating under the influence of periodical current impulses having a frequency near that of the natural oscillations of the balance. Such arrangements may be used for receiving and selecting periodical signals.

The arrangements shown on Figures 1 to 7 are given only by way of example. Movable magnets co-operating with stationary coils as well known in the art, or systems comprising a plurality of magnets and coils, or again a very flat coil moving in front of the pole pieces of one or more permanent magnets may be employed.

The arrangement described comprising a pivoted balance may be employed in several ways. For instance it may form a small travelling clock with a small balance having a vertical spindle and the oscillations of which are kept up electrically. This balance may be disposed at the lower part of the frame and appear underneath the dial. The rotation of the ratchet wheel with a vertical spindle may be transmitted to the horizontal spindle of the hands through a worm gear.

A clockwork movement comprising a small pivoting balance with electrically maintained oscillations may be used as described above, said balance being connected through a fork with a large removable pendulum built and suspended as in usual mechanical clocks.

The arrangements described above may be used with time pieces comprising an oscillating balance without any clockwork and adapted to control through synchronisation another balance controlling the hands and winding up one or more springs actuating a striking mechanism. In such arrangements the controlled balance may be provided with parts actuating directly, when required, the striking hammer. This may be provided through a releasing and strike-counting mechanism which after working would cut off the mechanical connection between the balance and the hammer. In order to avoid the damping of the oscillations of the receiving balance, during the striking, a supplementary coil periodically energised during the striking so as to increase the driving energy at this moment may be provided. Such an arrangement could be used also with independent clocks provided with a striking mechanism in which case a comparatively light balance would actuate the striking hammer when required. The parts lifting the hammer might be used for closing the intermittent contact sending current into the supplementary coil energized whilst the striking mechanism is operative. For instance, if the hammer is controlled through a ratchet wheel and a pawl, the electric contact may be provided between the two said parts.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An electromagnetic time-piece of the type comprising an arc-shaped magnet over which a coil carried by a balance is adapted to revolve by more than 180°, said coil being controlled through contacts which are allowed to remain in engagement for a comparatively long period (e.g. 20°—30°) of the total period of the balance, wherein the very light and small balance controls the clockwork and the contacts of the coil circuit through parts arranged closely adjacent to the axis of the balance so as to reduce the possible losses of energy through shocks and friction.

2. An electromagnetic time-piece as claimed in Claim 1 wherein the arc-shaped magnet comprises a single semi-circular part preferably of cobalt-containing steel, supported at one end by a thin support, the position of rest of the coil being over the other end of the semi-circular magnet.

3. An electromagnetic time-piece as claimed in Claim 1 wherein the coil circuit is controlled by a switch comprising two pins carried by the balance very near its axis preferably less than 3 m/m therefrom, and adapted to engage the prongs of a rocking fork the movements of which are mechanically damped, the circuit being closed through one of the pins and the fork during the angular movement of the balance in one direction through more than 30°.

4. An electromagnetic time-piece as claimed in Claim 1, comprising a ratchet wheel, a driving pawl pivotally secured to a part fixed to the balance and a detent pivotally secured to a part fixed to the casing wherein the parts carrying the pawl and the detent are disposed in planes parallel to that of the ratchet wheel and act on the latter through pins perpendicular to said planes, the pin of the driving pawl being disposed very near the axis of oscillation of the balance, say 1 to 2 mm. therefrom and passing if required through an aperture in the part to which the pawl is secured.

5. An electromagnetic time-piece as claimed in Claim 4, wherein the control of the coil circuit is provided by the usual contact carried by the detent, said contact being adapted to sweep the surface of a cooperating contact blade during the comparatively considerable angular movement of the balance required for the advance of the ratchet wheel by one tooth.

6. An electromagnetic time-piece as claimed in Claim 4 or 5 wherein the detent is carried by its support through pivots having a certain longitudinal play taken up by a spring.

7. An electromagnetic time-piece substantially as described with reference to and as illustrated on the appended drawings.

Dated this 4th day of July, 1928.

MARKS & CLERK.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1929.

Fig.1

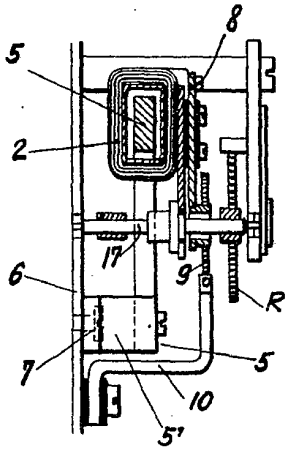


Fig.2

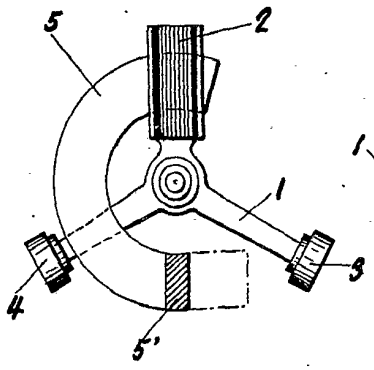


Fig.3

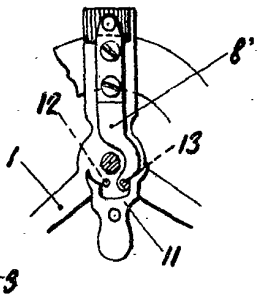


Fig.4

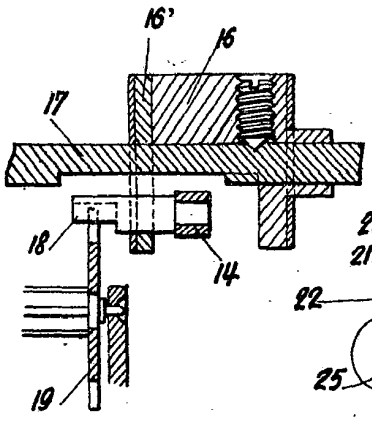


Fig.5

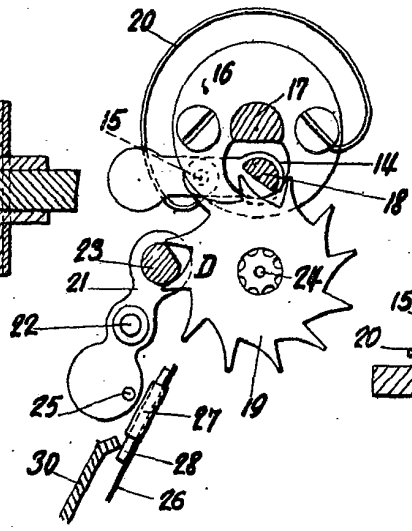


Fig.6

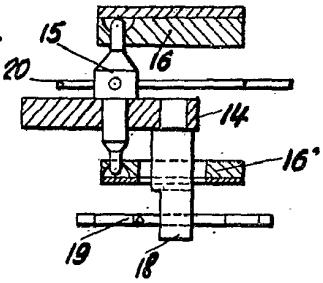
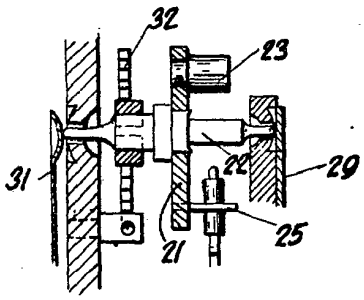


Fig.7



Charles & Read Ltd. Photo Litho.