From a study of the prior art it can be seen that the desirable objectives of electric watch construction have been long-recognized and that many different mechanisms have been proposed to attain them. None has more than a superficial resemblance to the mechanisms described herein and claimed as a general combination and in certain desirable and novel subcombinations.

In carrying out the invention, we propose to overcome the excessive power drain and faulty electrical contacts found in prior electric watches by mounting on an oscillatable balance wheel, armature pieces which are adapted to pass through the magnetic field of an energized electrical coil. A roller drum is mounted on the same staff as the balance wheel and in place of the conventional roller table. This roller drum encloses a deflectable latch which engages a ratchet tooth of an escape wheel to drive it in one direction on one swing of the balance wheel and brushes lightly over teeth on the return swing of the balance wheel, so that a minimum amount of energy is lost. A first lever is poised and pivoted about a staff parallel with the balance wheel staff and spring-biased to engage at one end the teeth of the escape wheel so that as this end passes over each single tooth, it will cause the first lever to turn about its pivot and contact a second similarly poised and pivoted lever. This second lever is spring-biased to oppose the motion of the first lever and is positioned against the bias by an adjustable banking pin. The first and second levers are insulated from the rest of the mechanism in such a manner that, when the two levers are in contact, an electrical circuit through a small battery and the coil will be closed and so impart, by means of the armature pieces, a driving force to the balance wheel. The end of the first lever in contact with the escape wheel may be advantageously provided with a stone so shaped as to compensate for the inertia forces existing in that lever when it turns about its pivot.

The first and second levers are so positioned with respect to one another that there is a brushing or sliding action between them during contact so that the electrical contact area is kept clean at all times. The banking pin provides a means so that the instant and length of time the electrical circuit is closed may be readily adjusted without altering this brushing action.

An embodiment of the invention is shown in the accompanying drawings in which:

Fig. 1 is a diagrammatic perspective view of a portion of an electric watch movement according to the invention with the electrical circuit open and closing;

Fig. 2 is a plan view of a portion of a movement according to the invention, showing the roller drum thereof in section, just before the oscillating balance wheel comes into driving engagement with the intermittently rotating escape wheel;

Fig. 3 is a view similar to Fig. 2 at the instant the electrical circuit is closed;

Fig. 4 is a view similar to Fig. 2 at the instant after the electrical circuit is broken;

Fig. 5 is a plan view of the new roller drum and latch employed in the invention to replace the conventional roller table of a watch;

Fig. 6 is a partial elevation of Fig. 5 viewed from the line 6–6; and

Fig. 7 is a plan view, on an enlarged scale, similar to Fig. 4, showing the positive wiping motion at the point of electrical contact and the geometric detail of the stone in engagement with the escape wheel.

Structure

Referring first to the structure shown in the drawings, 1 represents a conventional type balance wheel equipped with a standard non-magnetic balance spring 32 mounted for oscillation about balance staff 2. Mounted immediately below the balance wheel which is journaled in
jeweled bearings 30 and 31 and on the same shaft is an iron armature piece having poles 3, 4 and 5 spaced 120° apart. These poles are so placed as to be in the magnetic field of coil 6. Coil 6 is energized and builds up a magnetic field when the first lever 7 and second lever 8 contact each other and complete the electrical circuit between a small battery or power source 25 and its ground, which in this case, is the main plate for supporting the movement. One lead of the coil is connected directly to the battery while the other lead is connected to the return spring 10 attached to lever 8. Spring 10, is, of course, insulated from ground and is preferably of the coil type mechanically fixed to lever 8 so that the electric circuit from ground through battery 25, coil 6, and spring 10 into lever 8 is without make-and-break or moving contacts of any sort and hence waste of electric energy is avoided. Levers 7 and 8 and the gear train of the watch are advantageously insulated from ground by the jewel bearings in which their staffs are journalled. Below the armature on the balance shaft at the place where a roller table is usually mounted, is a roller drum 11 enclosing a deflectable pivoted latch 12 for engaging the escape wheel 14.

Referring particularly to Figs. 5 and 6, it is seen that latch 12 is biased near its pivot outwardly of the roller drum by an extremely light spring 13 mounted within the drum. The outside surface of latch 12 in the projected position is eccentric to the staff 2 so that never more than one tooth of escape wheel 14 will engage the latch. As shown in Fig. 6, the thickness of the main body of latch 12 is less than the slot in the roller drum through which it is projected so that foreign particles, oil droplets, etc., can never impede the deflection of the latch into the drum. It has been found by experiment that the force needed to push latch 12 into the oscillating roller drum when it brushes past a tooth of the escape wheel 14 on its return stroke is extremely small so that there is a minimum of power loss in the balance wheel on this stroke.

Escape wheel 14 is mounted on staff 15 which in turn is geared to a conventional gear train (not shown) for moving the time indicators of a watch. Escape wheel 14 is adapted to be engaged by pallet stone 16, which is attached at one end of the lever 7. Lever 7 is biased by return spring 17 so that it tends to force the pallet stone in contact with the escape wheel and thus insure return of the lever to the position where the stone is at the bottom of a tooth rise. This in turn arrests and accurately positions the escape wheel for the succeeding engagement with the palletstone.

In Fig. 7, it is seen that the pallet stone is cut so that there are two plane faces that may engage an escape wheel tooth. Face 18 engages the rise of a tooth of the escape wheel and so causes lever 7 to turn about its pivot as the escape wheel rotates. This face is slightly inclined to the rise of the teeth in order to provide theoretical line contact and hence an actual minimum area of contact with any single tooth of the escape wheel. Face 19 of the stone is cut on the opposite inclination to that of face 18. The purpose of this is to compensate for effects of inertia on lever 7 as it rotates about its pivot. Inertia causes lever 7 to continue to rotate even when a tooth of the escape wheel has moved past the tip of the lever and is not in contact with the pallet stone. The effect of the inclining face 19 of the pallet stone is to cut off the upward force exerted on the stone by a tooth sooner than if face 18 extended the complete width of a tooth. Inclining face 19 further results in removing resistance by the lever to the movement of the escape wheel during the time the wheel advances the angular distance equal to the projection of face 19 on its outer periphery. Within the time required for the escape wheel to advance this angular distance, the lever 7 recovers from its impulse or inertia away from the escape wheel and is biased by return spring 17 back towards its original position, i.e., with the pallet stone at the bottom or valley of a tooth rise. When the stone is at the bottom of a rise, it arrests the escape wheel against movement and so eliminates the necessity for a balance or winding member acting on the escape wheel such as found in conventional watch movements, thus further increasing the efficiency of our movement. Any slight recoil in the advancement of the escape wheel initiated by the roller latch is also automatically corrected by action of inclined face 19.

This is because inclined face 19 which is biased towards the escape wheel by return spring 17 would fall down on the tip of a tooth of the escape wheel and throw the tooth to slide along face 19 until it reached the left-off corner 24. At this point lever 7 would fall into the valley between two teeth and so arrest the escape wheel until the next succeeding engagement of a tooth by the latch.

Lever 7, as is lever 8, is a pivoted member pivoting about a staff that is, in turn, carried in jeweled bearings. These jewels and stone 18 insulate lever 7 from ground, but it is deliberately grounded through spring 17 which, like spring 19, is advantageous for the coil type not only for the recognized horological desirability of the type, but also to provide effective correspondence of the electric conductivity. Moreover, all undesirable vibrations and unwanted eddy and the like effects thereof are avoided.

Lever 7 contacts lever 8 at 20 which thus serves as the sole electrical make-and-break point in the electrical circuit. In order to minimize filming-over of the contact surfaces which would result in a poor electrical connection, it is important that the contact area be kept clean. This is achieved by having a positive wiping action between the two levers. This action appears clearly shown in Fig. 7 where the extreme positions of the levers are shown.

The wiping action might be more easily pictured if the lengths of the levers 7 and 8 from their fulcra to the contact points are thought of as the radii of two separate circles having their centers so placed that they will intersect at two points and thus form major and minor arcs on each circle. The point of circuit closure (when lever 7 contacts lever 8) will then correspond to one of the points of intersection of the circles and the total relative wiping action will be the distance between the two arcs generated as the two levers are rotated about their fulcra. Although a post is indicated on lever 7 at 20 in the drawings, this is a structural expedient only, preferred for the more compact arrangement of Figs. 2, 3, 4, and 7. In the arrangement shown in Fig. 1, identical operating characteristics would result if the end 9 of lever 7 itself were finished off in a fillet of radius equal to that of pin 20 positioned to provide a corresponding contact area with lever 8. Such an arrangement would permit levers 7 and 8 to be co-planar in strictest theory. However, all arrangements illustrated are practically co-planar, i.e., all elements may be conveniently arranged between the two planes which contain the bearings for balance wheel staff 2 and hence all provide the advantage of permitting our mechanism to be used in the popular and fashionable thin cases without crowding.

Spring 10 biases lever 8 toward an adjusting screw or banking pin 21, which, of course, is neither conducting nor insulated from ground. The adjusting screw 21 consists of a pin mounted eccentrically on a screw so that by a mere turning of the screw, the timing and the dwell of the electrical circuit closure can be regulated. This adjustment, unlike that of leaf spring contact points, can be made while the mechanism is running and does not affect the mechanical or electrical characteristics of the contact being made, but only its timing.

Operation

As balance wheel 1 rotates on its shaft, return-spring 13 biases outwardly the retractable latch 13 of roller drum 11 in order that it may engage a tooth of escape wheel.
2,909,892 5 14. As the latch 12 nears the line of centers (line connecting the escape wheel center and balance wheel center) it contacts an escape wheel tooth and carries it through said line of centers. At this point pallet stone 16 is raised sufficiently on the tooth rise for lever 7 to contact lever 8 at point 20 and so close the electrical circuit. At the particular instant of closing, the pallet stone has traveled approximately one-third its distance up the tooth rise. Closing the circuit energizes the coil 6 which then delivers the required impulse to the balance wheel.

At the instant of circuit closure (Fig. 3), poles 3, 4 and 5 of the armature are at a prescribed angular distance from the field pole pieces 22 and 23 and ahead of the in-beat position of the balance wheel. The in-beat position is that angular position which will bring the roller drum latch to the line of centers when the balance wheel is at rest.

As the latch and escape tooth engagement continues beyond the line of centers, the electrical contact remains closed for a predetermined and adjustable period of time (or angle of motion). In the position of poles 4 and 5 with respect to field poles 22 and 23 of the coil as shown in Fig. 4, the electrical contact has just been broken so that the poles of the armature are free to swing on beyond the poles of the coil. The point of electrical break occurs when the top of a tooth rise coincides with the "letoff" 24 of face 19. The pallet stone is then forced back into its original position at the bottom of the rise by spring 17 acting on lever 7. During this period of motion of the armature, the distance between the field pole pieces swinging beyond the field pole pieces, the balance wheel is detached from the escape wheel since the latch has gone beyond the point of engagement with the escape tooth.

Upon the return swing of the balance wheel, the retracting latch passes over a projecting tooth of the escape wheel and thus does not cause any appreciable loss of motion of the balance wheel or movement of the escape wheel. This is because the extremely light return spring which forces the latch out is overcome by the very slightest force acting on the latch and because the escape wheel is locked in place by the pallet stone. Thus, the escape wheel is kept in perfect position for the succeeding period of action.

As the pallet stone returns to its original position at the bottom of a rise, the return spring 10 forces lever 8 to its original position against the eccentric banking pin. The relationship or ratio of on time to off time for the electrical circuit is easily and accurately adjusted by altering settings of the eccentric banking pin. Thus, by turning eccentric screw 21 in the direction so that the banking pin is moved towards lever 8, the current-on time will be shortened as this will delay the contact of levers 7 and 8, while conversely, turning the screw so that the banking pin is moved away from lever 8 will lengthen the current-on time as the levers will contact each other sooner.

We claim:

1. A motor for an electric watch including, in combination: a source of electric current; an electromagnet supplied from said source; a poised balance wheel assembly, including a first pair of bearings, a first staff journaled in said first pair of bearings, a first hairspring tendency to maintain said first staff in a predetermined angular position about its axis, a roller latch on said first staff, and a pair of angularly displaced armature elements on said first staff disposed in the field of said electromagnet and oriented so that activation of said field tends to rotate said first staff about its axis against the bias of said first hairspring; a toothed escape wheel journaled about an axis parallel to said first staff in the plane of and in operating engagement with said roller latch; a first poised lever assembly, including a second pair of bearings, a second staff journaled in said second pair of bearings parallel to said first staff, a first lever on said second staff in the plane of said roller latch, a cam follower at one end of said first lever disposed to engage a tooth of said escape wheel, a first contact cam surface at the other end of said first lever, and a second hairspring tending to maintain said cam follower in engagement with said escape wheel; an adjustable banking pin; a second poised lever assembly including a third pair of bearings, a third staff journaled in said third pair of bearings parallel to said first staff, a second lever on said third staff coplanar with said balance wheel assembly, a second contact cam surface at one end of said second lever disposed to engage said first contact cam surface when said first lever is moved against the bias of said second hairspring by interaction of said cam follower and said escape wheel, a stop surface at the other end of said second lever disposed to engage said banking pin so as to prevent rotation of said third staff about its axis beyond a predetermined angular position in the direction opposite to that imparted by contact between said contact cam surfaces, and a third hairspring tending to maintain said stop surface in engagement with said banking pin; and electric conductor elements establishing a circuit from said source to said electromagnet through said contact cam surfaces.

2. A motor according to claim 1 in which the first and second levers are so positioned with respect to one another that the engagement between the contact cam surfaces takes place with a wiping action.

3. In a roller latch construction, the combination including: a staff; a pair of circular plates of like diameter mounted on said staff perpendicular thereto, concentric therewith, and spaced apart axially thereof; a cylindrical wall having a single aperture therein between said plates at the periphery thereof enclosing the space between them except at the aperture; a pivot pin adjacent said aperture within said space parallel to said staff; a latch member journaled on said pin arranged to project through said aperture beyond said wall and periphery, the portions of said latch member that are in any position within said space being thinner than the axial spacing between said plates; stop means limiting the movement of said latch member about said pin in a direction outward from said aperture; and leaf spring means within said space urging said latch member against said stop means.

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CERTIFICATE OF CORRECTION

Patent No. 2,909,892

Arsene N. Lucian et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 10, for "whih" read — which —; line 13, for "left-" read — let- —; line 74, for the numeral "13" read — 12 —.

Signed and sealed this 10th day of May 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents
UNITED STATES PATENT OFFICE
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October 27, 1959

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