POWER TAKE-OFF DEVICE WITH STAGGERED RATCHETS

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1 Claim. (Cl. 58—28)

This invention relates to energy-transfer or power take-off devices for transferring small amounts of energy from an oscillating member to an intermittently actuated continually advanced member, for example in an electrically actuated wrist watch.

A feature of the invention is the provision of an oscillating member having a projecting part, a rocking member moved by said part and having an actuator, and a continually advancing member having ratchets with staggered or offset teeth which are successively actuated from the rocker.

Another feature is the provision of an oscillating member having a projecting part, a rocking member moved by said part and having an actuator, and a driven member having ratchets with staggered or offset teeth which are successively and alternately engaged and moved by the actuator during the forward and return strokes of the oscillating member.

A further feature is the provision of a horological assembly including an oscillating member, means for impulsing the same, and a projecting jewel pin moved with the member; a pallet piece having a fork for receiving the pin and being moved thereby, and also having an actuator; and a counting train including a pair of ratchets having their teeth staggered or offset and presented in the path of said actuator for successive and alternate actuation thereby during the forward and return strokes of the member; and in which the pallet piece acts to prevent excessive oscillatory movement.

Another feature is the provision of a power take-off for an electrically actuated timepiece comprising a balance and train parts mounted with parallel axes, together with a shaft extending in a radial plane relative to the axes and having parts intermittently advanced from said balance and having a worm in driving relation to a train part, whereby a speed reduction is obtained.

With these and other features in view, as will appear in the course of the following description and claim, an illustrative form of practice is shown in the accompanying drawings, in which:

Fig. 1 is a plan view of parts of an electrically actuated watch, including a staggered-ratchet train drive or power take-off;

Fig. 2 is an upright section on a larger scale, substantially on broken lines 2—2 of Figs. 1 and 3;

Fig. 3 is a horizontal section of the same, substantially on line 3—3 of Fig. 2, that is, with the balance cock and parts of the balance removed;

Fig. 4 is a fragmentary upright section, substantially on line 4—4 of Fig. 2.

In the drawings, the watch has a support or frame structure comprising a pillar plate PP, a balance cock BC and bridges and plates 20, 21, 22, 23, on which are mounted the train and the actuator lever, and the magnetizable yoke 24 having pole pieces 28 and the electrical winding or coil C. A balance staff BS is journaled in bearings of the plate PP and the balance cock BC and has a diametrical arm 37 connected to the balance wheel rim BW which carries the diametrically opposed masses MA and MB. The wheel rim and masses MA and MB are of non-magnetizable material; and the mass MB is magnetizable for cooperation with the pole pieces 28 between which it passes as the balance oscillates (Fig. 2). A hairspring collet HSC is connected to one end of the hairspring HS, which at its other end is fixed to a stud HSD on the balance cock BC.

A roller collet RC on the balance staff BS supports a contact fin 50 which during each stroke encounters the contact blade CB near the neutral axis, i.e. at the time of maximum velocity, and causes the blade CB to selectively engage the side contacts 60, 60a whereby to close a current path from the blade CB through the contact 60 to the coil C, during the forward stroke of an oscillation cycle, or through the contact 60a to the coil C, during the return stroke thereof. A block 54 of insulating material is fixed on the pillar plate PP by screw 56 and slidingly carries a block 55 on which is mounted the contact blade CB. The block 55 can be moved toward and from the balance axis by the screw 57 which has a flange engaged in a kerf of the block 55: the binder screw 55b holds the block 55 in adjusted position, at the desired depth of engagement of the free end of contact blade CB with the contact fin 50. The side contacts 60, 60a, are also mounted in the block 54 at their best ends, and a conductor 62 is electrically associated at one end with the side contact pieces and at the other end with a terminal 65 of the coil C. The other terminal 69 of the coil C is connected by conductor 71 insulatedly carried on the plate PP to the connection clip 72. A second connection clip 212 is connected to the plate PP which thus serves as a return conductor.

The conventionally illustrated battery B is connected at one terminal to the clip 212 and at the other terminal to the clip 272 so that when the contact blade CB engages either side contact 60 or 60a, current flows from the battery to clip 212, the plate PP, screw 55b, block 55, contact blade CB, the contact 60 or 60a, conductor 62, through the coil C, and by conductor 71 and clip 212 back to the battery B. The positions and tensions in the contacts 60, 60a may be regulated by the screws 61, 61a, the contact 60 having a slight clearance extending beneath the contact blade and contact 60a. Every time the contact 60, 60a causes the blade CB to engage a contact 60, 60a, the pole pieces 28 are magnetized and deliver an impulse to the mass MB, and thereby the balance system is maintained in oscillation.

According to the present invention, the roller collet RC carries a so-called jewel pin 51, which may be of ruby, sapphire, metal, or other material. A pallet piece or rocker 10 has tines 11, 12 with a notch between them for receiving the pin 51, and is supported by the pivot 13 carried by the bridge 23 and the pillar plate PP. The pallet piece 10 carries projections providing an actuator 15 which has laterally extending ends having oppositely angled or beveled edges for respective engagement with the teeth of the ratchet wheels 81, 82. The piece 10 also carries a safety pin 19 for engaging in a passing hollow of the safety collet SC in the usual manner during the passing action.

Bearing standards 78 and 79 on the plate PP support a shaft 80 having thereon two ratchet wheels 81, 82 with like numbers of teeth but with these teeth staggered or offset as shown in Figs. 2 and 3, so that each tooth of one ratchet lies midway of a tooth space of the other.
ratchet. The lateral span and shaping of the actuator 15 (Fig. 1), and the tooth spacings of the ratchets 81, 82 are so correlated, as to show, that the actuator 15 is free of one ratchet 83, it completes its actuation of the other ratchet; whereby it permits movement of such other ratchet to a position at which the other ratchet receives the actuator into the next succeeding tooth gap.

A detent ratchet 83 is fixed on the shaft 80, and has twice as many teeth as either ratchet 81, 82. A detent spring pawl 84 is mounted on the plate PP, and cooperates with the detent ratchet for preventing retrograde movements. A worm 85 fixed on the shaft 80 is meshed with a worm wheel 86 of the counting train which leads to the indicating hand or hands (not shown) in usual fashion.

In operation, the balance assembly is maintained in oscillatory movement by the successive magnetic impulses delivered thereto. As the roller collet RC approaches neutral axis in the counterclockwise, e.g. forward stroke, as indicated by the arrow in Fig. 3, the pin 51 passes the line 11 of the pallet 10 which then has its actuator 15 resting in the ratchet 81, and enters the pallet notch.

The pin 51 then acts on the notch wall of line 12 to rock the pallet clockwise about its pivot 13; at the end of this rocking movement, the pin 51 escapes from the notch and leaves the pallet and continues in its forward stroke against the action of the hairspring HS until it reaches the end of the forward stroke. The balance assembly then moves back in the clockwise or return stroke; as the pin 51 again approaches the neutral axis, it passes the line 12 as the pallet 10 has its actuator resting in the ratchet 82, and again enters the pallet notch and acts on the line 11 to return the pallet 10 by a counterclockwise rocking movement until the pin 51 escapes from the notch and continues to the end of the return stroke of the balance assembly. The safety pin 19 partakes in the pallet movement, and cooperates with the safety collet SC so that the pallet can only move at the proper points in the cycle.

While the actuator rests in the ratchet 81, it lies partly between adjacent teeth of the ratchet 81 and is clear of the ratchet 82 (Fig. 3). During the clockwise rocking of the pallet 10 during the forward balance stroke, the actuator 15 moves into engagement with a tooth of the ratchet 82, causing this ratchet and therewith the shaft 80 to turn as shown by the arrows in Figs. 2, 3 and 4. This motion of the shaft 80 is through an angle of slightly greater than half the accurate tooth spacing of the ratchet 81, 82 and the pallet 84 passes from one tooth to the next on the ratchet 83. As the shaft 80 turns, the ratchet 81 also moves by a half-tooth, such movement being permitted as the actuator 15 moves from the tooth gap.

During the rest of the forward stroke and essentially half of the return stroke of the balance assembly, the actuator 15 remains in a tooth space of ratchet 82 and clear of ratchet 81. Thereafter when the pin 51 moves the pallet 10 clockwise, the actuator leaves the ratchet 82 and enters the next tooth space of ratchet 81 and produces a further half-tooth-space movement of ratchet 81 and of shaft 80. Thus the shaft 80 is intermittently rotated by successive and alternate actuations of the ratchets 82, 81 during the forward and return strokes of the actuator 15. The shaft 80 is moved by one ratchet tooth per ratchet 81 or 82 for each complete cycle of the balance system. This motion is transferred by worm 85 to the wheel 86 and thus to the train. At each half-step, the detent pawl 84 acts on the detent ratchet 83 to prevent retrogression.

The balance staff BS, the train gear 86, and other trains can be mounted on the support with their axes parallel; and a large speed reduction accomplished by the stepping of the ratchets and use of the worm drive. For example, with a 300-beat balance, and 15 teeth in each ratchet, the shaft 80 turns 10 revolutions per minute, and with a single thread worm 85, and a gear 86 of 10 teeth, the wheel 86 turns once per minute, i.e. at the proper rate for a seconds pinion, and can be multiplied by a 1:1 ratio drive to a center seconds pinion SP.

The structure and conditions of operation are particularly of merit with a balance system which is impelled during a stroke by means moved by the system, in that such a balance system is normally inherently capable of controlling excessive amplitudes of oscillation. For example, with the illustrative electrically actuated watch, it is desirable to have the balance move for about one and one-half turns, or 270 degrees at each side of the neutral axis, in each stroke. At neutral axis, the impulse is delivered. Now, if a shock occurs in the absence of a motion-limiting device, this amplitude of swing may increase to 360 degrees; whereupon a second movement of the contact blade could occur, with a further impulse in the same direction, thereby tending to cause an additional forward movement; and during the return stroke impaling occurs as the balance regains the position of a two-turns amplitude, a further like return impulse at the neutral axis, and probably a third impulse at two-turns amplitude in the return stroke. This is avoided by the employment of the rocker member of limited motion, because as the amplitude increases toward two turns, the jewel pin 51 ultimately encounters the line 11 or 12 of the rocker or pallet piece and thereby is brought to a standstill before the pin 51 can again engage and close the contact blade CB. Thus the maximum amplitude is limited to less than 360 degrees or two turns, and it is notable that the various frictions and resistances normally increase with amplitude, whereas the duration of contact closure, and hence the quantity of impulsive energy, decreases with increase of the balance velocity at neutral axis so that the system tends to regain and operate at a constant amplitude dependent upon the adjustment of the contact blade CB toward or from the balance staff.

In service, also, the system is effective to prevent disturbances and damage during setting, e.g. during movements of the hands to proper time position when the watch is placed in service. When the setting stem is actuated to cause the hands to move, rotational forces are exerted along the train toward the worm gear 86, but can produce no rotation of the worm 85 and shaft 80 due to the low pitch of the worm teeth. Hence there is no movement of the rocker 10 from the ratchets 81, 82; and no damaging stress exerted between parts on the rocker and parts on the balance.

It is obvious that the invention is not restricted to the illustrative form of practice, but may be employed in many ways within the scope of the appended claim.

We claim:

1. A power take-off device for an electrically actuated timepiece having a support and an oscillatory balance thereon, comprising a pallet piece rockably mounted on the support for movement from one end position to another about a pivot axis parallel to the balance axis and having a forked end, a first element carried in an accurate path concurrently with the balance for entering said forked end and moving the pallet piece from one end position thereof to the other and thereafter leaving the said forked end during the continuance of the balance stroke; a shaft rotatably mounted on the support with its axis spaced from the balance axis and substantially at right angles thereto, a pair of ratchets fixed thereto with their teeth staggered, and actuator elements on the pallet piece and located in a plane parallel to the shaft axis and intersecting the teeth of both ratchets, each said element having an inclined surface cooperative with the teeth of the corresponding ratchet, the said surfaces being oppositely inclined relative to one another; said ratchets being spaced from one another in said plane whereby when one actuator element is engaged with and moving
one said ratchet, the other actuator element moves into the space between the ratchets so that the other ratchet can pass the other actuator element; means for preventing retrograde movement of the ratchets, and means on the pallet piece and balance for preventing movement of the pallet piece from its occupied end position so long as said first element is out of the said forked end.

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<table>
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