QUICK CORRECTION MECHANISM FOR A SECONDS HAND OF A TIMEPIECE

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ABSTRACT

This invention relates to a quick correction mechanism for the seconds hand of an electronic timepiece.

The object is to provide a unique mechanism residing in such a point that by operating a manual control means, preferably shaped into a special stem other than the regular winding stem, to perform a number of reciprocations corresponding to the number of seconds to be corrected, a drive coil is energized to have a corresponding number of drive current pulses which are then utilized to rotate the rotor of a step motor by a corresponding angle. This rotational movement is transmitted through mechanical transmission means to the conventional seconds hand gear which thus corrects correspondingly the position of the seconds hand.

10 Claims, 9 Drawing Figures
QUICK CORRECTION MECHANISM FOR A SECONDS HAND OF A TIMEPIECE

This invention relates to a quick correction mechanism for a seconds hand of a timepiece. It has been highly and sincerely desired by those skilled in the art to provide an efficient mechanism adapted for performing quick corrections of the seconds hand in a battery-powered timepiece, especially those having a crystal oscillator and a pulse-driven motion converter such as, for instance, pulse motors.

In the conventional art, mechanical means such as cam, lever and the like members are mainly relied upon for performing the correction of the seconds hand position to show the correct time display. In this case, a rather heavier finger effort must be applied to the winding stem for pushing-in thereof. In addition, the correcting job is rather defective in such that the seconds hand cam only be corrected to a certain or other specifically selected position.

The main object of the invention is to provide an efficient quick correction mechanism capable of obviating the aforementioned drawbacks inherent in the prior art.

A further object is to provide an improved seconds hand corrector, capable of operating substantially electronically and each time for correction of just a one second of time.

Still a further object is to provide an efficient and convenient seconds hands corrector, capable of performing a desired series of correcting steps, and at any time to any hand position as desired.

These and other objects, features and advantages of the invention will become more apparent as the description proceeds by reference to the accompanying drawings illustrative of several preferred embodiments of the invention.

In the drawings:
FIG. 1 is a plan view, partially being broken away and sectioned for display of several inner working parts, of an electronic watch embodying the principles of the present invention.
FIG. 2 is a schematic arrangement plan of several main working blocks of the watch movement contained in the watch shown in FIG. 1, the present plan being, however, shown on a substantially enlarged scale relative to that employed in FIG. 1.
FIG. 3 is a perspective view of a motion converter unit employed in the electronic watch embodying the principles of the invention.
FIG. 4 is a block diagram showing a preferred embodiment of the electronic circuit section of the motion converter.
FIG. 5 is a block diagram showing a further embodiment of the electronic circuit section employable in this invention.
FIGS. 6 and 7 represents several voltage cues as appearing at several parts of the electronic circuit according to this invention.
FIGS. 8 and 9 represent two embodiments of a reset circuit employable in the present invention.

Referring now to the accompanying drawings, especially FIG. 1 thereof, numeral 1 represents generally an electronic watch which is fitted with a second hand quick corrector according to this invention. This watch is fitted with a first or conventional winding stem 2 which is mounted in watch casing 1a and arranged axially movable and rotatable as known per se.
another and so designed and arranged that each of these stages receives the output frequency of the preceding stage and divides frequency by two.

Frequency divider 10 represents two separate and different signal outputs A1 and B1. In the similar way, frequency dividers 11, 12 and 13 represent each two separate outputs signal A2, B2, etc. An = 1, Bn = 1, An and Bn, respectively. 14 and 16 represent pulse-shaper circuits, although shown in a highly simplified and schematic way with respective blocks. 15 and 17 represent drive circuits for the pulse motor to be described.

10R, 11R and 12R represent respective reset terminals of frequency dividers 10, 11 and 12 and connected to a common reset line 18, 19 and 21 represents two separate drive coils of said pulse motor and connected electrically with each other and with said drive circuits, as shown. Arrows 20 and 22 hint respective current passage directions. A schematically shown rotor 23 belongs also to the pulse motor and is adapted for being driven by the magnetic fluxes emanating from these drive coils 19 and 21. Although not specifically described, the plurality of circuit sections, terminals, coils and the like described so far in connection with FIG. 4, are electrically connected one after another as shown, as most clearly be understood at a glance thereof.

In FIG. 5, 24 represents generally a pair of input terminals adapted for receiving a series of time base signal pulses from the time base oscillator such as crystal oscillator or tuning fork vibrator, as the case may be as before. Numerals 25, 26, 27, 28 and 29 represent respective frequency divider stages designed and arranged, so as to divide the frequency of the foregoing stage value by two, as before. 30 and 32 represent AND-circuits and 31 and 33 demonstrate respective inverters. 34 shows the drive coil for the rotor 36 of the pulse motor. Arrows generally shown at 35 hint the alternatingly changing directions of the current passage through the pulse motor which comprises a rotor 36 only schematically shown and adapted for being driven under the influence of magnetic fluxes provided by the drive coil 34.

In FIG. 9, a pressure-sensitive semi-conductor 41 is used in place of a terminal.

Next, the operation of the aforementioned embodiments, together with additional description of minor remaining structure, will be given hereinbelow:

Under normal operational conditions drive coils 19 and 21 are impressed alternatively with drive voltage pulses having a frequency of 1 Hz and a proper pulse width or duration period, so as to rotate the rotor 23 of the pulse motor comprising said drive coils, in a certain predetermined direction at a certain speed.

In the case of a modified arrangement shown in FIG. 5, the sole drive coil 34 is impressed in an alternatively way with a series of voltage pulses having a frequency of 1 Hz and of a proper pulse width or pulse duration period, so as to rotate the rotor 36 of the pulse motor comprising said drive coil 34, in a certain predetermined direction.

In either case shown in FIGS. 4 or 5, the rotor 23 or 36 is given a drive pulse per each second. Thus, motion is transmitted from the rotor 57 shown in FIG. 3 which is similar to that denoted 23 or 36 shown in and described in connection with FIGS. 4 or 5, respectively, to a unitary pinion 105 to the second hand wheel 60 meshing therewith, thence through arbor 101 to the seconds hand 61 which thus performs a pulsative rotational movement with a pulse per second. This pulsatively rotational movement of the hand 61 is assumed by the provision of a sprocket wheel 58 cooperating with the stop pawl 59. Although not shown, the root end of this stop pawl 59 is fixedly, yet adjustably mounted on a certain stationary member, preferably the conventional pillar plate, of the movement 4, by means of an adjustable fixture shown at 106 in FIG. 3. This stepping motion will be further transmitted through a unitary pinion 107 with the wheel 60 to the conventional time display gear train, not precisely shown.

When it is desired to advance the seconds "n" being a certain integer, the second stem 3 shown in FIGS. 1 and 2 is pushed in "n" times, so as to on-off control the mating contacts 6 and 7 in a corresponding number of reception.

Now it is assumed that the prefinal frequency divider stage FFN-1 has binary outputs: An-1 = 1 and Bn-1 = 0 and a resetting operation is initiated under these conditions in FIG. 4. It is further assumed that the direction of resetting is towards the conditions:

\[
(A1 = 1; B1 = 0), (A2 = 1; B2 = 0) \text{ and } (An-1 = 1; Bn-1 = 0).
\]

Under these conditions, frequency divider stages FF1, FF2, ..., FFN-1 are not reversed in their respective state by the resetting operation. By making the resetting to off from these conditions, the stage FFN-1 will rapidly reverse its state at a high frequency FF1, an output "Tn-1" representing a positive trigger pulse 38 from Bn-1. When the frequency divider stage FFN has been designed to reverse by such phenomenon, the FFN will convert its operating state, and, as an example, "0" becomes "1" at An and "1" becomes "0" at Bn, thereby a positive trigger pulse Tn will be delivered from terminal An which is then processed in the signal shaper 14 and thence conveyed through drive circuit 15 to drive coil 19, current thus flowing therethrough in the direction of arrow 19 so that rotor 23 makes a rotational one step. By selecting a proper overall gear ratio, the seconds hand 61 can perform a 1-second step.

For better understanding, reference may be had to FIG. 6 showing several related pulse wave curves.

Next, referring to FIG. 7, resetting operation is assumed to be taken under the conditions of: An - 1 = 0; Bn - 1 = 0.

In this case, all the stages FF1, FF2, ..., FFN - 1, will work so as to be:

\[
(A1 = 1; B1 = 0), (A2 = 1; B2 = 0), (A3 = 1; B3 = 0) \text{ and } (An - 1 = 1; Bn - 1 = 0).
\]

Therefore, a negative trigger pulse 39 will be issued through Bn - 1, thereby, however, the stage FFN being not reversed in its state. When the reset operation is terminated, however, a positive trigger pulse 38 will be issued so that the stage FFN will be converted in its state.

Therefore, "1" turns to "0" at An and "0" will become "1" at Bn. A positive trigger pulse "Tn" will be delivered through Bn and thus a drive pulse will be given to the drive coil so that the motor makes a rotational step corresponding to the sole drive pulse. Therefore, the seconds hand 61 will make an advance movement just by a second.
According to the arrangement suggested by the present invention, by manipulating the second stem so as to make an axial reciprocation, the seconds hand can perform a one-second advance step, irrespective of the conditions in the peripheral frequency divider stage FFn - 1. By nth repetition of the above manipulation, the seconds hand can advance n seconds.

Similar operation and effect can be obtained by use of the arrangement shown in FIG. 5. In this arrangement, the drive current flows through the sole drive coil in an alternating way, but operation of the seconds hand is similar to that appearing in the foregoing arrangement shown in FIG. 4.

In the present embodiment shown in FIG. 5, the outputs from the respective frequency divider stages are fed to the AND-circuits 30 and 32 as the inputs thereto. The number of connecting terminals to these circuits 30, 32 will decide the width of the drive voltage pulse.

In the modified arrangement shown in FIG. 8, the reset mechanism comprising the second stem 3 and switch contacts 6, 7 is coupled with a first frequency divider stage of bipolar transistor type comprising transistors t1 and t2 connected as shown therein. The operational results will be substantially similar as before.

In the further modified arrangement shown in FIG. 9, the mechanical switch contact has been replaced by a pressure-sensitive semiconductor diode 40 having a pressure-receiving zone 40a which is disengaged and arranged to cooperate with the actuating end 3a of the stem 3.

When pressure is transmitted from the end 3a of stem 3, the diode 40 becomes conductive, so that the collector-emitter passage of transistor 41 being short-circuited. Therefore, the similar effect as described in connection with the foregoing embodiments can be attained. In this FIG. 9, the chain dotted parts are similar to those shown in FIG. 8.

From the foregoing description, it would be clear that the circuit shown in the foregoing can be comprised of bipolar-IC, MOS-IC or the like composite circuit elements. It would be self-explanatory that the invention can equally be applied to the clocks.

In the foregoing description, the seconds hand correction has been described in the case of advancement of the hand: But, it is naturally necessary frequently to retard the hand. In this case, second stem 3 is continuously depressed for a certain predetermined period, so as to keep the hand in its stopped position. This operation will invoke in effect the corresponding retardation in the positive of the hand. Upon completion of this hand-stoppage operation, the regular stepping performed correcting operation can, when necessary, be adopted.

The embodiments of the invention in which an exclusive property or privilege is claimed are as follows:

1. An electronic timepiece, comprising a series of frequency divider stages connected in sequence for obtaining timing drive pulses, said series-connected stages forming a pulse frequency divider, a reset circuit connected with at least some of the frequency divider stages and excluding the final stage of said frequency divider, said frequency divider stages each receiving the output frequency of the preceding stage and dividing it by two, and an off-on control means controlling said reset circuit.

2. An electronic timepiece, comprising a series of frequency divider stages connected in sequence for obtaining timing drive pulses, said series-connected stages forming a pulse frequency divider, a reset circuit connected with at least some of the frequency divider stages and excluding the final stage of said frequency divider, an off-on control means controlling said reset circuit, a plurality of AND gates with inputs connected to the outputs of said frequency divider stages, and motor means with drive coils connected to the outputs of said AND gates.

3. An electronic timepiece, comprising a series of frequency divider stages connected in sequence for obtaining timing drive pulses, said series-connected stages forming a pulse frequency divider, a reset circuit connected with at least some of the frequency divider stages and excluding the final stage of said frequency divider, an off-on control means controlling said reset circuit, and contact means between a terminal of said reset circuit and one end of said off-on control means, said contact means comprising a pressure-sensitive semiconductor.

4. An electronic timepiece according to claim 1 including contact means between a terminal of said reset circuit and one end of said off-on control means.

5. An electronic timepiece according to claim 1 wherein said frequency divider stages comprises bistable circuit means.

6. An electronic timepiece according to claim 2 wherein said motor means comprises pulse controlled step motor means.

7. An electronic timepiece according to claim 2 including amplifying means between said AND gates and said drive coils.

8. An electronic timepiece according to claim 1 wherein said off-on control means comprises push-button switching means.

9. An electronic timepiece according to claim 1 including oscillating means for applying regularly-spaced pulses to said frequency divider.

10. An electronic timepiece according to claim 2 including signal shaping means connected between said motor means and the output of said frequency divider.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,810,354 Dated May 14, 1974

Inventor(s) Akira NIKAIDO et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading, correct the spelling of the first inventor's name to read --Akira Nikaido--.

Signed and sealed this 1st day of October 1974.

(SEAL)
Attest:

McCoy M. Gibson Jr. C. Marshall Dann
Attesting Officer Commissioner of Patents
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