

In an analogue electronic or quartz-crystal watch, one can accommodate by purely electronic means the irregularities in the number of days in the month of the year, as well as the additional day in February of each leap year. To this end, one simply needs to initialize the number of the year between 1 and 4 in a four year cycle, the number of the month of the year and the number of the day of the month, in order that these indications remain correct throughout the period of time during which the clockwork functions, i. e. during the life span of the battery. When the battery reaches the ends of its life span and its voltage is no longer sufficient, this information is lost and upon replacement of the battery, one must not only reset the watch on time but he must also reinitialize its perpetual calendar. Stopwatches of this type are also already known for example from a description given in the article by E. FAVRE and al. "The most complete wrist stopwatch in the world", Actes du Congrès Européen de Chronographie, N° 1, 23-24, September 1988.

This initialization of the perpetual calendar of analogue quartz-crystal watches is normally carried out in the factory by means of an apparatus external to the watch, which entails the drawback that the user cannot change the battery himself, nor generally have it changed immediately in a retail shop, because the latter is most often not equipped with the equipment necessary.

An analogue quartz-crystal watch is known from the document CH 672.222, in which the perpetual calendar can be programmed by means of the knob of the watch. This embodiment suffers several drawbacks. In particular, it is necessary to provide, just for the programming of the

perpetual calendar, three different axial positions for the knob for selecting time, i. e. at least five positions for this knob, if a position for selecting time and a neutral rest position are desired. This entails important axial movements of the knob which can weaken it and, in addition, the user never knows with certainty in which position the knob is.

Furthermore, this solution cannot be considered for a stopwatch, since one or even two additional axial positions for the knob would need to be provided, for correcting the display of the stopwatch and, further for providing a time zone shift function.

Furthermore, the solution proposed in this document necessitates a complete programming of the perpetual calendar at each changing of the battery, which is a drawback. There is known, from patent FR-A-2.404.250, an electronic timepiece which does not have the functions and the display of a stopwatch, and which, when it includes a perpetual calendar (see page 3, lines 5 and 6 of said document) cannot be initialized by means of components which form part of the watch and which would enable to do away with any complicated tooling and instrumentation external to the watch.

This electronic timepiece, which does not provide any stopwatch function, includes control members, namely a knob and two push-buttons, for selecting the time, i. e. resetting the seconds, minutes and hours, for changing the time zone and for setting off an alarm, but which do not allow for an initialization of a perpetual calendar.

Actually, it is essential for the initialization of a perpetual calendar to take into account the 4 year cycle including one leap year. However, this document mentions nowhere the possibility of displaying

or correcting the year.

Accordingly, there is no possible initialization of a perpetual calendar for this timepiece, through the use of the knob and the two push-buttons.

Furthermore the push-buttons of this French document are merely considered to be control members for certain parameters, in combination with the knob, but do not have in this document the function of normal push-buttons of a stopwatch mechanism.

The present invention is aimed at enabling an initialization of the perpetual calendar of a stopwatch and not of a watch, which avoids the use of a device external to the stopwatch and which does not necessitate a total reinitialization of the perpetual calendar when changing the battery, so that this initialization can be carried out in particular by non qualified staff in any retail shop, for example when changing the battery.

The present invention is aimed at a method for initializing a perpetual calendar of a quartz-crystal stopwatch by means of components forming part of this stopwatch, which obviates the aforementioned drawbacks, as well as a stopwatch for carrying out this method.

This method and this stopwatch are novel in the characteristic features set out respectively in the independent claims of the present patent.

The annexed drawing illustrates schematically and by way of example one method for carrying out the initialization process and an embodiment of the stopwatch according to the invention.

Figure 1 is a plan view of the stopwatch.

Figures 2 to 5 illustrate schematically the display, by means of

the central seconds hand and of the minutes dial, of the different parameters to be initialized, i. e. the number of the year, the number of the month, the day of the month and the hour.

Figure 6 illustrates a state diagram of the different functions which can be carried out with the watch having a stopwatch function according to the invention.

The stopwatch illustrated schematically in figure 1 includes an analogue display having a circular hours and minutes dial 1 concentric with respect to the hours hand 2 and the minutes hand 3. This display furthermore includes a seconds hand 4 of the stopwatch at the center, cooperating with the dial 1, a 30 minutes stopwatch counter having a dial 5 and a hand 6 illustrated at the five o'clock position and a 12 hours stopwatch counter having a dial 7 and a hand 8 illustrated at the seven o'clock position. Finally, this display includes a display for the day of the month, with a dial 9 with 31 divisions and a hand 10, illustrated at the midday position.

This stopwatch includes furthermore a stem for selecting the time, having three axial positions and ending with a knob 11, and two stopwatch push-buttons P1, P2.

This embodiment of watch with a stopwatch function is provided with three motors controlled by an electronic circuit including a microprocessor.

The minutes hand 3 and the hours hand 2, as well as the hand 10 indicating the day of the month, are driven via a mechanical gear from a first motor operating at a normal frequency of $1/12$ Hz, and capable of a fast forward motion at 64 Hz and a fast reverse motion at 32 Hz.

The information relating to the time measured is displayed up the

day of the month, but is calculated upwards by the microprocessor in a manner taking into account the occurrence of leap years.

With the knob pulled into the intermediate position, it is possible to change the time zone forward and backward, according to the direction of rotation of the knob for selecting time.

The hours hand is driven mechanically, while the state of the electronics is adjusted by means of the contacts of the knob 11.

The adjustment of the hour produces a corresponding adjustment of the information of the perpetual counter, i. e. the day of the month and the year.

By pulling the knob 11 into a second position, the display of the watch is stopped. One can then change the time of the watch forward or backward by steps of one fifth of a second. The changing of the time influences the totality of the information of the perpetual counter, from the seconds up to the year.

When the knob is pushed down, the minutes hand carries out the next step after twelve seconds (time signal).

In the stopwatch mode, the knob for selecting time is in the normal position and the hours display remains operative permanently.

The stopwatch includes two stopwatch motors. The first motor of the stopwatch drives the central seconds hand 4, which makes one full rotation of the dial per minute. This motor has a normal 5 Hz frequency and is capable of a fast 64 Hz forward motion, as well as of a fast 32 Hz reverse motion.

The second motor of the stopwatch drives the minutes hand 6 and the hours hand 8 of the stopwatch displays. This motor has a normal frequency of 1 step per minute and is capable of a fast 64 Hz forward mo-

tion as well as of a fast 32 Hz reverse motion.

When the knob 11 is in the normal position, a mere depression of the push-button P1 makes it possible to start the stopwatch. The timepiece is then in the simple stopwatch mode (START).

In the previous state (START), it is possible to interrupt the rotation of the stopwatch hands in two ways :

- a. By depressing P1, the rotation of the hands and the operation of the counters is stopped.

After reading the time measured, one can :

- Activate P2, which amounts to resetting to zero the hands of the stopwatch and to exiting from the stopwatch mode. In this case, a complete cycle in the simple stopwatch mode is carried out.
- Activate P1 and the stopwatch is restarted while taking into account the first event of which the duration was measured. The stopwatch is then in the ADD mode.

- b. By depressing the push-button P2, the rotation of the hands is interrupted, while the electronic counter continues its operation. The stopwatch is then in the SPLIT mode.

A new activation of P2 restarts the hands, which catch up to match the state of the electronic counter.

During rapid displacements of the hands, i. e. when resetting to zero the stopwatch and when catching up by the hands in the SPLIT mode, the seconds hand 4, as well as the minutes hand 6 and the hours hand 8 move independently, while following the shortest path.

The functions of the stopwatch are controlled by a timepiece microprocessor associated with peripheral circuits.

The circuit includes an applications portion at the input and output interfaces and a processor portion with its control unit and its processor unit.

The circuit includes 4 blocs of input interfaces corresponding to the various function control components :

Time base :

The circuit is provided with the clocks needed in particular for the measurement of time, and also for the sequencing of the processor and for various logical operations; it is basically comprised of the following circuits :

- a 32 Hz oscillator
- a digital adjustment of the frequency, by inhibition
- a division chain for the measurement of the current time
- a division chain for the stopwatch
- a system for ensuring a reset upon startup.

The adjustment of the quartz-crystal frequency is achieved by the inhibition of a given number of 32 kHz cycles during a period of 12 seconds.

The circuit for controlling the inhibition includes, in particular, non volatile memories (FAMOS) into which is loaded the binary value corresponding to the desired setting.

Input interfaces :

When correcting the hour, the displacement of the hours hand is done mechanically, through the first motor controlled by the processor which updates the registers according to the input signals through the knob

for selecting time.

When a control input of the system is actuated, it acts to activate a register which starts up the microprocessor and transmits information to a store (Flags); the processor then reads the data contained in this store and carries out the functions corresponding to the flag activated, after which it reset it to zero using the DATA field.

The circuit includes the blocs necessary for operating the components which it controls, in particular the motors.

Processor portion :

The applications programme contained in a ROM provides the basis for the operations of the processor. The number of instructions which it contains and their format are dependant upon the architecture of the microprocessor and upon the functions to be carried out.

The control unit is responsible for controlling the operations of the processor and of the peripherals; it is comprised of a ROM, a programme counter, a sequencer and a decoder.

The ROM contains the applications programme from which the processor carries out the various functions. Each instruction contained in the programme is selected by the programme counter and executed by means of a decoder which carries out the corresponding function by controlling the various components of the processor unit and of the peripherals. The sequencer controls the timing of all these operations.

The programme counter provides to the ROM, the address of the instruction to be carried out; after which, except if an order is issued by the memory, it increments the address by 1 step and provides it to the ROM; however, certain instructions can impose thereto another ad-

dress under certain conditions, thus enabling it to make jumps in the programme or to proceed to sub-programmes.

The sequencer controls the various steps required for the execution of the instructions.

The circuit used is mainly comprised of a binary divider, of a flip-flop D and of a logical circuit.

From a clock signal (16 kHz), it generates continuously execution cycles according to instructions, until the issuing of the HALT signal stops the sequencing and brings the processor to a halt; the startup is ensured by the signal INT.

The decoder is a logical circuit which produces the variables necessary for carrying out the desired function.

The processing unit carries out the functions provided for in the applications programme under the control of the control unit. It is essentially comprised of a RAM and of an arithmetical unit ALU.

The RAM consists of registers memorizing momentarily data such as the time measured by the stopwatch, dates and also other data.

The arithmetic and logic unit is a circuit carrying out operations on the data for the execution of the applications programme.

The implementation of this electronic circuit and of the method makes use of known techniques and for this reason, will not be described here in detail.

However, this electronic circuit and this processor make it possible to carry out at least two new original functions which are the initialization of the perpetual calendar (day, month, year) and of the hour, as well as the saving of the data relating to the perpetual calendar, at least upon the detection of the end of the life of the bat-

tery or the opening of the case.

According to the present method, the initialization process for the perpetual calendar and of the hour are achieved only through the use of components which form part of the stopwatch. To display the data introduced, use is made of the seconds hand 4 at the center of the stopwatch in relation to the minutes dial 1, but as will be seen later, the size of the unitary steps of this hand depends on the parameter which is initialized.

To enter the initialization mode of the perpetual calendar, the user places the knob for selecting time into its second position, by pulling the knob 11 to its outmost position. Then, he depresses three times the push-button P2, and then he depresses three times the push-button P1. The stopwatch is then in the state I of the initialization function, with the seconds hand 4 at the center reverting automatically to a position corresponding to the state of the memory.

By depressing the push-button P2, the hand 4 of the stopwatch progresses by $1/4$ of a full rotation (75 steps of the motor) until the value of the number 1, 2, 3 or 4 of the year in the four year cycle is reached (figure 2). If the value of the number of the year which is thus displayed is not correct, the seconds hand 4 of the stopwatch is made to progress by successive steps by depressing repeatedly the push-button P2. When the correct value is reached, the user depresses once the push-button P1, which puts the stopwatch into the state II of the initialization and the seconds hand 4 reverts automatically to a position corresponding to the state of the memories.

This state II corresponds to the initialization of the number of the month. Should this value not be the right one, the user makes the

seconds hand 4 progress by successive steps of $1/12$ of a full rotation (25 steps of the motor) by depressing repeatedly the pusher P2 until the correct value is reached (Fig. 3).

The user depresses once the push-button P1, to memorize the value of the month and to progress to state III of the initialization function for the day of the month and the seconds hand 4 reverts automatically to a position corresponding to the state of the memories. Should this value not be the right one, the user makes the hand 4 progress by successive steps of $1/60$ of a full rotation, by depressing repeatedly the push-button P2 until the exact number of the day is reached. If the value 28, 30 or 31 (depending on the number of days introduced previously) is exceeded, the seconds hand 4 reverts automatically to the starting position and the cycle can start again (figure 4).

In this embodiment, the initialization function includes furthermore a state IV for the initialization of the hour. By depressing once again the push-button P1, the user progresses to this state IV, the number of the day of the year previously adjusted is memorized and the seconds hand 4 progresses by steps of $1/60$ of a full rotation (5 steps of the motor) to the value of the hour memorized. If this value is not the right one, the user makes the seconds hand 4 progress by steps of $1/60$ of a full rotation until the right value is reached. If in doing so, he exceeds 23 steps, the seconds hand reverts automatically to zero and the initialization cycle for the hour can start again (figure 5).

Then, the user depresses once the push-button P1 to memorize the value of the hour and causes again the resetting to zero of the seconds hand 4 and the end of the initialization function. The knob for selec-

ting the time is pushed to assume its normal retracted position.

This stopwatch further includes a function for indicating the end of the life of the battery, which ensures that, when the voltage delivered by the battery decreases beneath a certain preselected level, the seconds hand 4 of the stopwatch positions itself on the "10 seconds" position, and the watch stops and memorizes its current state, inclusive of the data relating to the perpetual calendar, in the FAMOS. An identical saving of the values is made at each opening of the case, by virtue of an appropriate contact of the case.

After changing the battery, the closing of the case causes through the actuation of the contact of the case, the transfer of the values memorized in the FAMOS, into the counter of the stopwatch. The user then ensures the catching up of the time elapsed by a fast correction of the day of the month and of the hour. After each closing of the case and before the correction by catching up of the time elapsed, the stopwatch can proceed automatically to a non static state during which the display of the state of the perpetual calendar is possible. Thus, the user can check that the perpetual calendar is properly set and can, should the need arise, carry out a new initialization of the same.

These different functions and others, which the present stopwatch is capable of carrying out are schematically illustrated in figure 6, wherein :

T1 is the contact of the intermediate position of the knob for selecting time.

T2 is the contact of the outmost extended position of the knob for selecting the time.

Cb is the contact of the case which indicates whether the case is open

or closed and which causes the saving of the values upon opening of the case.

P1 is the first push-button of the stopwatch.

P2 is the second push-button of the stopwatch.

I1 is a contact actuated by the rightward rotation of the knob 11 when the same is in its fully protracted position or its intermediate position.

I2 is a contact actuated by the leftward rotation of the knob 11 when the same is in its fully protracted or intermediate position.

Thus, a rotation of the knob 11 makes it possible, when the knob for selecting time is fully protracted, to make the minutes hand 3 progress or reverse for setting the watch on time, the hour being indicated by the procedure of initialization of the perpetual calendar or by the correction function of the time zones in the forward or the reverse direction.

Thus, for the first time, a method has been developed for initializing a perpetual calendar of a watch with a stopwatch function and for resetting the data contained therein when the battery life ends, by means of components which are exclusively part of the stopwatch, as well as a watch with a stopwatch function for carrying out this method.

It is clear that a particular mode of carrying out the method and a particular embodiment of the watch with a stopwatch function were described by way of example, but numerous alternate versions thereof, in particular involving other control procedures of the various functions by use of the knob for selecting time and the push-buttons can be envisaged without departing from the scope of the protection claimed.



CLAIMS

1. A method for initializing a perpetual calendar of an analogue watch with a stopwatch function including a case, a knob (11) for selecting time and two stopwatch push-buttons (P1, P2), a dial (1) graduated in hours and minutes, a central second hand (4) of the stopwatch well as off-center circular scales on the stopwatch for minutes (5, 6) and hours (7, 8), each one being graduated and provided with a corresponding hand; at least one motor for driving these hands, an electronic circuit including a microprocessor controlled by a quartz time base, and a display for the day of the month (9, 10), characterized in that the initialization of the perpetual calendar, i. e. the number of the year in a four year cycle, the number of the month of the year and the indication of the day of the month is controlled by means of the knob (11) for selecting time and the two stopwatch push-buttons (P1, P2), and in that each one of the parameters to be initialized is displayed successively by means of the hands (2, 3, 4) and of the corresponding scale (1).

2. A method according to claim 1, characterized in that the parameters initialized by means of the second hand (4) at the center of the stopwatch cooperating with the hours/minutes dial (1) are displayed.

3. A method according to claim 1 and to claim 2, characterized in that the initialization function of the perpetual calendar is selected by placing the knob (11) for selecting time in a determined axial position and by pressing down the push-buttons P1 and P2 of the



stopwatch according to a predetermined sequence.

4. A method according to claim 3, characterized in that once the initialization function selected, the number of the year is initialized by pressing down successively the first push-button (P2), with each pressing down of this push-button producing additionally a progression by one quarter of a full rotation of the second hand (4) of the stopwatch.

5. A method according to claim 4, characterized in that, after having initialized the number of the year, this information is memorized and the next step is carried out by pressing once on the second push-button (P1) and then the number of the month is initialized by pressing down successively the first push-button (P2), each pressing down of this push-button producing a progression by one twelfth of a full rotation of the second hand (4) of the stopwatch.

6. A method according to claim 5, characterized in that after having initialized the number of the month, this value is memorized and the next step is carried out by pressing down once the second push-button (P1) and then the day of the month is initialized by pressing down successively the first push-button (P2), each pressing down of this button producing a progression by one sixtieth of a full rotation of the second hand (4) of the stopwatch.

7. A method according to claim 6, characterized in that after having initialized the day of the month, this information is memorized and



the next step is carried out by pressing down once the second push-button (P1) and then the hour is initialized by pressing down successively the first push-button (P2), each pressing down of this push-button producing a progression by one sixtieth of a full rotation of the second hand (4) of the stopwatch, and finally this value is memorized and the second push-button (P1) is pressed down to return to the initial stage of the initialization.

8. A method according to one of the preceding claims, characterized in that the point of time when the voltage of the battery falls beneath a predetermined value, the current indications of the perpetual calendar are memorized automatically (year, month, day and hour) and in that the second hand (4) of the stopwatch is arrested at a position different from its position of reset to zero.

9. A method according to one of the preceding claims, characterized in that at the instant when the watch case is opened, the current indications of the perpetual calendar (year, month, day, hour) are memorized automatically.

10. An analogue watch with a stopwatch function for carrying into effect the method according to claim 1 including a case, a knob (11) for selecting time and two stopwatch push-buttons (P1, P2); a dial (1) graduated in hours and minutes, a central second hand (4) of the stopwatch, off-center circular scales on the stopwatch for minutes (5, 6) and hours (7, 8), each one being graduated and provided with a corresponding hand, as well as a display of the day of the month including



an off-center circular scale (9) and a corresponding hand (10); at least two motors for driving these hands and an electronic circuit including a microprocessor controlled by a quartz time base, characterized in that it includes a knob (11) for selecting time with three axial positions of which one causes via contacts the implementation of the "initialization" mode and in that the push-buttons (P1, P2) of the stopwatch make possible the initialization of the perpetual calendar, i. e. successively of the year, the month, the day and the hour, and the display by the second hand (4) of the stopwatch, of the parameters initialized.