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(54) ELECTRONIC SWITCH FOR TIMEPIECES

(71) We, TIMEX CORPORATION, a Corporation organized under the laws of the State of Delaware, United States of America, of Waterbury 20, Connecticut, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to battery-operated timepieces, for example quartz watches, and particularly to a means for preventing the battery from running down during storage.

In battery-powered timepieces, a means must be provided to prolong the shelf life of the battery so that the consumer purchases a watch with a relatively long-lived power supply. Conventionally, a switch or guard is provided to disconnect the power supply during storage. A typical arrangement is shown in United States Patent No. 3,200,578 to R. Besson wherein a switch short circuits a transistor thereby stopping the regulating member of an electric timepiece. Another arrangement is disclosed in United States Patent No. 3,526,088.

In a highly accurate quartz watch, however, means must be provided to disconnect the battery without adversely affecting the timekeeping properties of the watch. Mechanical switches can often be affected by shock and vibration.

Accordingly, it is an object of this invention to provide a new and improved switch means for battery-operated timepieces to prevent drain of the battery during storage.

Another object of this invention is to provide a new and improved electronic switch to disconnect the battery of a quartz watch to prolong the life thereof.

A further object of this invention is to provide a new and improved switch arrangement which senses the motion of a mechanical oscillator, such as a balance

wheel, and disconnects the battery when no motion is sensed for a predetermined time interval.

According to one aspect of the present invention there is provided a battery-operated timepiece comprising an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electro-mechanical oscillator or motor, a delay circuit connected to the driver and to switch means, said switch means being coupled to the oscillator-divider circuit and controlled by the delay circuit to virtually disconnect the battery supply from the oscillator and frequency divider circuit when the electromechanical oscillator is stopped for a predetermined time interval.

According to another aspect of the present invention there is provided a method of minimizing battery drain in a timepiece having an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electromechanical oscillator or motor, comprising the steps of sensing if the electromechanical oscillator or motor has stopped for a predetermined time by means of a delay circuit and, if so, preventing battery drain by inhibiting the oscillator in the oscillator and frequency divider circuit from oscillating.

In accordance with a preferred embodiment of the invention, a watch, particularly of the quartz variety, includes a delay circuit which senses the motion of the mechanical oscillator and causes a series switch between the battery and the oscillator-divider circuit to disconnect the battery from the oscillator-divider circuit after a predetermined time interval. The delay circuit is reset to zero by each output drive pulse which occurs twice per balance wheel cycle. If the balance wheel is held off normal, i.e., mechanically held from

oscillating such that a switch coupled to the balance wheel and the delay circuit is in an open position, however, for a period which exceeds a worst case synchronization interval, the delay circuit completes its predetermined timing cycle, and causes the series switch between the battery and the oscillator-divider circuit to virtually disconnect the battery from the oscillator-divider circuit thereby effectively turning off the oscillator-divider.

Other features and advantages of the present invention will become apparent from the following description of preferred embodiments thereof, given with reference to the accompanying drawings wherein:—

Figure 1 is a circuit diagram illustrating a first embodiment of the invention including a series switch transistor; and,

Figure 2 is a circuit diagram illustrating a second embodiment of the invention comprising a shunt switch mode of operation.

Referring to Figure 1 of the drawings, the battery-operated watch is more particularly a quartz watch of the type disclosed in Application No. 15739/72, Serial No. 1,366,251, to which reference may be had for further details. The watch includes an oscillator-divider circuit 10 which counts down pulses from a high frequency quartz oscillator and supplies output pulses to the gate 12 of an output driver transistor 11. The pulses are used to synchronize a balance wheel (not shown) by feeding pulses to drive coil 17 during the contacts closed interval of a contact switch 16. These pulses function both to synchronize and provide the energy to maintain the oscillations of the balance wheel. The contact switch 16 is connected in series with the source 14 and drain 13 circuit of transistor 11 and is intermittently closed by the oscillating balance wheel.

A delay circuit is connected between the source 13 of the output driver transistor 11 and the gate 20 of a series switch transistor 19. The source 21 and drain 22 circuit of the transistor 19 is in series with the power supply to the oscillator-divider circuit 10.

Drain on the battery is substantially eliminated during storage by sensing the motion of the balance wheel and disconnecting the battery from the oscillator-divider circuit 10 under predetermined conditions. When the balance wheel is held off normal in a conventional manner by pulling out the watch crown, the contact switch 16 is held open. The delay circuit 18 is normally reset to zero each time a positive pulse appears at the drain 13 of transistor 11 but, in this instance, the delay circuit 18 completes its timing cycle of approximately 5 seconds and turns off transistor 19. The battery is, therefore, effectively removed from the circuit.

If, due to angular accelerations of the balance wheel, the contact switch 16 closure interval is temporarily phase displaced with respect to the output of the divider to a point where transistor 11 is saturated during the entire contact switch 16 closure interval, the delay circuit will start its timing function. In other words the delay circuit 18, which normally senses balance wheel motion and is reset when a positive voltage appears at the drain 13 twice per balance wheel cycle, cannot sense motion if transistor 11 is already on. When the balance wheel resynchronizes to the drive frequency, the positive voltage appears and the delay circuit 18 is reset. A time interval of approximately 5 seconds is selected for the delay circuit 18 since this is generally longer than that needed for the balance wheel to resynchronize in the worst case.

If, on the other hand, the delay circuit 18 completes its timing cycle, the series switch transistor 19 opens and turns off the oscillator-divider circuit 10. This would occur only as a matter of intent, for example, when it is desired to store the watch. The balance wheel would then be held off normal in a conventional manner initiating the timing cycle. When the balance wheel is released the contact switch 16 closes, resetting the delay circuit, and turning on the switch transistor 19 effectively closing the series circuit between the battery and the oscillator divider circuit which in turn starts the oscillator.

Figure 2 depicts a second embodiment of the invention comprising a shunt switch mode of operation. The oscillator 29 including a quartz crystal 28, and divider 30, are part of a watch similar to that described above, as well as an output driver transistor 31, contact switch 36 and a drive coil 37. A pair of transistors 45 and 39 are provided in the output of the delay circuit 38. The transistor 45 is connected with its source 48 and drain 47 across transistor 31 and its gate 46 coupled to the delay circuit 38. The transistor 39 is connected across the input of the oscillator 29 with its gate 40 connected to the delay circuit 38.

The circuit functions similarly to the embodiment of Figure 1 and hence will not be described in detail. Transistor 45 is provided to turn off transistor 31 when the delay circuit 38 completes a timing cycle. Transistor 39 is similarly turned on by the delay circuit at the end of a timing cycle halting the oscillator 29. The power supply is thus removed from the circuit to prevent battery drain with the oscillator stopped the battery drain approaches zero because of the low static power requirements of the CMOS counter stages.

It is now obvious that when the oscillator stops the driver transistor 31 could be in its

conducting state. As noted previously, transistor 45 precludes this possibility. If the driver transistor 31 were saturated during the storage period the start-up pulse generated by the freed balance wheel would not be sensed when the crown is pushed in to start the watch.

WHAT WE CLAIM IS:—

1. A battery-operated timepiece comprising an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electro-mechanical oscillator or motor, a delay circuit connected to the driver and to switch means, said switch means being coupled to the oscillator-divider circuit and controlled by the delay circuit to virtually disconnect the battery supply from the oscillator and frequency divider circuit when the electro-mechanical oscillator is stopped for a predetermined time interval.

2. A timepiece according to Claim 1, wherein the delay circuit comprises a circuit which is reset by pulses from the driver to the electro-mechanical oscillator but, if no pulses are received by the delay circuit for a predetermined time interval, the circuit opens the switch means to prevent battery drain.

3. A timepiece according to Claim 1 or Claim 2, wherein the switch means comprises a transistor connected in series between the battery and the oscillator-divider circuit and having its control input connected to the delay circuit.

4. A timepiece according to any one of Claims 1 to 3, wherein the electro-mechanical oscillator comprises a balance wheel.

5. A battery-operated timepiece comprising an oscillator and frequency divider circuit providing pulses to an output driver to synchronize and drive an electro-mechanical oscillator, a delay circuit connected to the driver, switch means coupled to the oscillator-divider circuit and controlled by the delay circuit to virtually disconnect the battery supply from the oscillator and frequency divider circuit when the electro-mechanical oscillator is stopped for a predetermined time interval, and transistor means coupled to the circuit to prevent the driver from being in the conducting state when the battery supply is virtually disconnected from the oscillator and frequency divider circuit, said transistor means being coupled to and controlled by the output of the delay circuit.

6. A timepiece according to Claim 5 wherein the delay circuit comprises a circuit which is reset by drive pulses to the electro-mechanical oscillator but, if the pulses are stopped for a predetermined interval, said circuit completes its timing cycle and

controls said switch means to inhibit oscillations in the oscillator-divider circuit said switch means being coupled to the input of the oscillator-divider circuit.

7. A timepiece according to Claim 6, wherein the oscillator and divider circuits include semi-conductor components of the CMOS type so that the current drain from the battery is limited to the quiescent requirements of the CMOS circuitry when the electro-mechanical oscillator is stopped.

8. A battery powered timepiece of the quartz crystal control kind comprising an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electro-mechanical oscillator through an intermittent contact switch, switch means in series circuit between the battery and the oscillator-divider circuit, and a delay circuit connected between the output driver and the series switch means to sense the motion of the balance wheel and control the switch means to virtually disconnect the battery if the balance wheel is stopped for a predetermined time interval, to prevent battery drain.

9. A method of minimizing battery drain in a timepiece having an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electro-mechanical oscillator or motor, comprising the steps of sensing if the electro-mechanical oscillator or motor has stopped for a predetermined time by means of a delay circuit and, if so, preventing battery drain by virtually disconnecting the battery supply from the oscillator and frequency divider circuit.

10. A method of minimizing battery drain in a timepiece having an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electro-mechanical oscillator or motor, comprising the steps of sensing if the electro-mechanical oscillator or motor has stopped for a predetermined time by means of a delay circuit and, if so, preventing battery drain by inhibiting the oscillator in the oscillator and frequency divider circuit from oscillating.

11. A battery powered timepiece comprising a high frequency oscillator circuit, a multiplicity of frequency divider stages providing pulses to an output driver stage to synchronize and drive an electro-mechanical oscillator, a delay circuit connected to the driver output, and switch means connected between the battery and the oscillator-divider circuit and controlled by the delay circuit to disconnect the battery when the electro-mechanical oscillator is stopped for

conducting state. ²As noted previously, transistor 45 precludes this possibility. If the driver transistor 31 were saturated during the storage period the start-up pulse generated by the freed balance wheel would not be sensed when the crown is pushed in to start the watch.

WHAT WE CLAIM IS:—

1. A battery-operated timepiece comprising an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electro-mechanical oscillator or motor, a delay circuit connected to the driver and to switch means, said switch means being coupled to the oscillator-divider circuit and controlled by the delay circuit to virtually disconnect the battery supply from the oscillator and frequency divider circuit when the electro-mechanical oscillator is stopped for a predetermined time interval.

2. A timepiece according to Claim 1, wherein the delay circuit comprises a circuit which is reset by pulses from the driver to the electro-mechanical oscillator but, if no pulses are received by the delay circuit for a predetermined time interval, the circuit opens the switch means to prevent battery drain.

3. A timepiece according to Claim 1 or Claim 2, wherein the switch means comprises a transistor connected in series between the battery and the oscillator-divider circuit and having its control input connected to the delay circuit.

4. A timepiece according to any one of Claims 1 to 3, wherein the electro-mechanical oscillator comprises a balance wheel.

5. A battery-operated timepiece comprising an oscillator and frequency divider circuit providing pulses to an output driver to synchronize and drive an electro-mechanical oscillator, a delay circuit connected to the driver, switch means coupled to the oscillator-divider circuit and controlled by the delay circuit to virtually disconnect the battery supply from the oscillator and frequency divider circuit when the electro-mechanical oscillator is stopped for a predetermined time interval, and transistor means coupled to the circuit to prevent the driver from being in the conducting state when the battery supply is virtually disconnected from the oscillator and frequency divider circuit, said transistor means being coupled to and controlled by the output of the delay circuit.

6. A timepiece according to Claim 5 wherein the delay circuit comprises a circuit which is reset by drive pulses to the electro-mechanical oscillator but, if the pulses are stopped for a predetermined interval, said circuit completes its timing cycle and

controls said switch means to inhibit oscillations in the oscillator-divider circuit said switch means being coupled to the input of the oscillator-divider circuit.

7. A timepiece according to Claim 6, wherein the oscillator and divider circuits include semi-conductor components of the CMOS type so that the current drain from the battery is limited to the quiescent requirements of the CMOS circuitry when the electro-mechanical oscillator is stopped.

8. A battery powered timepiece of the quartz crystal control kind comprising an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electro-mechanical oscillator through an intermittent contact switch, switch means in series circuit between the battery and the oscillator-divider circuit, and a delay circuit connected between the output driver and the series switch means to sense the motion of the balance wheel and control the switch means to virtually disconnect the battery if the balance wheel is stopped for a predetermined time interval, to prevent battery drain.

9. A method of minimizing battery drain in a timepiece having an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electro-mechanical oscillator or motor, comprising the steps of sensing if the electro-mechanical oscillator or motor has stopped for a predetermined time by means of a delay circuit and, if so, preventing battery drain by virtually disconnecting the battery supply from the oscillator and frequency divider circuit.

10. A method of minimizing battery drain in a timepiece having an oscillator and frequency divider circuit which in operation applies pulses to a driver which in turn applies synchronizing and drive pulses to an electro-mechanical oscillator or motor, comprising the steps of sensing if the electro-mechanical oscillator or motor has stopped for a predetermined time by means of a delay circuit and, if so, preventing battery drain by inhibiting the oscillator in the oscillator and frequency divider circuit from oscillating.

11. A battery powered timepiece comprising a high frequency oscillator circuit, a multiplicity of frequency divider stages providing pulses to an output driver stage to synchronize and drive an electromechanical oscillator, a delay circuit connected to the driver output, and switch means connected between the battery and the oscillator-divider circuit and controlled by the delay circuit to disconnect the battery when the electro-mechanical oscillator is stopped for



a predetermined time interval.

12. A timepiece according to claim 11 wherein the delay circuit comprises a circuit which is reset by the drive pulses to the electromechanical oscillator but, if the pulses are stopped for a predetermined time, the circuit opens the switch means to prevent battery drain.
- 5 13. A battery-operated timepiece sub-

stantially as hereinbefore described with reference to Figure 1 or Figure 2 of the accompanying drawings. 10

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