# United States Patent

[11] 3,587,223


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[21] Appl. No. **28,159**
[22] Filed **Apr. 6, 1970**
[45] Patented **June 28, 1971**
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[54] **ELECTRONIC WRIST WATCH**
**5 Claims, 3 Drawing Figs.**


[52] **U.S. Cl.** ..... **58/23BA**
[51] **Int. Cl.** ..... **G04c 3/00**
[50] **Field of Search** ..... 58/23, 23 (BA), 23 (TF)



[56] **References Cited**
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| 3,282,042 | 11/1966 | Schaller | 58/23TF |
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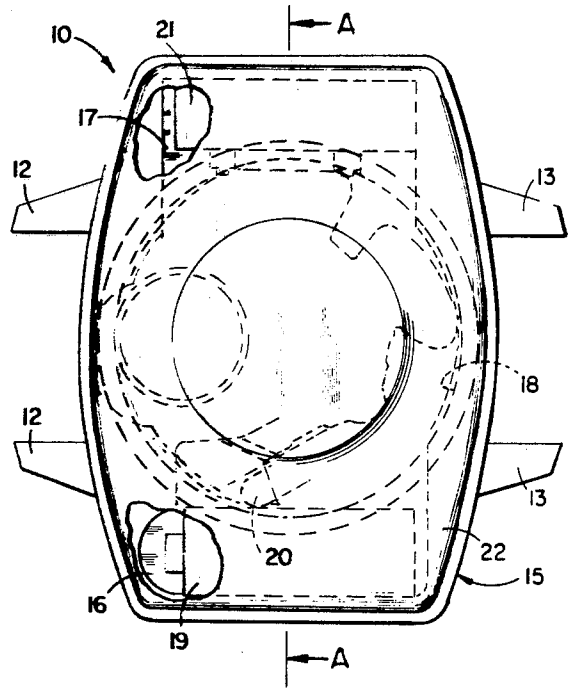
**ABSTRACT:** An electronic wrist watch includes a watch case having three compartments. One side compartment contains a quartz crystal, the central compartment contains a balance wheel movement including a dial train drive and time indicating hands, and the other side compartment contains electronic circuitry. A clear glass or plastic crystal is positioned over the central compartment.

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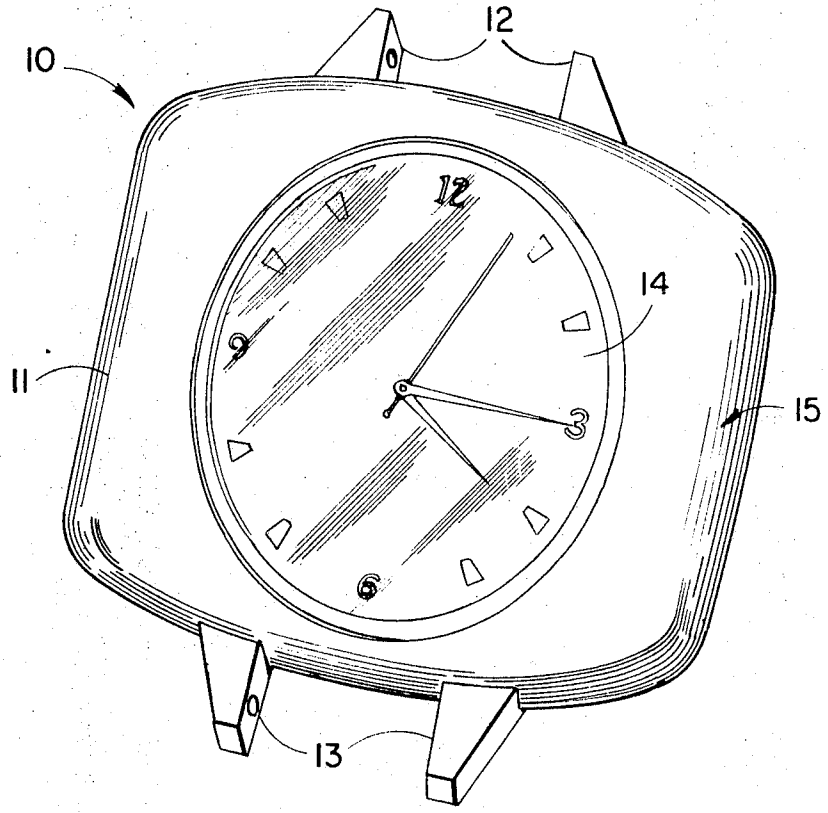


FIG. 1

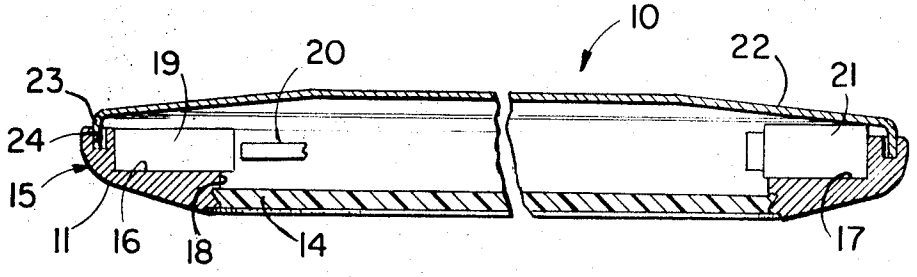


FIG. 3

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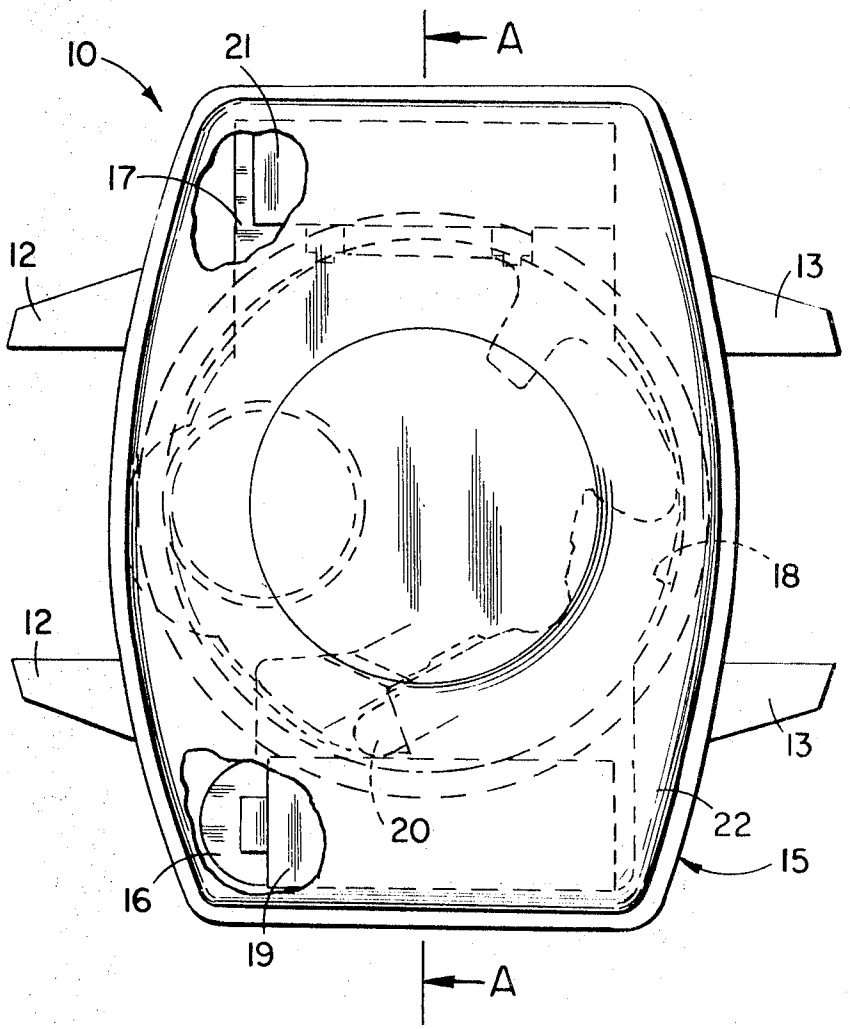


FIG. 2

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# ELECTRONIC WRIST WATCH

## DESCRIPTION

The present invention relates to horology and more particularly to the construction of an electronic wristwatch.

Electric and electronic wristwatches of various types have been proposed and some models have been marketed. Such wristwatches include a battery cell as its source of power, an electronic circuit, an electromechanical transducer such as a tuning fork or a balance wheel, a dial train drive consisting of a number of wheels, and a time indicating mechanism, using revolving hands, the hands being rotated by the dial train drive.

It has also been proposed that a high frequency time base, such as piezoelectric crystal oscillator, may be used as the primary timing element in a wristwatch. The time base would provide a controlled and accurate frequency to an electromechanical transducer, either directly through a count-down circuit or indirectly through a synchronization circuit. Although the basic concepts of crystal oscillator horological movements have been known for many years, and those concepts have been incorporated in clocks and other timing mechanisms, nevertheless wristwatches incorporating such high frequency time bases have not been commercially marketed.

One possible reason for the difficulties experienced in adapting the high frequency crystal oscillator to a wristwatch is the problem of size. A wristwatch, compared to a stationary clock, is very small. In order for it to be accepted by the public, a wristwatch cannot exceed a generally acceptable size either in diameter or height. In addition, to be acceptable, such a wristwatch cannot be greatly in excess of the weight of a conventional mechanical wristwatch.

The problem of designing a wristwatch of an acceptable size and weight is particularly acute in those piezoelectric crystal wristwatches in which the crystal time base is utilized to synchronize an electromechanical transducer. The electromechanical transducer must be of a certain minimum size in order to have a natural frequency which is reasonably close to the final timekeeping frequency, so that a large amount of synchronization energy is not required. For example, both a tuning fork and a balance wheel require a certain minimum space in order to properly function. Generally it is expensive, and may be impossible, to economize on space within the wristwatch by rearrangement of the wheels of the dial train drive. Dial train drives have been studied in connection with mechanical wristwatches for many years in an attempt to reduce their size.

There has been some optimism that it might be possible to reduce the size of the electronic components, particularly with advances in solid-state devices, such as the integration of circuits. Unfortunately, certain components, and particularly the resistance-capacitance networks of the count-down portion of the electronic circuit, must be of a larger size than is presently technically feasible to obtain using integrated circuit techniques. Consequently, the electronic circuit, even when its active components (the transistors) are very small, cannot be reduced, at this time, below a certain minimum size.

The piezoelectric crystal likewise presents a problem in regard to the reduction of its size. Its natural frequency bears a direct relationship to its physical size. To have a time base utilizing a crystal of a certain predetermined frequency, using the present technology of crystal-making, requires that the crystal be of a certain minimum size.

It is the objective of the present invention to present a wristwatch utilizing a high frequency crystal oscillator which synchronizes an electromechanical transducer, which watch is of an acceptable size and weight.

It is a further objective of the present invention to provide such a wrist watch in which the subsystems of the overall system are physically separated so that they may be readily replaced by a watch repairer in the event of a malfunction in one of the subsystems.



It is a further objective of the present invention to provide such a wristwatch which presents an attractive appearance.

In accordance with the present invention, a wrist watch is provided in which the power source is a small battery cell. The power source is utilized to drive a high frequency piezoelectric quartz crystal oscillator, which is the primary time base of the watch. The power source also drives an electronic circuit which is utilized to impulse an electromechanical transducer. The electromechanical transducer is preferably a balance wheel which cooperates with one or more magnets. Preferably the balance wheel carries a coil which is impulsed by the circuit, the path of the moving coil being adjacent one or more fixed magnets. Alternatively, the balance wheel may carry one or more magnets and the coil may be fixed.

The watch body is divided into three compartments, with the compartments containing (1) the piezoelectric crystal, (2) the oscillator and count-down circuits, and (3) the balance wheel, dial train drive and hands. A clear crystal is removable at the face of the movement and covers the hands and dial. A single removable backing plate covers the back of the three compartments.

Other objectives of the present invention will be apparent from the following detailed description of the inventor's best mode of practicing the invention. The description should be taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a perspective view of the wristwatch of the present invention;

FIG. 2 is a bottom plan view of the watch partly broken away; and

FIG. 3 is a side cross-sectional view taken along line A–A of FIG. 2.

As shown in FIGS. 1—3 the watch **10** includes a bezel **11** having a first pair of protruding lugs **12** and a second pair of protruding lugs **13**. The lugs each have a hole to receive a spring-loaded pin, the pin being enfolded by the end of a watch band.

A crystal **14**, of glass or a suitable clear plastic resin, is fixed on the face of the watch **10**. The crystal preferably is of a slightly flexible plastic resin so that it may be removed and replaced using a special tool.

The body **15** of the case **10** has two seats **16** and **17** forming compartments and a central round seat **18** forming a central compartment. The electronic circuitry consists of a number of integrated circuits and associated discrete components mounted on a small circuitry board **19**. Alternatively, they may be encapsulated. The board **19** is removably attached to seat **16**, for example, by screws.

The balance wheel and the dial train drive may be the to those or similar to those used in a conventional electronic watch movement. The dial train drive is a series of toothed meshing wheels, with the first wheel being driven, either directly or through a fork, by the balance wheel. The wheels are connected to three hands, namely, the hour, minutes and seconds hands, which revolve over a dial having time indicia thereon. That movement **20** is removably fixed on the seat **18**. Preferably the movement uses a balance wheel carrying a coil, three magnets of alternate polarity fixed to the plate, and an impulsing circuit. The details of a suitable movement are described in Zemla's U.S. Pat. No. 3,046,460. The movement **20** also includes the output impulsing portion of the electronic circuit, although that circuit portion could alternatively be fixed on the circuitry board **19**.

The quartz crystal **21**, within its can or case, is removably fixed to seat portion **17**. A metal back cover **22** is removably attached to the case. A flange **23** around the circumference of the back **22** fits into a groove **24** around the compartments. The flange tends to move outward and grips the outer wall of the groove.

The back **22** may be alternatively have a separate removable battery cover. The cover would screw onto the back **22** and cover the battery cell within the central compartment.

The circuitry board or encapsulated circuitry is formed so that it is about the same size and shape as the can of the quartz crystal.

The crystal can and the circuit board are arranged symmetrically on opposite sides of the central compartment. Each one of the elements, for example, the crystal can, may be separately removed from its compartment and replaced in the event of a malfunction.

The watch, when viewed toward its face, presents an attractive appearance and, due to the placement of its elements, is of an acceptable size and shape.

I claim:

1. A wristwatch comprising a case having three compartments, the first compartment containing a piezoelectric crystal enclosed in a can; the second compartment containing an electromechanical transducer, a dial train drive and time indicating means moved by said dial train drive; and including a dial having time indicia thereon, said dial being covered with a clear crystal removably connected to said case; the third compartment containing electronic circuitry for the synchronization of the transducer; wherein said second compartment is positioned between said first and third compartment when seen in a bottom plan view.

2. A watch as in claim 1 wherein a single cover plate covers the rear of the three compartments and is removably attached to the case.

3. A watch as in claim 1 and also including a battery cell removably connected within the second compartment.

4. A watch as in claim 1 wherein the crystal is of a flexible plastic resin and is removably connected at the front of the case.

5. A wristwatch as in claim 1 wherein said second compartment contains a drive circuit for impulsing said transducer.