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PATENT SPECIFICATION

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DRAWINGS ATTACHED



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(54) ELECTRONIC WRIST WATCH

(71) We, TIMEX CORPORATION, a Corporation organised 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 horology and more particularly to the construction of an electronic wrist watch.

Electric and electronic wrist watches of various types have been proposed and some models have been marketed. Such wrist watches include a battery cell as a 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 a piezoelectric crystal oscillator, may be used as a primary time base element in a wrist watch. 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 wrist watches 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 wrist watch is the problem of size. A wrist watch, compared to a stationary clock, is very small. In order for it to be accepted by the public, a wrist watch cannot exceed a generally acceptable size either in diameter or height. In addition, to be acceptable, such a wrist watch cannot be greatly in excess of the weight of a conventional mechanical wrist watch.

The problem of designing a wrist watch of an acceptable size and weight is particularly acute when it is wished to employ a piezoelectric crystal wrist watch time base 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 function properly. Generally it is expensive, and may be impossible, to economize on space within the wrist watch by rearrangement of the wheels of the dial train drive. Dial train drives have been studied in connection with mechanical wrist watches 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 an objective of the present invention to present a wrist watch utilizing a high-frequency crystal oscillator which synchronizes an electromechanical transducer, which watch can be of an acceptable size and weight.

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It is a further objective of the present invention to provide such a wrist watch in which the sub-systems 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 sub-systems.

It is a further objective of the present invention to provide such a wrist watch which can present an attractive appearance.

In accordance with the present invention there is provided a wrist watch comprising a case having three sections, the first section containing a piezoelectric crystal enclosed in a can; the second section containing an electromechanical transducer, a dial train drive and time indicating means moved by said dial train drive, and including a dial facing the front of the case and having time indicia thereon, said dial being covered with a clear crystal; the third section containing electronic circuitry for the synchronization of the transducer, wherein said second section is positioned between said first and third sections when viewed from the rear of the case.

A watch embodying the invention conveniently has a power source which 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 co-operates 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 case or body is divided into three sections, with the sections 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 dial 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 sections.

A preferred embodiment of wrist watch according to the present invention will now be described by way of example, reference being made to the accompanying drawings, in which:—

Fig. 1 is a perspective view of the wrist watch from the front and one side;

Fig. 2 is a rear 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 the drawings 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 (not shown), the pin being enfolded by the end of a watch band.

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

The case 15 of the watch 10 has two seats 16 and 17 forming respective outer sections and a central round seat 18 forming a central section. 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.

A movement 20 is removably fixed on the seat 18. The movement includes a balance wheel and a dial train drive which may be the same 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, an hour, minutes and seconds hands, which revolve over a dial having time indicia thereon. Preferably the movement 20 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 United States Patent No. 3,046,460. The movement 20 may include the output impulsing portion of the electronic circuit, or that circuit portion may instead be fixed on the circuitry board 19.

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

The back cover 22 may alternatively have a separate removable battery cover portion which would screw onto the back cover 22 and cover a battery cell within the central section.

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 section. Each one of the elements, for example, the crystal can, may be

separately removed from its section and replaced in the event of a malfunction.

- 5 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.

WHAT WE CLAIM IS:—

- 10 1. A wrist watch comprising a case having three sections, the first section containing a piezoelectric crystal enclosed in a can; the second section containing an electro-mechanical transducer, a dial train drive and time indicating means moved by said dial train drive, and including a dial facing the front of the case and having time indicia thereon, said dial being covered with a clear crystal; the third section containing electronic circuitry for the synchronization of the transducer; wherein said second section is positioned between said first and third sections when viewed from the rear of the case.
- 20 2. A watch as claimed in claim 1 where-

in a single cover plate covers the rear of the three sections and is removably attached to the case.

- 25 3. A watch as claimed in claim 1 or claim 2, including a battery cell removably connected within the second section.

4. A watch as claimed in any one of the preceding claims, wherein the crystal is of a flexible synthetic plastic resin and is removably connected to the front of the case.

5. A watch as claimed in any one of the preceding claims, wherein the impulsing drive circuit is within the second section.

- 30 6. A wrist watch substantially as hereinbefore described with reference to the accompanying drawings.

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3. A watch as claimed in claim 1 or claim 2, including a battery cell removably connected within the second section.

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