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(54) IMPROVEMENTS IN OR RELATING TO ELECTRIC WATCHES

(71) We, KABUSHIKI KAISHA SUWA SEIKOSHA, a Japanese Company of 3—4, 4-chome, Ginza, Chuo-ku, Tokyo, Japan, 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:—

This invention relates to electric watches.

It is highly desirable, especially in the case of an electric watch including a motor, to make the watch as thin as possible. The part of the watch which makes this desirable objective most difficult to attain in a known watch is the motor itself. If, as is usual in known watches, the motor is designed and manufactured as a unit, so that it can be removed as a unit from the watch, it is necessarily relatively thick and the watch must be correspondingly thick, since it must house the motor. The present invention seeks to avoid this limitation and to provide, in a watch, a pulse driving motor arrangement which can be made considerably thinner than a known pulse driving motor and therefore enables the watch which houses it to be made correspondingly thinner than a known comparable watch. The attainment of reduced thickness in a watch, especially a wrist watch, is very important commercially since a thin watch is much more attractive than a thick one.

According to this invention there is provided a watch comprising: a quartz crystal oscillator circuit for producing a time standard signal; a divider circuit for producing from the time standard signal a relatively low frequency signal; a pulse or stepping motor including a driving coil arranged to receive as an input thereto the relatively low frequency signal from the divider circuit; a stator magnetically coupled to the driving coil, and a rotor made of permanently magnetic material having a mechanical output transmitting member,

time indicating means; and mechanical gearing connected directly between said mechanical output transmitting member and the time indicating means so that the latter is driven by the pulse or stepping motor, the rotor, driving coil and stator being arranged in a plane substantially parallel to the plane of movement plate and disposed within the area of the movement plate on which the oscillator circuit, divider circuit and mechanical gearing are also disposed.

The invention is illustrated in the accompanying drawings, in which:—

Figure 1 is a simplified electrical circuit diagram of an electric watch in accordance with this invention; and

Figure 2 is a plan view of an electric watch in accordance with the present invention, and in which there is a round movement plate.

Referring to Figure 1 the electrical circuit diagram of an electric watch according to the present invention comprises a crystal oscillator 1 with its electrodes, an associated oscillation circuit 2, a step variable condenser 3 for adjusting the frequency, a temperature compensating element 4, a frequency divider circuit 6 which produces from a relatively high frequency time standard signal preferably of at least 16 kHz generated in the oscillation circuit 2 a relatively low frequency signal suitable for driving a pulse stepping motor, and a motor driving circuit 7 to which the relatively low frequency signal is fed and which drives the motor (not shown in Figure 1). The parts shown in Figure 1 are further described and illustrated in the specification of our co-pending application No. 34220/71 (Serial No. 1361229) out of which the present application is divided and attention is directed to the said co-pending specification for further information. In particular, the oscillation circuit includes a MOS transistor

for maintaining the crystal oscillator in oscillation and the divider circuit includes a MOS transistor.

5 The general arrangement of the watch, and in particular, the motor arrangement are illustrated in Figure 2, which corresponds with Figure 5 of our co-pending Specification 34220/71 (Serial No. 1361229). For certain details relating to Figure 2 and not described below, attention is again directed to the description in our said co-pending specification.

15 Referring now to Figure 2 the watch therein shown is a round movement watch and has a round battery and a crystal oscillator in a cylindrical case. There is a pulse or stepping motor the driving coil of which is cylindrical. In order that the electro-mechanical conversion shall be acceptably efficient, the drive coil has to be relatively large and occupies a good deal of the space of the round movement. It is more-
20 over of substantial thickness so that it is impracticable to pile other components on top of it. With a crystal oscillator and electronic circuitry, electric power and electric signal terminals are necessary and simplicity of connection and arrangement of these terminals is important in the design. The arrangement of Figure 2 and especially the motor arrangement employed satisfies these and other design requirements. It provides a very favourable relationship of the watch elements in the round movement, is very convenient as regards wiring, and, by reason mainly of the motor arrangement, enables the watch to be made thin.

25 In Figure 2, 100 is a stem near the position of 3 o'clock, 200 a round movement plate, 300 is a battery cover disposed near 12 o'clock and containing a battery, 400 is the negative terminal of the battery, and 500 is the case for the time standard arrangement which comprises a quartz crystal oscillator
30 600 of the tuning fork type for producing the time standard signal and an electronic circuit formed as a unit. The crystal oscillator 600 is disposed in a channel in the case 500. 700 is a fine adjustment means for frequency, including a step adjustable condenser. 800 is a temperature compensating device for frequency and includes a BaYiO₃ condenser, 900 is the electronic circuit. This is potted in epoxy-resin or the like, the potting being carried out in a channel of the case 500. The terminals
35 referenced 110 with letter suffixes are electrical signal and power terminals of the electronic circuit 900, 110a being the terminal for signals for driving the pulse or stepping motor and 110b being an earth terminal. These are wired on the driving coil side (the left side as viewed in Figure 2). 110c are connecting terminals for the oscillator, 110d
40 is a connecting terminal for the battery and

110e is a reset terminal. These are wired on the battery side (the right side as viewed in Figure 2). 111 are the electrical signal and output terminals of the crystal oscillator and are disposed on the same side as the connecting terminals 110c of the crystal oscillator. This arrangement simplifies wiring. 112 is a group of terminals for connecting the condenser 700 and the BaTiO₃ condenser 800.

70 The references 113 with letter suffixes refer to the pulse or stepping motor, which converts the relatively low frequency output signal from the electrical circuit into rotary movement of the gear train. This pulse or stepping motor comprises a cylindrical driving coil 113a which, in the present embodiment, contains 15000 turns of copper wire of 2.5/100 mm diameter wound on a stator formed of magnetic material and of generally C-shape. This stator of high magnetic permeability material extends through and beyond the coil into extensions which terminate in stator pole pieces 113b and 113c. In the gap between these pole pieces is a rotor 114 made of permanently magnetic material. A pulsed current which reverses in polarity every second flows from the driving circuit through the coil 113a of the pulse or stepping motor and the rotor 114 rotates through a predetermined angle at each pulse. As shown the rotor has six poles with N and S poles alternately and has a mechanical output transmitting member 113e. Mechanical gearing is directly connected between the output transmitting member and time indication means (not shown) so that the latter is driven by the pulse or stepping motor. The mechanical gearing comprises a fourth wheel 115, which drives a third wheel which, in turn, drives a centre wheel. 116 is a second hand jumper acting on the fourth wheel 115 to prevent rotation thereof except in a predetermined direction. 117 is a setting lever for the second hand. One end of this setting lever is engaged with one end of the stem 100 and the other end is engaged with the jumper 116. There is a reset mechanism (not shown) disposed near the stem and having a switch mechanism which is arranged, when actuated, to open some part of the divider circuit to put it in non-operative condition and thus cut off the relatively low frequency signal of the divider circuit. The details of the reset mechanism of the watch form per se no part of this invention and will not be described herein. They may be as known per se.

75 As will now be seen, in the electric wrist watch illustrated in Figure 2, the components are arranged on the round movement plate in such manner that the stem is conveniently disposed near the position of 3 o'clock, the battery is disposed near 12
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o'clock, the case in which the crystal oscillator and the electronic circuit are combined into a unit, is disposed adjacent to the battery, the driving coil of the pulse or stepping motor is disposed between this case and the stem, and the round movement plate has round it the stem, the battery, the case for the oscillator time standard and the driving coil. Thus it will be seen that the oscillator circuit, divider circuit and mechanical gearing, inter alia, are disposed within the area of the movement plate. Moreover, the rotor and the stator of the electro-mechanical converter, the gear-train and the stem are also conveniently arranged with the setting mechanism and the reset mechanism arranged in the remaining portion of the space near the stem. It should be particularly noted that the driving coil 113a and the rotor 114 are physically separated from one another and are magnetically connected by the stator with its extensions and pole pieces while the rotor itself is part of the mechanical gearing driving the hands of the watch. It will also be seen that the rotor, driving coil and stator of the pulse or stepping motor are arranged in a plane substantially parallel to the plane of the movement plate. These features are of great advantage in that they lend themselves to the obtaining of a motor which is of small thickness, thus enabling the watch to be thinner than would otherwise be possible. The arrangement provides simplified terminal connections for the electrical input and output signals, and results in a thin round watch. There are three main blocks in the watch movement, one being the battery for power source, another being the case containing the oscillator time standard and the third being the motor. Each block can be separately adjusted and each can be removed by undoing screws and readily replaced so that after-sales service such as repairing is easy.

An electric watch having the above

features is also described and claimed in the specification of our co-pending Application No. 34220/71 (Serial No. 1361229).

WHAT WE CLAIM IS:—

1. An electric watch comprising: a quartz crystal oscillator circuit for producing a time standard signal; a divider circuit for producing from the time standard signal a relatively low frequency signal; a pulse or stepping motor including a driving coil arranged to receive as an input thereto the relatively low frequency signal from the divider circuit, a stator magnetically coupled to the driving coil, and a rotor made of permanently magnetic material having a mechanical output transmitting member; time indicating means; and mechanical gearing connected directly between said mechanical output transmitting member and the time indicating means so that the latter is driven by the pulse or stepping motor, the rotor, driving coil and stator being arranged in a plane substantially parallel to the plane of a movement plate and disposed within the area of the movement plate on which the oscillator circuit, divider circuit and mechanical gearing are also disposed.

2. A watch as claimed in claim 1 and in which the movement plate is round.

3. A watch as claimed in claims 1 or 2 wherein the stator is of generally C-shape having portions extending from the ends of a portion on which the driving coil is situated to adjacent spaced pole pieces in the gap between which the rotor is situated.

4. An electric watch as claimed in claim 1 and substantially as herein described with reference to and as shown in the accompanying drawings.

J. MILLER & COMPANY,
Agents for the Applicants,
Chartered Patent Agents,
262 High Holborn,
London WC1V 7EF.

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