

SPECIFICATION

Analogue electronic timepiece

This invention relates to an analogue electronic timepiece.

- 5 According to the present invention there is provided an analogue electronic timepiece comprising a first stepping motor; which is arranged to step at one second intervals; a first gear mechanism driven by the first stepping motor; timekeeping time indicating means driven stepwise by the first gear mechanism; a second stepping motor which is arranged to step at 1/10th second intervals; driving means for driving the first and second stepping motors; a second gear mechanism driven by the second stepping motor; and chronograph time indicating means driven stepwise by the second gear mechanism.

- The driving means may comprise first and second stepping driving circuits for respectively driving the first and second stepping motors, there being provided an oscillator for producing a time standard pulse output, and a dividing circuit which is arranged to receive the pulse output of the oscillator and which is arranged to supply outputs to the first and second stepping motors. The dividing circuit is preferably connected to the second driving circuit by way of a gate circuit, the gate circuit normally preventing operation of the second stepping motor.

- 30 The oscillator may be quartz crystal oscillator. The dividing and driving circuits may form part of an integrated circuit.

- The timekeeping time indicating means may comprise a timekeeping seconds hand which is spaced from the centre of the timepiece.

- 35 The chronograph time indicating means may comprise a chronograph seconds hand disposed substantially at the centre of the timepiece.

- The invention is illustrated, merely by way of example, in the accompanying drawings, in which:—

- Figure 1 is a block diagram of an analogue electronic timepiece according to the present invention,

- 45 Figure 2 is a plan view of the timepiece of the present invention, and

Figure 3 is a broken-away sectional view of the said timepiece.

- In Figure 1 there is shown a block diagram of an analogue quartz crystal electronic timepiece according to the present invention. As shown in Figure 1 the timepiece comprises a quartz crystal oscillator circuit 21 for producing a time standard pulse output, and a dividing circuit 22, of the MOS IC type, which is arranged to receive the pulse output of the oscillator circuit 21. The dividing circuit 22 supplies output signals, at a rate of one a second and of suitably shaped waveform, to a timekeeping driving circuit 23 for driving a timekeeping stepping motor 24. The timekeeping stepping motor 24 is constituted by an electro-magnetic transducer which comprises a rotor, a stator and a coil whose construction is described below with reference to Figures 2 and 3. This

- 65 transducer transduces the signals which are produced at second intervals by the timekeeping driving circuit 23 into rotary motion, and this rotary motion is transmitted to drive a timekeeping seconds hand, a timekeeping minute hand, and a timekeeping hour hand (which are not shown in Figure 1, but which are shown in Figure 3), by way of a driving gear train 25 and a display gear train 26.

- As so far described, the construction is that of a conventional analogue quartz crystal timepiece. In such a timepiece, the intermittent movement of the seconds hand once a second reduces the current consumption. Moreover, during the greater part of each second, the seconds hand stands still and is therefore not affected by externally applied shocks.

- In contrast to the prior art, however, the timepiece of the present invention, in addition to comprising the timekeeping device described above, in which a seconds hand is stepped at seconds intervals, also comprises a chronograph device in which a seconds hand is stepped at shorter intervals such as one tenth second intervals.

- 90 For this purpose, the timepiece comprises an externally operable member 31 such as a stem or a button, which, when operated, causes a signal 32 to be applied to a gate circuit 33 so that the latter permits transmission of signals from the dividing circuit 22 to a chronograph driving circuit 27. The chronograph driving circuit 27 produces a suitably shaped signal for operating a chronograph stepping motor 28 which constitutes a transducer for converting signals from the chronograph driving circuit 27 into rotary motion. This rotary motion is transmitted to a chronograph seconds hand, a chronograph minutes hand and if desired a chronograph hours hand (none of which are shown in Figure 1) by way of a driving gear train 29 and a display gear train 30 so as to make the chronograph device suitable for indicating lap time.

- The chronograph stepping motor 28, which constitutes the chronograph transducer, is a conventional stepping motor comprising a rotor, a stator and a coil (not shown in Figure 1). The periods during which the chronograph stepping motor 28 is driven are shorter than those of the timekeeping signal which is generated every second. For example, if the periods during which the chronograph stepping motor 28 is driven are one tenth of a second, the chronograph seconds hand will move at a speed 10 times as fast as the timekeeping seconds hand. Accordingly, when the chronograph device is brought into operation, the lap time can be read with an accuracy of one tenth of a second. On the other hand, this means that the current consumption of the chronograph stepping motor 28 is ten times as great as that of the timekeeping stepping motor 24. However, since the stepping motors 24, 28 are separate from each other, this does not mean that the timepiece of the present invention has a current

consumption ten times as great as usual.

For example, a stepping motor having a current consumption of about $1.5\mu\text{A}$ and a battery life of about 5 years, has been put into practical use as a

5 stepping motor for a timekeeping device. The stepping motor of such a timekeeping device, however, has to produce substantial torque in order, inter alia, to drive a calendar member or members, whereas the output torque of a
10 chronograph stepping motor merely needs to be sufficient to drive the seconds, minutes and hour hands of the chronograph device. Consequently, the chronograph stepping motor may have a small coil and may have a current consumption which is
15 substantially only one third of that of the timekeeping device. Moreover, the chronograph gear train is driven at intervals which are only one tenth those of the timekeeping device and consequently the chronograph gear train produces
20 an output torque ten times as great as that of the timekeeping device because the reduction ratio from the chronograph rotor to the chronograph seconds hand is $1/10$. In view of this, the actual output from the chronograph stepping motor
25 may be small.

For example, although the chronograph hands are driven stepwise during periods which are only one tenth those during which the timekeeping hands are driven, the current consumption for the
30 chronograph device may be reduced to $10/3 \approx 3.3$ times that of the timekeeping device, on the assumption that the output torque is reduced to $1/3$. If one assumes that, in a timepiece with five years of battery life, both the chronograph gear
35 mechanism 29, 30 and the timekeeping gear mechanism 25, 26, are driven at all times, and that the current consumption of the quartz crystal time standard oscillator circuit 21 is relatively small as compared with that required for driving
40 the timekeeping stepping motor 24, then the battery life will be

$$\frac{5}{3.3 + 1}$$

years ≈ 1.2 years.

In actual practice, however, the chronograph device is not used at all times. Normally the gate circuit 33 prevents operation of the chronograph
50 stepping motor 28, and even after the member 31 has been operated, so as to enable the chronograph stepping motor 28 to be operated, a timer (not shown) comes into operation so as to cut off the driving signals to the chronograph device after a certain period of time.

If the chronograph device is driven every day for an hour, or is stopped an hour after it has been
55 started, then the current consumption for one day is not 3.3 times as large as the current consumption of the timekeeping device, but is reduced to $3.3/24 \text{ hours} \approx 0.1375$ times. Thus although a timepiece which merely had a
60 timekeeping function would have a battery life of 5 years, if the timepiece additionally had a

chronograph device included, then the battery life would become

$$\frac{5}{0.1375 + 1} \approx 4.4 \text{ years,}$$

70 where the current consumption for the timekeeping device itself is 1. Moreover, in the case of a timepiece having a normal battery life of three years, then if such a timepiece is provided with a chronograph device the battery life becomes

$$\frac{3}{1.1375} \approx 2.64 \text{ years.}$$

75 Accordingly, it is possible to provide the timepiece with a chronograph device without losing much battery life.

Figures 2 and 3 illustrate the mechanical construction of the timepiece provided with the circuits shown in the block diagram of Figure 1.

As shown in Figure 2, the timepiece is provided with signal generating circuit block 46 comprising a quartz crystal oscillator and MOS IC components, the latter not being shown in detail
80 since they have been indicated in the description of Figure 1. The timepiece comprises a timekeeping device which is powered by at least one battery 40 and which comprises a driving gear train made up of wheels 2, 3, 4, 5, and a seconds
85 hand wheel 44. The pulse signals produced by the circuit block 46 are applied to a coil 41 forming part of a timekeeping stepping motor transducer for transducing the signals into rotary motion, the transducer comprising a stator 42 and a magnet
90 rotor 6. The rotor 6 drives a timekeeping seconds hand 44a (Figure 3) stepwise once a second, and also drives a timekeeping minutes hand 62, a timekeeping hour hand 61, and a calendar mechanism, not shown.

95 The timepiece also has a chronograph transducer which responds to signals having periods shorter than those of the timekeeping device, this transducer comprising a coil 45, a stator 43 and a rotor 18. The chronograph device
100 has a wheel 12 for driving a chronograph minutes hand 12a, and wheels 13, 14, 15, 16, 17.

The timekeeping minutes hand 62 and the timekeeping hours hand 61 are positioned substantially at the centre of the dial of the
105 timepiece. However, the seconds hand wheel 44, and the timekeeping seconds hand 44a driven thereby, may as shown in the drawings be disposed at a short distance from the said centre of the dial. The chronograph has a chronograph
110 seconds hand 14a which is positioned substantially at the centre of the timepiece, the chronograph minutes hand 12a being spaced from the centre of the timepiece. Although a chronograph hours hand is not shown in the drawings, it is possible if desired to provide a
115 chronograph hours hand which has a drive connection with the chronograph minutes hand

12a. This arrangement of the hands of the timekeeping and chronograph devices enables them to be disposed over the whole surface of the dial of the timepiece in such a way that the timepiece can be read as easily as in the case of a mechanical chronograph watch.

When it is desired to operate the chronograph device, an externally operable start button 47 (Figure 2) is depressed. This causes displacement of a lever 49 so that a part 49a of the latter electrically contacts a contact pin 53 so as to cause a chronograph start signal to be produced for effecting operation of the gate circuit 33. When it is desired to stop the chronograph device, a chronograph stop button 48 is depressed. This causes displacement of a lever 50 to an extent controlled by a chronograph driving cam 51 known per se, and as a result hammers 52 engage heart-shaped members which are fixed on the seconds wheel 14 and on the minutes wheel 12 so as to re-set the latter to zero.

The timepiece described above does not incorporate a friction clutch mechanism for positioning the chronograph seconds hand such as is used in a mechanical chronograph timepiece. Moreover, the timekeeping gear mechanism 25, 26 and the chronograph gear mechanism 29, 30 are separate from each other. The wheels are therefore arranged so that they do not overlap one another in plan view, and consequently the timepiece of the present invention does not need to be as thick as in the case of the mechanical chronograph timepiece.

If the timepiece of the present invention is provided with dial scales which give both chronograph seconds indications and timekeeping minutes indications, the timekeeping seconds hand 44a will move step-wise once a second, whereas the chronograph seconds hand 14a will rotate by one tenth second graduations. It can therefore be seen at a glance that the chronograph seconds hand 14a moves smoothly. This provides the timepiece with a characteristic design feature.

If the chronograph seconds hand 14a moves during one tenth second periods and rotates through 10 dial divisions per second, a lap time of one tenth of second can easily be measured and read because one dial division itself corresponds to one tenth of a second. This advantage arises in the case of the present invention from the fact that two stepping motors 24, 28 are provided which are separate from each other, whereas a corresponding advantage does not occur in the case of a conventional mechanical chronograph timepiece and a tuning fork type chronograph timepiece. The chronograph device of the timepiece of the present invention may therefore have the very high accuracy that is obtainable in quartz crystal timepieces.

As indicated above, the chronograph seconds hand moves swiftly over the dial so that it can be

clearly distinguished from the timekeeping seconds hand, which moves stepwise.

CLAIMS

1. An analogue electronic timepiece comprising a first stepping motor which is arranged to step at one second intervals; a first gear mechanism driven by the first stepping motor; timekeeping time indicating means driven stepwise by the first gear mechanism; a second stepping motor which is arranged to step at 1/10th second intervals; a driving means for driving the first and second stepping motors; a second gear mechanism driven by the second stepping motor; and chronograph time indicating means driven stepwise by the second gear mechanism.

2. A timepiece as claimed in Claim 1 in which the driving means comprises first and second driving circuits for respectively driving the first and second stepping motors, there being provided an oscillator for producing a time standard pulse output and a dividing circuit which is arranged to receive the pulse output of the oscillator and which is arranged to supply outputs to the first and second stepping motors.

3. A timepiece as claimed in Claim 2 in which the dividing circuit is connected to the second driving circuit by way of a gate circuit, the gate circuit normally preventing operation of the second stepping motor.

4. A timepiece as claimed in Claim 2 or 3 in which the oscillator is a quartz crystal oscillator.

5. A timepiece as claimed in any of claims 2—4 in which the dividing and driving circuits form parts of an integrated circuit.

6. A timepiece as claimed in any preceding claim in which the timekeeping time indicating means comprises a timekeeping seconds hand which is spaced from the centre of the timepiece.

7. A timepiece as claimed in any preceding claim in which the chronograph time indicating means comprises a chronograph seconds hand disposed substantially at the centre of the timepiece.

8. An analogue electronic timepiece substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

9. An analog quartz crystal timepiece comprising a timekeeping mechanism and a chronograph mechanism: said timekeeping mechanism including a quartz crystal oscillator for a time standard, divider and driver circuits made up of integrated circuit, a step motor responding to a signal from said driver circuit, a driving gear train and a displaying gear train, and said chronograph mechanism including a step motor for driving a chronograph mechanism, a chronograph driving gear train and a chronograph displaying gear train; wherein said chronograph mechanism is driven with a period shorter than that for driving said step motor of said



12a. This arrangement of the hands of the timekeeping and chronograph devices enables them to be disposed over the whole surface of the dial of the timepiece in such a way that the timepiece can be read as easily as in the case of a mechanical chronograph watch.

When it is desired to operate the chronograph device, an externally operable start button 47 (Figure 2) is depressed. This causes displacement of a lever 49 so that a part 49a of the latter electrically contacts a contact pin 53 so as to cause a chronograph start signal to be produced for effecting operation of the gate circuit 33. When it is desired to stop the chronograph device, a chronograph stop button 48 is depressed. This causes displacement of a lever 50 to an extent controlled by a chronograph driving cam 51 known per se, and as a result hammers 52 engage heart-shaped members which are fixed on the seconds wheel 14 and on the minutes wheel 12 so as to re-set the latter to zero.

The timepiece described above does not incorporate a friction clutch mechanism for positioning the chronograph seconds hand such as is used in a mechanical chronograph timepiece. Moreover, the timekeeping gear mechanism 25, 26 and the chronograph gear mechanism 29, 30 are separate from each other. The wheels are therefore arranged so that they do not overlap one another in plan view, and consequently the timepiece of the present invention does not need to be as thick as in the case of the mechanical chronograph timepiece.

If the timepiece of the present invention is provided with dial scales which give both chronograph seconds indications and timekeeping minutes indications, the timekeeping seconds hand 44a will move step-wise once a second, whereas the chronograph seconds hand 14a will rotate by one tenth second graduations. It can therefore be seen at a glance that the chronograph seconds hand 14a moves smoothly. This provides the timepiece with a characteristic design feature.

If the chronograph seconds hand 14a moves during one tenth second periods and rotates through 10 dial divisions per second, a lap time of one tenth of second can easily be measured and read because one dial division itself corresponds to one tenth of a second. This advantage arises in the case of the present invention from the fact that two stepping motors 24, 28 are provided which are separate from each other, whereas a corresponding advantage does not occur in the case of a conventional mechanical chronograph timepiece and a tuning fork type chronograph timepiece. The chronograph device of the timepiece of the present invention may therefore have the very high accuracy that is obtainable in quartz crystal timepieces.

As indicated above, the chronograph seconds hand moves swiftly over the dial so that it can be

clearly distinguished from the timekeeping seconds hand, which moves stepwise.

CLAIMS

1. An analogue electronic timepiece comprising a first stepping motor which is arranged to step at one second intervals; a first gear mechanism driven by the first stepping motor; timekeeping time indicating means driven stepwise by the first gear mechanism; a second stepping motor which is arranged to step at 1/10th second intervals; a driving means for driving the first and second stepping motors; a second gear mechanism driven by the second stepping motor; and chronograph time indicating means driven stepwise by the second gear mechanism.

2. A timepiece as claimed in Claim 1 in which the driving means comprises first and second driving circuits for respectively driving the first and second stepping motors, there being provided an oscillator for producing a time standard pulse output and a dividing circuit which is arranged to receive the pulse output of the oscillator and which is arranged to supply outputs to the first and second stepping motors.

3. A timepiece as claimed in Claim 2 in which the dividing circuit is connected to the second driving circuit by way of a gate circuit, the gate circuit normally preventing operation of the second stepping motor.

4. A timepiece as claimed in Claim 2 or 3 in which the oscillator is a quartz crystal oscillator.

5. A timepiece as claimed in any of claims 2—4 in which the dividing and driving circuits form parts of an integrated circuit.

6. A timepiece as claimed in any preceding claim in which the timekeeping time indicating means comprises a timekeeping seconds hand which is spaced from the centre of the timepiece.

7. A timepiece as claimed in any preceding claim in which the chronograph time indicating means comprises a chronograph seconds hand disposed substantially at the centre of the timepiece.

8. An analogue electronic timepiece substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

9. An analog quartz crystal timepiece comprising a timekeeping mechanism and a chronograph mechanism: said timekeeping mechanism including a quartz crystal oscillator for a time standard, divider and driver circuits made up of integrated circuit, a step motor responding to a signal from said driver circuit, a driving gear train and a displaying gear train, and said chronograph mechanism including a step motor for driving a chronograph mechanism, a chronograph driving gear train and a chronograph displaying gear train; wherein said chronograph mechanism is driven with a period shorter than that for driving said step motor of said

(17)



timekeeping mechanism.

10. An analog quartz crystal timepiece as claimed in claim 9, wherein a timekeeping

seconds hand is not co-axial with the centre of said timepiece and a chronographic seconds hand is disposed almost in the middle of said timepiece.

Printed for Her Majesty's Stationary Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained