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DRAWINGS ATTACHED

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(54) A DRIVING CIRCUIT ARRANGEMENT FOR A TIMEPIECE

(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 driving circuit arrangements for timepieces and, in particular, although not so restricted, to driving circuit arrangements for watches.

According to one aspect of the present invention there is provided a driving circuit arrangement for a timepiece comprising: an oscillator for producing a relatively high frequency signal, a frequency divider for producing from said relatively high frequency signal a relatively low frequency signal, and for supplying the same to a driving means of the timepiece, and capacitor means connected in parallel and in permanent electrical connection with the frequency divider, the arrangement being such that, in operation, said capacitor means will continue to power the driving circuit arrangement for a predetermined time after current from an external power source has ceased.

Preferably, said frequency divider has a plurality of stages, each of which includes a complementary pair of metal oxide semiconductor means.

The driving circuit arrangement may be in combination with the driving means. Thus, the driving means may comprise an electro-mechanical transducer, for example, a pulse motor.

The oscillator may include a quartz crystal oscillator.

According to a further aspect of the present invention, there is provided a timepiece or a watch provided with a driving circuit arrangement as recited above.

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

Figure 1 is a schematic diagram of a conventional driving circuit arrangement for a watch;

Figure 2 is a circuit diagram of a driving circuit arrangement according to the present invention for a watch; and

Figure 3 is a plan view of one embodiment of watch provided with the driving circuit arrangement of Figure 2.

Referring first to Figure 1, there is shown a schematic diagram of a conventional driving circuit arrangement for a watch having a ratchet wheel 1 and a continuously rotating seconds hand 2. The driving circuit arrangement includes a tuning fork vibrator V1, a driving coil L2, a capacitor C1, a biasing resistor R1 and a switching transistor T1. The tuning fork is driven by current supplied from a battery B to the driving coil L2.

The vibrator continues to vibrate for a short length of time after the current to the driving coil L2 ceases, after which time the watch stops. Thus, if the current ceases for an instant caused, for example, by an external mechanical shock to the watch disconnecting the battery B, the watch will not lose time unless the current fails to return until after the vibrator has stopped vibrating. A watch of this type therefore never loses or gains time.

In a driving circuit arrangement incorporating a frequency divider the watch stops immediately current to the driving circuit arrangement ceases. Thus the watch will lose time even if the driving circuit arrangement stops for an instant and so such a driving circuit arrangement needs to be provided with an arrangement which will continue to supply it with power for a predetermined time when the supply of current from the battery ceases for one reason or another.

It might be thought that one should go to the root cause of the problem and improve the construction of a holder or a connector to the battery so that an external mechanical shock to the watch will not cause disconnection of the battery. However, it is impossible to prevent such disconnection of the battery as a result of an external mechanical shock unless the battery is welded or soldered directly into the driving mechanism in which

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case it would be far from easy to renew the battery.

Referring now to Figure 2 there is shown a circuit diagram of a driving circuit arrangement according to the present invention, for a watch. The driving circuit arrangement has a crystal oscillator 10 the frequency of which may be between 8 kHz and 33 kHz. The oscillator 10 includes a quartz crystal 11, a temperature compensating capacitor Cth, a variable capacitor Cs, and a variable capacitor Cp. The capacitors Cth, Cp are provided to compensate for deviations in the frequency of oscillation of the quartz crystal resulting from changes in ambient temperature. The capacitor Cs is provided to allow adjustment of the frequency of oscillation of the quartz crystal to be effected. The output signal from the oscillator 10 is amplified and fed to a first inverter INV1 one half of the output signal of which is fed directly to a frequency divider and the other half of the output signal of which is fed to a second inverter INV2. The output signal from the inverter INV2 is fed to the frequency divider. The frequency divider is, therefore, provided with two clock signals which differ in phase by π radians. The frequency divider comprises a plurality of stages FF1, FF2, . . . FFn, . . . FF15 each of which produces an output signal the frequency of which is half the frequency of the input signal. In the embodiment illustrated there are fifteen stages to the frequency divider and so, if the oscillator 10 produces a signal frequency of 32.768 kHz the output signal from stage FF15 will be 1 Hz. Each stage of the frequency divider includes a complementary pair of metal oxide semiconductor means such as are well known in the art. It is advantageous to use complementary pairs of metal oxide semiconductor means because their power consumption is low.

The output from the frequency divider is fed to a driver DRIV which drives an electromechanical transducer, for example, a pulse motor 3. A switch Rs is provided and, when closed, this switch zeroes the frequency divider so that the seconds hand of the watch can be set against some standard time. When the switch Rs is closed the inverter INV1 is OFF, thus reducing the power consumption of the driving circuit arrangement. A battery B¹ supplies power to drive the driving circuit arrangement and a capacitor C_b is provided in parallel with the battery and in parallel with the frequency divider.

Referring to Figure 3 there is shown a plan view of one embodiment of a watch provided with the driving circuit arrangement of Figure 2. The watch includes a base plate 3¹ on which is mounted the battery B¹, the capacitor C_b, the capacitor Cth, the oscillator 10, the capacitor Cp and a driving

coil 7 for driving an electromechanical transducer.

The capacitor C_b is arranged so that it is in permanent electrical contact, e.g. by means of screws, welding or soldering, with the frequency divider so that in normal operation it is charged from the battery B¹. If the watch is subject to an external mechanical shock which causes the battery B¹ to be disconnected from the driving circuit arrangement for an instant but finite length of time the charge stored in the capacitor C_b will provide enough power to the driving mechanism until the power from the battery is restored. Accordingly, the watch will not lose time as a result of this disconnection of the battery unless the finite length of time of disconnection is longer than the time taken by the capacitor C_b to discharge. Thus, the capacitor C_b must have as large a value as possible commensurate with the dictates of space, etc.

The present invention is particularly applicable to watches having an electro-optical display and/or integrated circuit construction.

The above described driving circuit arrangement has a relatively very low power consumption and a watch or other timepiece in which it is provided will not lose time as a result of an external mechanical shock.

WHAT WE CLAIM IS:—

1. A driving circuit arrangement for a timepiece comprising: an oscillator for producing a relatively high frequency signal, a frequency divider for producing from said relatively high frequency signal a relatively low frequency signal, and for supplying the same to a driving means of the timepiece, and capacitor means connected in parallel and in permanent electrical connection with the frequency divider, the arrangement being such that, in operation, said capacitor means will continue to power the driving circuit arrangement for a predetermined time after current from an external power source has ceased.

2. A driving circuit arrangement as claimed in claim 1 in which said frequency divider has a plurality of stages, each of which includes a complementary pair of metal oxide semiconductor means.

3. A driving circuit arrangement as claimed in claim 1 or 2 in combination with the driving means.

4. A driving circuit arrangement as claimed in claim 3 in which the driving means comprises an electromechanical transducer.

5. A driving circuit arrangement as claimed in claim 4 in which the electromechanical transducer is a pulse motor.

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2. A driving circuit arrangement as claimed in claim 1 in which said frequency divider has a plurality of stages, each of which includes a complementary pair of metal oxide semiconductor means.

3. A driving circuit arrangement as claimed in claim 1 or 2 in combination with the driving means.

4. A driving circuit arrangement as claimed in claim 3 in which the driving means comprises an electromechanical transducer.

5. A driving circuit arrangement as claimed in claim 4 in which the electromechanical transducer is a pulse motor.



6. A driving circuit arrangement as claimed in any preceding claim in which the oscillator includes a quartz crystal oscillator. a driving circuit arrangement as claimed in any preceding claim.

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- 5 7. A driving circuit arrangement for a timepiece substantially as herein described with reference to and as shown in Figures 2 and 3 of the accompanying drawings.
8. A timepiece or a watch provided with

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