PATENT SPECIFICATION (11) 1 525 167

(21) Application No. 46804/76 (22) Filed 10 Nov. 1976
(31) Convention Application Nos.
50/135 560 (32) Filed 11 Nov. 1975 in
50/135 556
(33) Japan (JP)
(44) Complete Specification published 20 Sept. 1978
(51) INT. CL.² G04C 3/00
(52) Index at acceptance
G3T 301 QB
G1N 17TR 19B2Q 19B2X 19D11 19X5

1 525 167



(54) ELECTRONIC TIMEPIECE

(71) We, KABUSHIKI KAISHA DAINI SEIKOSHA, a Japanese Company of 31-1, 6-chome, Kameido, Koto-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 concerns an electronic timepiece having an electrically operated time display means.

Electronic timepieces having a time display means constituted by a liquid crystal display have previously had the time display means operative throughout the time that the timepiece itself is operative. Thus, for example, the time display means has been rendered operative even when this has been completely unnecessary, as for example when the user of the timepiece has been asleep, and this has involved an unnecessary drain on the power of a battery used to drive the timepiece.

In the case of an electronic timepiece having a time display means comprising light emitting diodes, it is known to arrange that the time display means is operated only when a mechanical switch is manually actuated. However, it is not always convenient to operate such a mechanical switch, e.g. if both hands of the user of the timepiece are being used for some other purpose such as carrying loads.

According to the present invention, there is provided an electronic timepiece having electrically operated time display means for displaying time information in a digital form; a switching circuit which controls operation of the time display means; a case within which the time display means and the switching circuit are mounted, the case having a case back at least the rear surface of which is of insulating material; and electrode means mounted on the rear surface of the case back, the switching circuit being controlled by the electrode means which detect whether or not the timepiece is in contact with the body of a user.

In one embodiment of the present invention, the electrode means comprises an electrode in which, in operation, an alternating current signal is produced when the electrode is in contact with the said body, the alternating current signal being used to control operation of the time display means. In this case the switching circuit may comprise means including a field effect transistor, responsive to said signal, for controlling the value of a voltage applied to the time display means.

In another embodiment of the present invention the electrode means comprises two spaced apart electrodes which are insulated from each other but which are arranged to be electrically connected to each other when contacted simultaneously by a part of the body of the user. In this case the switching circuit may comprise a transistor which is respectively rendered conductive and non-conductive in dependence upon whether the two electrodes are electrically connected to each other, the transistor controlling the value of a voltage applied to the time display means.

The time display means may comprise a liquid crystal display.

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

Figure 1 is a diagrammatic cross-sectional view of one embodiment of an electronic timepiece according to the present invention,

Figure 2 is a broken-away cross-sectional view showing a modification of the structure shown in Figure 1,

Figure 3 is a circuit diagram of a circuit used in the timepiece of Figure 1 or Figure 2,

Figure 4 is a diagrammatic cross-sectional

view of another embodiment of an electronic timepiece according to the present invention,

Figure 5 is a broken-away cross-sectional view of a modification of the structure shown in Figure 4, and

Figure 6 is a circuit diagram of the timepiece shown in Figure 4 or in Figure 5.

In Figure 1 there is shown an electronic timepiece having a case which comprises a case back 1, a case body member 2 which is attached to the case back 1, and a timepiece glass 2*a* which is attached to the case body member 2.

Mounted on the rear surface 1*a* of the case back 1 is an electrode 3 which, as described in greater detail below, is adapted to detect whether or not the timepiece is in contact with the body of a user by reason of the fact that, in operation, an alternating current signal is produced therein when the electrode 3 is in contact with the body of the user. Thus the electrode 3 is adapted to detect the induced hum which is generated in the human body.

If the case back 1 is made of plastics and thus of insulating material, the electrode 3 is fixed directly to the rear surface 1*a*. If, however, the case back 1 is made of metal or other electrically conductive material, the electrode 3 is fixed to the rear surface 5*a* of an insulating layer 5' which itself is secured to the rear surface 1*a* of the case back 1, as shown in Figure 2.

Mounted within the case is a circuit block 7 which is connected to the electrode 3 by wires 6 which pass through the case back 1. The circuit block 7 controls operation of the timepiece and is provided with a switching circuit (Figure 3) which controls operation of a time display 17, the switching circuit and time display 17 being mounted within the case. The time display 17 comprises a liquid crystal display (not shown) and thus displays time information in a digital form.

As shown in Figure 3, the electrode 3 is connected to the gate of a MOSFET field effect transistor 8 having an especially high input impedance. The gate and the drain of the field effect transistor 8 are connected to a point 3*a* through resistors 9, 10 respectively, the point 3*a* being held, by means not shown, at a voltage $-V_{DD}$. The electrode 3 is also earthed by way of a resistor 7*a*. A condenser 11, which is arranged in parallel with the resistor 10, is connected to a point A which is itself connected to the drain of the field effect transistor 8. The point A, and thus the drain of the field effect transistor 8, is connected to the base of a transistor 12 by way of a Zener diode 13 and a resistor 14 which are connected in series.

The emitter of the transistor 12 is connected to the point 3*a* having the potential $-V_{DD}$, while the collector of the transistor 12 is connected to earth through a resistor 15. An inverter 16 is connected between an output terminal of the collector of the transistor 12 and the time display 17.

In operation, when the timepiece of Figures 1 to 3 is worn on the arm of the user, or is otherwise in contact with the body of the user, the electrode 3 detects the induced hum which is generated in the human body. A signal, constituted by a very small alternating current, is thus transmitted to the gate of the field effect transistor 8, and a pulsating signal is generated at the drain of the transistor 8 which charges the condenser 11. When the voltage at A is sufficiently high to make the Zener diode 13 conductive, the transistor 12 also becomes conductive and the voltage of the output terminal of the collector of the transistor 12 thus changes from earth potential to the voltage $-V_{DD}$. In consequence, the voltage of the output from the inverter 16 changes from a low level voltage to a high level voltage and the time display 17 is thus operated.

When, however, the timepiece is taken off the arm of the user and thus is not in contact with the body any longer, the gate of the field effect transistor 8 does not receive the said alternating current signal and the voltage of the collector of the transistor 12 is thus at earth potential, whereby the time display 17 is not operated. When therefore the timepiece has been taken off the arm of the user or is otherwise out of contact with the body of the user, the time display 17 is not operated and as a result, the drain on the battery of the timepiece is reduced.

In Figure 4 there is shown an electronic timepiece according to the present invention having a case which comprises a case back 18 secured to a case body member 19, the case body member 19 being provided with a timepiece glass 19*a*. Mounted on the rear surface 18*a* of the case back 18 are two spaced apart electrodes 20, 21 which are insulated from each other but which are arranged to be electrically connected to each other when contacted simultaneously by the arm, finger or some other part of the body of the user.

When the case back 18 is made of plastics material, and thus of insulating material, the electrodes 20, 21 are fixed directly to the rear surface 18*a* as shown in Figure 4. However, if the case back 18 is made of metal, its rear surface 18*a* is provided with a layer of insulating material 22, as in Figure 5, the electrodes 20, 21 being secured on the rear surface 22*a* of the layer 22.

Each of the electrodes 20, 21 is connected to a circuit block 24 by means of a respective wire 23 which passes through the case

back 18, the circuit block 24 being disposed within the timepiece case and comprising a switching circuit as shown in Figure 6. The electrodes 20, 21 thus collectively constitute a detector 26 (Figure 6) adapted to detect whether or not the timepiece is in contact with the body of a user.

As shown in Figure 6, the electrode 20 is connected to the positive terminal of a battery power source 25, while the electrode 21 is connected to the base of a transistor 27 whose emitter is connected to earth. The collector of the transistor 27 is connected to the positive terminal of the battery power source 25 through a resistor 28 and is also connected to a time display 30 through an inverter 29. The time display 30, which is mounted within the case, comprises liquid crystal material and thus displays time information in a digital form.

In operation, when the timepiece of Figures 4 to 6 is put on a human arm, each of the electrodes 20 and 21 contacts the arm and the electrodes 20, 21 are thus electrically connected to each other by a resistance circuit which is shown diagrammatically in Figure 6 by the resistor 31. The electrical connection of the electrodes 20, 21 by way of the resistors 31 thus connects the base of the transistor 27 to the positive terminal of the battery power source 25 with the result that the transistor 27 becomes conductive. The voltage of the collector of the transistor 27, and consequently the input signal to the inverter 29, thus changes from a high level value to a low level value, and consequently the output signal of the inverter 29 changes from a low level to a high level, thus causing time display 30 to operate.

When, however, the timepiece is removed from the arm and the electrodes 20, 21 are insulated from each other, the transistor 27 is non-conductive and the voltage applied to the time display 30 is thus at a low value such that the time display 30 is not operated. Accordingly, the drain on the battery power source 25 is thus reduced, whereby to increase its life.

In the construction of Figure 4 each of the electrodes 20, 21 is secured to the case back 18. However, if desired, only one of the electrodes 20, 21 need be so secured, the other electrode being connected to some earthed portion of the timepiece which is insulated from the said one electrode.

WHAT WE CLAIM IS:—

1. An electronic timepiece having electrically operated time display means for displaying time information in a digital form; a switching circuit which controls operation of the time display means; a case within which the time display means and the switching circuit are mounted, the case having a case back at least the rear surface of which is of insulating material; and electrode means mounted on the rear surface of the case back, the switching circuit being controlled by the electrode means which detect whether or not the timepiece is in contact with the body of a user.

2. An electronic timepiece as claimed in claim 1 in which the electrode means comprises an electrode in which, in operation, an alternating current signal is produced when the electrode is in contact with the said body, the alternating current signal being used to control operation of the time display means.

3. An electronic timepiece as claimed in claim 2 in which the switching circuit comprises means including a field effect transistor, responsive to said signal, for controlling the value of a voltage applied to the time display means.

4. An electronic timepiece as claimed in claim 1 in which the electrode means comprises two spaced apart electrodes which are insulated from each other but which are arranged to be electrically connected to each other when contacted simultaneously by a part of the body of the user.

5. An electronic timepiece as claimed in claim 4 in which the switching circuit comprises a transistor which is respectively rendered conductive and non-conductive in dependence upon whether the two electrodes are electrically connected to each other, the transistor controlling the value of a voltage applied to the time display means.

6. An electronic timepiece as claimed in any preceding claim in wihch the time display means comprises a liquid crystal display.

7. An electronic timepiece substantially as hereinbefore described with reference to and as shown in Figures 1 to 3 or in Figures 4 to 6 of the accompanying drawings.

J. MILLER & CO.
Chartered Patent Agents
Agents for the Applicants,
Lincoln House,
296-302 High Holborn,
London, WC1V 7JH.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1978.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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When, however, the timepiece is removed from the arm and the electrodes 20, 21 are insulated from each other, the transistor 27 is non-conductive and the voltage applied to the time display 30 is thus at a low value such that the time display 30 is not operated. Accordingly, the drain on the battery power source 25 is thus reduced, whereby to increase its life.

In the construction of Figure 4 each of the electrodes 20, 21 is secured to the case back 18. However, if desired, only one of the electrodes 20, 21 need be so secured, the other electrode being connected to some earthed portion of the timepiece which is insulated from the said one electrode.

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2. An electronic timepiece as claimed in claim 1 in which the electrode means comprises an electrode in which, in operation, an alternating current signal is produced when the electrode is in contact with the said body, the alternating current signal being used to control operation of the time display means.

3. An electronic timepiece as claimed in claim 2 in which the switching circuit comprises means including a field effect transistor, responsive to said signal, for controlling the value of a voltage applied to the time display means.

4. An electronic timepiece as claimed in claim 1 in which the electrode means comprises two spaced apart electrodes which are insulated from each other but which are arranged to be electrically connected to each other when contacted simultaneously by a part of the body of the user.

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Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1978.
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