

PATENT SPECIFICATION

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(54) ELECTRIC 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 electric timepieces, and throughout this specification and claims the term "electric" is intended to include timepieces which are driven electronically.

In one known electronic timepiece there is an electronic device circuit including at least one transistor the base of which is connected to a source of current. When it is desired to store such a timepiece, clearly it is desirable to minimise the wastage of the energy stored in the source of current, e.g. a battery, so as to avoid a flow of current to the base of the transistor during such storage.

In known devices this problem was solved by the provision of a switch adjacent the electric power source to enable the electric power source to be disconnected. However, in this known arrangement, if a fault occurs in the operation of the switch, due to dirt or other malfunctioning, the electric contact resistance of the switch is increased and stored electric energy is still lost through the contact point of the switch. As a result, the stored energy left for driving the timepiece is decreased and this is liable to cause the isochronism of the timepiece to be upset and may indeed finally stop the timepiece.

The present invention seeks to eliminate the above defects and to provide means to avoid the flow of an excessive current when the electronic control circuit is inoperative, e.g. when the timepiece is stopped during storage, and to enable, when the contact resistance in the said means is increased, the timepiece nevertheless to continue to function correctly.

According therefore to the present invention, there is provided an electric timepiece including an electric drive circuit connectible

to an electric power source, a transistor the collector-emitter path of which forms part of said drive circuit, a control circuit portion connected to the base of the said transistor and to said drive circuit, and a switch in the said control circuit portion to connect said base to said power source in such a manner that in operation when said power source is connected to said drive circuit but said switch is open, any current drawn from the said power source is insubstantial compared with the same when the switch is closed.

Preferably the current drawn from the power source when said switch is open is at least a factor of ten smaller than that when said switch is closed.

In a typical advantageous embodiment, the current drawn from the power source when said switch is open is less than 3% of that when said switch is closed.

Preferably, said switch is electrically connected between the emitter of said transistor and the junction of two series-connected drive coils.

The said switch may be mechanically connected to a movable crown by way of a pivoted lever.

The said lever is preferably provided with an abutment portion for stopping a balance member.

In an alternative preferred embodiment, the timepiece is piezo-electrically operated, the switch being so disposed that during storage of the timepiece an oscillator circuit only is operative, but frequency dividing and drive circuits are inoperative.

In a further alternative preferred embodiment, the said circuit serves intermittently to wind the mainspring of the timepiece, there being means for opening the switch between each winding operation.

Preferably the switch is automatically controlled by the degree of winding of the mainspring.

The invention will now be described, merely by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a fragmentary plan view of a

[Price 25p]

preferred embodiment of an electronic watch in accordance with the present invention, and

Figure 2 is an electronic circuit diagram of the electronic timepiece shown in Figure 1.

Referring to the drawings, the electronic timepiece comprises an electric cell or battery 1 (not shown in Figure 1), connected to a pair of driving coils 2 and 3 connected in series, which coils are located in the driving circuit the output of which causes an anchor magnet (not shown) to maintain oscillation of a balance member 4.

The electronic circuit is carried by a pair of insulating plates 5 and 6, the insulating plate 5 being in the form of an annular segment, while the insulating plate 6 is in the form of a ring. The plate 5 carries a controlling transistor 7, a driving transistor 8, fixed resistors 9, 10 and 11 and a capacitor 12. The insulating plate 6 carries the driving coils 2 and 3, a detecting coil 13 and a diode 14. The electric connection of the parts 1, 2, 3 and 7 to 14 is shown in Figure 2.

The electronic circuit includes also a switch 15 connected between the junction of the driving coils 2 and 3 and the resistor 9 which in turn is connected to the emitter of the controlling transistor 7. The switch 15 is mechanically actuable by a switch operating portion 16a of a balance regulating lever 16 mounted for pivotal movement about a pivot 16c. The balance regulating lever 16 has a pair of projections 16b, 16d, the former of which is engaged in a groove 17a of a setting lever 17 which has an end surface 17b engaged with a time indicating hands setting pinion. The pinion is mounted on a stem carrying at its outer end a crown 18 which is outside the case of the timepiece.

When the time indicating hands are to be set, the stem and crown 18 are pulled radially outwardly and this displacement causes the balance regulating lever 16 to turn clockwise (as viewed) about its pivot 16c. This in turn causes the switch operating portion 16a to open the contact 15a of the switch 15. As can be seen from Figure 2, this means that the emitter circuit of the controlling transistor 7 is open whereby the operation of the said transistor is stopped and the whole circuit is broken.

At the same time, the projection 16d of the balance regulating lever engages a part contacting the side of the balance member 4 to lock the latter against further movement.

When the timepiece is to be stored, the crown 18 is brought into its hand setting position so as to stop the balance movement. In this inoperative position, with the usual values of the components, any current drawn from the cell 1 through the coils 2 and 3 and the transistor 8 is very small, and is typically between 0.05 and 0.3 microamperes. This is less than 3% of the current

consumed when the switch 15 is closed and the timepiece is running normally. The energy used up after storage of the timepiece for one year in this example will be less than 3 mAh.

The main advantage of this preferred embodiment of the invention resides in the fact that the switch 15 is placed in the control circuit portion of the electric circuit. If the switch 15 develops a mechanical fault or is dirty and the contact resistance is increased by 1—2 kilohms, the terminal voltages of the driving coils 2 and 3 are not substantially decreased; and therefore the control circuit can continue to operate correctly. Thus the performance of the timepiece is not substantially impaired, and at the same time if the switch is open, any leakage current is very low.

The present invention is also applicable to electric timepieces in which the circuit does not serve to control the regulating or balance member of the timepiece directly, but serves, for example, to wind a mainspring in an intermittent manner. In such a case, preferably means are provided to open the contact point of the switch between each winding operation to avoid unnecessary wastage of the cell 1. In some timepieces, provision can be made for automatically controlling the switch by the degree of winding of the mainspring so as to maintain the degree constant.

The invention is also applicable to timepieces regulated by quartz crystals or other piezo-electric means so that, when they are stored, only the oscillation circuit is maintained operative, but the frequency dividing circuit and the driving circuit are not operative (which saves wastage of power) so that the regulating means is operative, whereby the crystal is substantially prevented from ageing.

WHAT WE CLAIM IS:—

1. An electric timepiece including an electric drive circuit connectible to an electric power source, a transistor the collector-emitter path of which forms part of said drive circuit, a control circuit portion connected to the base of the said transistor and to said drive circuit, and a switch in the said control circuit portion to connect said base to said power source in such a manner that in operation when said power source is connected to said drive circuit but said switch is open, any current drawn from the said power source is insubstantial compared with the same when the switch is closed.

2. An electric timepiece as claimed in claim 1 wherein the current drawn from the power source when said switch is open is at least a factor of ten smaller than that when said switch is closed.

3. An electric timepiece as claimed in claim 1 or 2 wherein the current drawn from the

preferred embodiment of an electronic watch in accordance with the present invention, and

Figure 2 is an electronic circuit diagram of the electronic timepiece shown in Figure 1.

Referring to the drawings, the electronic timepiece comprises an electric cell or battery 1 (not shown in Figure 1), connected to a pair of driving coils 2 and 3 connected in series, which coils are located in the driving circuit the output of which causes an anchor magnet (not shown) to maintain oscillation of a balance member 4.

The electronic circuit is carried by a pair of insulating plates 5 and 6, the insulating plate 5 being in the form of an annular segment, while the insulating plate 6 is in the form of a ring. The plate 5 carries a controlling transistor 7, a driving transistor 8, fixed resistors 9, 10 and 11 and a capacitor 12. The insulating plate 6 carries the driving coils 2 and 3, a detecting coil 13 and a diode 14. The electric connection of the parts 1, 2, 3 and 7 to 14 is shown in Figure 2.

The electronic circuit includes also a switch 15 connected between the junction of the driving coils 2 and 3 and the resistor 9 which in turn is connected to the emitter of the controlling transistor 7. The switch 15 is mechanically actuable by a switch operating portion 16a of a balance regulating lever 16 mounted for pivotal movement about a pivot 16c. The balance regulating lever 16 has a pair of projections 16b, 16d, the former of which is engaged in a groove 17a of a setting lever 17 which has an end surface 17b engaged with a time indicating hands setting pinion. The pinion is mounted on a stem carrying at its outer end a crown 18 which is outside the case of the timepiece.

When the time indicating hands are to be set, the stem and crown 18 are pulled radially outwardly and this displacement causes the balance regulating lever 16 to turn clockwise (as viewed) about its pivot 16c. This in turn causes the switch operating portion 16a to open the contact 15a of the switch 15. As can be seen from Figure 2, this means that the emitter circuit of the controlling transistor 7 is open whereby the operation of the said transistor is stopped and the whole circuit is broken.

At the same time, the projection 16d of the balance regulating lever engages a part contacting the side of the balance member 4 to lock the latter against further movement.

When the timepiece is to be stored, the crown 18 is brought into its hand setting position so as to stop the balance movement. In this inoperative position, with the usual values of the components, any current drawn from the cell 1 through the coils 2 and 3 and the transistor 8 is very small, and is typically between 0.05 and 0.3 microamperes. This is less than 3% of the current

consumed when the switch 15 is closed and the timepiece is running normally. The energy used up after storage of the timepiece for one year in this example will be less than 3 mAh.

The main advantage of this preferred embodiment of the invention resides in the fact that the switch 15 is placed in the control circuit portion of the electric circuit. If the switch 15 develops a mechanical fault or is dirty and the contact resistance is increased by 1—2 kilohms, the terminal voltages of the driving coils 2 and 3 are not substantially decreased, and therefore the control circuit can continue to operate correctly. Thus the performance of the timepiece is not substantially impaired, and at the same time if the switch is open, any leakage current is very low.

The present invention is also applicable to electric timepieces in which the circuit does not serve to control the regulating or balance member of the timepiece directly, but serves, for example, to wind a mainspring in an intermittent manner. In such a case, preferably means are provided to open the contact point of the switch between each winding operation to avoid unnecessary wastage of the cell 1. In some timepieces, provision can be made for automatically controlling the switch by the degree of winding of the mainspring so as to maintain the degree constant.

The invention is also applicable to timepieces regulated by quartz crystals or other piezo-electric means so that, when they are stored, only the oscillation circuit is maintained operative, but the frequency dividing circuit and the driving circuit are not operative (which saves wastage of power) so that the regulating means is operative, whereby the crystal is substantially prevented from ageing.

WHAT WE CLAIM IS:—

1. An electric timepiece including an electric drive circuit connectible to an electric power source, a transistor the collector-emitter path of which forms part of said drive circuit, a control circuit portion connected to the base of the said transistor and to said drive circuit, and a switch in the said control circuit portion to connect said base to said power source in such a manner that in operation when said power source is connected to said drive circuit but said switch is open, any current drawn from the said power source is insubstantial compared with the same when the switch is closed.

2. An electric timepiece as claimed in claim 1 wherein the current drawn from the power source when said switch is open is at least a factor of ten smaller than that when said switch is closed.

3. An electric timepiece as claimed in claim 1 or 2 wherein the current drawn from the



- power source when said switch is open is less than 3% of that when said switch is closed.
4. An electric timepiece as claimed in any preceding claim wherein said switch is electrically connected between the emitter of said transistor and the junction of two series-connected drive coils.
5. An electric timepiece as claimed in any preceding claim wherein the said switch is mechanically connected to a movable crown by way of a pivoted lever.
6. An electric timepiece as claimed in claim 5 wherein the said lever is provided with an abutment portion for stopping a balance member.
7. An electric timepiece as claimed in any of claims 1 to 3 wherein the timepiece is piezo-electrically operated, the switch being so disposed that during storage of the timepiece an oscillator circuit only is operative, but frequency dividing and drive circuits are inoperative.
8. An electric timepiece as claimed in any of claims 1 to 3 wherein the said circuit serves intermittently to wind the mainspring of the timepiece, there being means for opening the switch between each winding operation.
9. An electric timepiece as claimed in claim 8 wherein the switch is automatically controlled by the degree of winding of the mainspring.
10. An electric timepiece substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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