

TIME BASE DEVICE FOR A WATCH

FIELD OF THE INVENTION

The present invention concerns a time base device for a watch, particularly an electronic watch. The time base device has at least one electric motor coil able to be used for driving analogue display means, a module that has at least one time base oscillator circuit mounted in a case of the module, and an electric power source.

BACKGROUND TO THE INVENTION

In the state of the art, it is known to make a time base device for a timepiece movement with an oscillator connected to a quartz resonator. This time base device also includes a frequency divider for dividing the oscillator frequency, and a control circuit for an electric motor connected to the frequency divider. Said electric motor is controlled by the control circuit for driving, in particular, the hands of a time display, for example on a watch dial.

Each element of the time base device is generally secured to at least one printed circuit board, on which electrical connections are made between the various electronic elements of the time base device. The printed circuit board, including said time base device, may also be connected to the watch movement. These different elements are also powered by a voltage source, such as a battery or accumulator, which may be mounted in a housing provided for this purpose, which is connected to the printed circuit board. The assembly of all of these time base device electronic elements thus occupies a relatively large volume, which is a drawback for assembly or integration in a timepiece of small dimensions.

In order to reduce the volume of the electronic element assembly of the time base device, it is known to use a quartz resonator, in the form of a tuning fork associated with an oscillator, to form one part of the time base. Said tuning fork quartz resonator and the integrated circuit including the oscillator may be grouped together within the same case.

Grouping together various electronic components in the same case is known, in particular from US Patent No. 3,784,725. In that document, an electronic assembly for a watch forms a single unit. Electronic components of the assembly are mounted and connected, generally individually, on a printed circuit board, which may create some problems and costs for mounting in a watchcase of small dimensions. However, this electronic assembly groups together all of the electronic components, and the dial, to facilitate mounting the assembly in a conventional watch movement, a plastic watchcase or a piece of jewellery.

Although the prior solutions can partly reduce the volume occupied particularly by some components of a time base, the available space remains, nonetheless, insufficient to make a timepiece of small dimensions. The need to mount several integrated circuits to perform several watch functions on one or more printed circuit boards means that a large amount of space is occupied in the watch. This requires increasing the volume of the watch excessively, which is undesirable.

SUMMARY OF THE INVENTION

It is thus a main object of the invention to overcome the aforementioned drawbacks, by providing a time base device for a watch, which is compact and easy to handle for assembly operations in a watchcase of small dimensions.

The present invention concerns a time base device for a watch including at least one coil of an electric motor, an electronic module having at least one time base oscillator circuit mounted in a case of the module,

and an electric power voltage source, said time base device being characterized in that the coil, the electronic module with an oscillator circuit and the voltage source are connected to each other mechanically and electrically without using a printed circuit board so as to form a compact unit.

Particular embodiments of the time base device are defined in the dependent claims 2 to 11.

One advantage of the time base device according to the invention lies in the fact that the electrical connection between the voltage source, which may be a battery, or an accumulator, and the electronic time base module, and the electrical connection between the motor coil and said electronic module are achieved without the use of a printed circuit board. Metal flanges connect the positive and negative battery poles to two external connection terminals of the module, and two metal wires of a coil winding are directly connected to two other external connection terminals of the module. In the case of a two-phase motor, there may advantageously be three metal coil wires directly connected to the three external connection terminals of the module.

Because the electronic module advantageously contains within the same case, an oscillator, such as a quartz oscillator, a frequency divider and a motor control circuit, only 4, or 5 electrical connection terminals are required on an external surface of the module case. The oscillator, frequency divider and control circuit may form a single integrated circuit. This reduces the volume of all the elements of the time base device, i.e. it reduces the volume of the watch movement by moving the motor closer to the battery.

Grouping together the various elements of the time base device in a reduced space also reduces the length of the connections between the electronic elements of the device, and also the sensitivity of the oscillator to external interference. This also removes several mechanical operations for

assembling the electronic components, which reduces the production costs of the movement fitted with the time base device according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects, advantages and features of the time base device for a watch will appear more clearly in the following description made in a non-limiting manner with reference to the drawings, in which:

- Figure 1 shows a schematic view of an electronic watch with an analogue display, which includes the time base device according to the invention;
- Figure 2 shows a three-dimensional view of the various elements of the time base device according to the invention;
- Figure 3 shows a partial longitudinal cross-section of the electronic module of the time base device according to the invention; and
- Figure 4 is a partial top view of the electronic module of the time base device according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, all those elements of the time base device for an electronic watch that are well known to those skilled in the art in this technical field are related merely in a simplified manner.

Figure 1 shows schematically various components of an electronic watch, which includes a time base device according to the invention. This watch has a voltage source 8, for example a battery or an accumulator, for powering an electronic module 1 that has a time base and means for controlling an electric motor 6. The electric motor is controlled so that it drives gear trains (not shown) for rotating the analogue display means, such as hands 9, used for indicating the time, for example.

The time base device is essentially formed of voltage source 8, electronic module 1, and at least one coil of an electric motor 6. These time base device elements are advantageously mechanically and electrically connected without using a printed circuit board to form a compact unit of small dimensions, as explained below with reference to Figure 2.

Electronic module 1 includes, in a case, an oscillator 3, which may be an oscillator with, for example, a piezoelectric resonator 2, as a quartz resonator, or even a silicon MEMS resonator connected to the terminals of oscillator 3. Electronic module 1 further includes a frequency divider 4, whose input is connected to the output of oscillator 3, to obtain the desired working frequency for the watch so as to indicate the exact time. The output of frequency divider 4 is connected to a control circuit 5 for an electric motor 6 for driving hands 9. Oscillator 3, with resonator 2, and frequency divider 4 may form part of a time base oscillator circuit.

A Lavet-type stepping motor may be used as electric motor 6, also called a bipolar motor, formed of a magnetised rotor, a stator with high magnetic permeability to form the magnetic circuit loop, and at least one coil. The function of this coil, when it is live, is to create a magnetic field in the stator, which thus converts to a magnet whose polarity depends upon the direction of the current in the coil. Thus, control circuit 5 for motor 6 supplies a current that flows in the coil. The motor is controlled by a series of positive and negative pulses separated by a current outage. However, other types of motor may be used, such as, for example, a two-phase stepping motor, to obtain a two-directional motor that can set the time of the watch both forwards and backwards. In the case of a two-phase motor, three motor outputs have to be provided on electronic module 1.

Advantageously, as shown in Figure 1, oscillator 3, frequency divider 4 and the electric motor control circuit 5 all form part of a single integrated circuit 7. This reduces the space occupied by these electronic elements in electronic module 1, and decreases electromagnetic interference on the

electronic elements, due in particular to the length of the wired connections between said elements.

As Figures 2 to 4 show, and owing to the grouping of all the elements described above within electronic module 1, said electronic module 1 only has four, or five external connection terminals instead of eight terminals as is normal. Indeed, two connection terminals are normally provided for exciting resonator 2, two other terminals for connection to integrated circuit 7, two more terminals for powering the integrated circuit and finally two terminals for controlling the motor. In electronic module 1, four terminals shown in the Figures, or five terminals are necessary on the outside of the case, namely the two terminals for powering the integrated circuit and the two or three terminals for connecting the integrated circuit to control the motor. The other terminals are arranged only inside the case of electronic module 1.

Figure 2 shows a three-dimensional view of the time base device according to the present invention. The same reference signs are used for identical elements explained with reference to Figure 1. This time base device therefore includes a voltage source 8, which is preferably a battery, an electronic module 1 and an electric motor coil 30.

Contained in a case, particularly a ceramic case, electronic module 1 comprises the oscillator and resonator, the frequency divider and the electric motor control circuit. As explained above, the oscillator, the frequency divider and the control circuit may form a single integrated circuit, but of course, one could envisage making these elements on more than one integrated circuit, if necessary.

Four connection terminals 14, 15, 16 and 17 are provided on an external surface of electronic module 1. These connection terminals, as explained with reference to Figures 3 and 4, are arranged on an external surface of one wall of the case. The integrated circuit and conductive connecting paths that connect said integrated circuit to the resonator and to the connection terminals are mounted on the inner surface of said wall. The

four connection terminals shown are preferably arranged respectively at the four corners of the external surface. These connection terminals on the external surface are advantageously used as a base for connecting other elements of the time base device. This simplifies assembly of the time base device elements of the watch movement, and also greatly reduces the volume of the assembly by reducing the number of components.

This electronic module 1 may be housed in a receptacle 10 of generally parallelepiped shape, which is open over one or two surfaces. Receptacle 10 may be defined as all or part of a metal or plastic plate, or may form part of an integrated watch movement. In the example shown in Figure 2, receptacle 10 is open on two surfaces.

Once electronic module 1 has been secured, for example by bonding, in the receptacle, its four, or five connection terminals are accessible from an open top surface of the receptacle. Preferably, the external surface of module 1, on which connection terminals 14, 15, 16 and 17 are placed, is arranged at the same level as the mouth of the open top surface of receptacle 10, particularly at the top edge of the vertical receptacle walls. This facilitates the electrical and mechanical connection of the other elements of the time base device.

The first two connection terminals 14 and 15 of the external surface of the module are for electrical connection, respectively via two conventional metal flanges 24 and 25, to the two positive and negative poles of voltage source 8, which is preferably a battery here. A first flange 24 is secured or welded to one of the first metal connection terminals 14 so as to connect the positive pole of the battery, whereas the second flange 25, which surrounds an external part of receptacle 10, is secured or welded to the other first metal connection terminal 15 so as to connect the negative pole of said battery.

The second two connection terminals 16 and 17 of the external surface of the module, which are arranged on an opposite side to the first two terminals 14 and 15, are connected to a conventional winding of an

electric motor coil 30. A first metal wire 31 of coil 30 is welded to one of the second metal connection terminals 16, whereas a second metal wire 32 of coil 30 is welded to the other second metal connection terminal 17. The core of coil 30 is one part of a magnetic circuit 33, which may be secured, for example by screws through two apertures provided for this purpose, to another part of a magnetic circuit of the electric motor that is not shown.

One could also envisage using receptacle 10 of electronic module 1 as a support for motor coil 30, possibly with the entire mechanism thereof. This coil may also be directly secured to the edge of an open lateral surface of receptacle 10. Battery connection flanges 24 and 25 may be integrated in a housing for receiving the battery, which is not shown. This housing may form part of receptacle 10 or be secured to a lateral wall of the receptacle.

The arrangement of all the elements inside the, for example, ceramic case of the electronic module, is now explained with reference to Figures 3 and 4. The same reference signs are used for identical elements explained with reference to Figures 1 and 2.

Figure 3 is a median and longitudinal cross-section of electronic module 1 of the time base device. Inside case 11 of said module, resonator 2 is secured by welding or bonding with a conductive adhesive the connection pads of two groups of electrodes located on the resonator base to corresponding conductive paths 18 provided on steps 19 of the bottom of case 11. This allows resonator 2 to be positioned above integrated circuit 7 arranged on an inner surface of a bottom wall of case 11.

The connection between the connection pads located on the base of resonator 2 and integrated circuit 7 for exciting the electrodes and vibrating the resonator may be achieved via conductive pads 18, connected to holes 22. These holes 22 are formed in steps 19 and filled with a suitable conductive material, and connected to conductive paths arranged on the inner surface of the bottom wall of the case. These conductive paths are in turn connected to corresponding contact pads of integrated circuit 7.

Integrated circuit 7 may be connected at the exterior of the case to connection terminals 14, 15, 16 and 17, which are arranged on an external surface of the bottom wall of the case, as explained above. In order to do this in this example, connections studs 12 are provided on the inner surface of the bottom wall, advantageously underneath integrated circuit 7. These connection studs or bumps 12 are arranged in the same arrangement as contact pads of integrated circuit 7 so that they can electrically connect said contact pads of the integrated circuit via flip chip technology. Some of the integrated circuit contact pads are thus electrically connected by conductive paths to the external connection terminals 14, 15, 16 and 17, via holes 20 that pass through the bottom wall of case 11, which are filled with a conductive adhesive 21 or any other suitable conductive material. As these holes are located opposite connection terminals 14, 15, 16 and 17, conductive adhesive 21 provides the electrical connection with the inside of the case.

Figure 4 is a top view of electronic module 1, without a sealed cover, of the time base device. For the sake of simplification, the resonator is not shown in the case, which may be made of ceramic material and of generally parallelepiped shape. The cover, which is not shown, but which hermetically seals the case, may advantageously be made of glass to allow precise laser adjustment of the resonator frequency.

Inside case 11 of electronic module 1, an integrated circuit 7 is secured via its contact pads 13, shown transparently, onto connection bumps (not shown), which are arranged on the inner surface of the bottom wall of the case. As indicated above, the arrangement of the contact bumps is the same as that of contact pads 13, so that said integrated circuit can be secured by the flip chip technique. Integrated circuit 7 includes the oscillator, frequency divider and the electric motor control circuit.

The resonator electrodes (not shown) are welded onto conductive pads 18, which are connected to holes 22. These holes 22 are formed in steps 19 and filled with a suitable conductive material, such as a conductive

adhesive or metal. Thus conductive pads 18 are connected to conductive paths 23, arranged on the inner surface of the bottom wall of the case. These conductive paths 23 connect conductive pads 18 to some of contact pads 13 of integrated circuit 7, and also some of the other conductive pads 13 of integrated circuit 7 to the external connection terminals 14, 15, 16 and 17.

Integrated circuit 7 is electrically connected to the external connection terminals via holes 20 that traverse the bottom wall of case 11. These holes 20 are filled with a conductive adhesive 21 or any other suitable conductive material. Since the holes are located opposite connection terminals 14, 15, 16 and 17, conductive adhesive 21 provides electrical connection to the electronic elements in the case. The first two external connection terminals 14, 15 are connected to a voltage source, such as a battery, for powering integrated circuit 7. The second two external connection terminals 16 and 17 are connected to a winding of an electric motor coil to supply positive and negative electrical pulses.

Because of the arrangement of integrated circuit 7, which is connected to the resonator inside the case, the space occupied by the all of these elements is optimised. Moreover, integrated circuit(s) 7 are protected from any external interference, also because of the relatively short connection paths between the various elements.

From the description that has just been given, those skilled in the art can devise several variants of the compact time base device without departing from the scope of the invention defined by the claims. Several electric motors could be connected across the same connection terminals of the electronic module or across different connection terminals. The actuation timing of each of the motors connected to the electronic module may be different. The electronic module may be connected to the voltage source and to the coil without being arranged in a receptacle. The voltage source powering the electronic module with electricity may be formed in part by a solar cell in combination with a battery or accumulator.

CLAIMS

1. Time base device for a watch including at least one coil (30) of an electric motor (6), an electronic module (1) having at least one time base oscillator circuit (2, 3, 4) mounted in a case (11) of the module, and an electric power voltage source (8), characterized in that the coil (30), the
5 electronic module (1) with an oscillator circuit and the voltage source are connected to each other mechanically and electrically without using a printed circuit board so as to form a compact unit.

2. Time base device according to claim 1, characterized in that the electronic module (1) includes, inside the case, an oscillator (3), a
10 frequency divider (4) and a control circuit (5) for an electric motor (6), the oscillator and the frequency divider forming the time base oscillator circuit, which is powered from outside the case by the voltage source.

3. Time base device according to claim 2, characterized in that the oscillator (3) is connected to the inside of the case, to a piezoelectric
15 resonator (2), such as a quartz resonator, or a silicon MEMS resonator, and in that the oscillator, the frequency divider and the motor control circuit are made in a single integrated circuit (7).

4. Time base circuit according to claim 2, characterized in that the oscillator, the frequency divider and the motor control circuit are made in
20 several integrated circuits (7).

5. Time base device according to claim 3, characterized in that contact pads (13) of the integrated circuit (7) are connected to conductive
bumps (12) that have the same arrangement as the contact pads, the conductive connection bumps (12) being arranged on an inner surface of a
25 bottom wall of the case of the electronic module (1), and in that conductive paths (23) connect some conductive bumps on the inner surface of the bottom wall, to the resonator (2) and to connection terminals (14, 15, 16, 17), which are arranged outside the module case (11).

6. Time base device according to claim 5, characterized in that some conductive paths (23) connect at least four connection terminals (14, 15, 16, 17) via conductive holes (20) through the bottom wall of the case, and in that the four connection terminals are arranged at the four corners of the external rectangular surface, the first two connection terminals (14, 15) being connected to the voltage source by means of two contact flanges (24, 25) and the second two connection terminals (16, 17) being connected on an opposite side to the first two terminals, respectively to two metal wires (31, 32) of a winding of an electric motor coil (30), with the control circuit (5) in the case controlling said motor to drive analogue display means.

7. Time base device according to claim 6, characterized in that the electronic module (1) includes three second external connection terminals, which are respectively connected to three metal wires of at least one winding of a two-phase motor coil (30).

8. Time base device according to any of claims 1 to 6, characterized in that the electronic module (1) is housed in a receptacle (10) that is open on at least a top surface, and in that the electronic module (1) includes four connection terminals (14, 15, 16, 17) arranged at the four corners of an external rectangular surface of a bottom wall of a case (11), said module being arranged in the receptacle such that the four connection terminals are accessible through the open top surface of the receptacle (10).

9. Time base device according to claim 8, characterized in that the external surface of the module (1), on which the connection terminals (14, 15, 16 and 17) are placed, is arranged at the same level as the mouth of the open top surface of the receptacle (10), in that the first two connection terminals (14, 15) are connected via two metal flanges (24, 25) to the two negative and positive poles of the voltage source, such as a battery (8), and in that the second two connection terminals (16, 17) on an opposite side to the first connection terminals, are each connected to a respective metal wire of the coil (30) of an electric motor (6).

10. Time base device according to claim 9, characterized in that the coil (30) and/or the voltage source are secured to the receptacle (10) as a support to define a compact unit.

11. Time base device according to claim 9, characterized in that the
5 receptacle (10) forms one part of a watch movement or part of a watch.