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(54) IMPROVEMENTS IN OR RELATING TO ELECTRONIC TIMEPIECES

(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 electronic timepieces of the kind comprising a time-standard oscillator or vibrator of relatively high frequency (i.e. of the order of KHz or tens of KHz), numeric time indicating display means, and means including frequency dividers for deriving from the output of said oscillator or vibrator signals for the operation of the numeric time-indicating display means.

The main object of the invention is to provide an improved timepiece of the kind referred to having an alarm which can be easily and conveniently set to operate with precision—if desired with an accuracy of one second—at any desired time but which shall nevertheless be capable of being made of small size, suitable for a travelling clock or even for a wrist watch, and which shall be of low power consumption and capable of operating from the usual battery of such a timepiece.

Hitherto small numeric time indicating timepieces have usually incorporated motor drives requiring a relatively high voltage alternating current supply for energising the same and there has long been a need for such a timepiece, especially a wrist watch, which can be driven by a battery, and which shall be truly and conveniently portable and self-contained. Indeed, hitherto, it has been usual to provide analogue time indication (by means of watch hands) when small size and convenient portability are requirements. Analogue time indication has the advantage, over numeric time indication, that time reading errors are almost unknown whereas, with numeric indication, the smaller the indicated figures, the more likely are reading errors to occur as by mis-reading a figure 3 for a figure 8 or vice versa or

mis-reading a figure 7 for a figure 9. The possibilities of mis-reading the figures indicated by the numeric time display means of a small timepiece of the kind referred to make it particularly desirable to provide such a timepiece with an alarm which can be conveniently and easily set to sound off accurately at a desired set time and the present invention seeks to satisfy this requirement in a simple and reliable manner.

According to this invention an electronic timepiece comprises a time-standard pulse generator adapted to supply a time-standard pulse output of relatively high frequency; numeric time display means; a plurality of frequency dividers adapted to produce from said time-standard output a plurality of time signals suitable for operating said time display means; an alarm control circuit adapted to be set to operate an alarm at a desired predetermined time; memory means adapted to memorise said predetermined time; comparator means connected to compare the information in said frequency dividers with that in said memory means; and means, actuated automatically when the information fed to the comparator means from said frequency dividers and from said memory means is the same, for causing said alarm control circuit to operate the alarm, the means for setting said alarm control circuit to operate the alarm at said predetermined time being such as to enable the time memorised in said memory means to be adjusted.

Preferably the time-standard pulse generator includes a quartz oscillator.

Preferably an alarm device constituted by a buzzer or a miniature speaker is provided.

The numeric time display means may consist of a plurality of devices composed of liquid crystal or other light emitting elements.

A preferred form of timepiece in accordance with this invention comprises numeric time display means consisting of a plurality of numeric time display devices fed with operating signals from signal distributor circuits; logic gate circuits for transmitting to

said distributor circuits time signal information from the dividers or information from the memory means in dependence upon the position of externally operable switch means; and externally operable means for setting up in said memory circuits information corresponding with any desired time.

The divider circuits and/or memory circuits and/or comparator circuits and/or signal distributor circuits and/or logic gate circuits are preferably in the form of complementary MOS integrated circuits.

The invention is illustrated in the accompanying drawing, which is a simplified diagram showing the main parts of a small-sized electronic timepiece employing numeric display of the time and in accordance with the present invention. Referring to the drawing, the time-standard of the electronic timepiece therein represented is a pulse generator 1 which includes a time-standard oscillator of relatively high frequency (i.e. of the order of KHz or tens of KHz), for instance, a quartz oscillator or a suitable mechanical vibrator. The output from the pulse generator 1 is divided into signals of one-second period or of one-minute period by a suitable frequency divider 2. In the usual case of an accurate timepiece giving an indication of seconds, the divider 2 divides down the output of the generator 1 by whatever factor is necessary to provide signals at 1 second intervals from divider 2. These signals are further frequency divided by a chain of frequency dividers 3 to 8 to provide signals for operating the time display means. In the particular embodiment now being described, the dividers 3 to 8 divide down to $\frac{1}{10}$, $\frac{1}{6}$, $\frac{1}{10}$, $\frac{1}{6}$, $\frac{1}{10}$, and $\frac{1}{2}$ or $\frac{1}{3}$ respectively to provide signals suitable for operating numeric indicators for the ten and unit figures of the hours, minutes and seconds.

An externally accessible switch 30, when moved to the position shown (contact W) applies positive voltage to AND gates 33 causing them to open so that information is transmitted from the dividers 3 to 8 to OR gates 34 and thence to distributor circuits 35 to 40 controlling the numeric display devices 41 to 46. Thus, for example, if the information from the divider circuit 7 corresponds, at some particular time to the numeral 2, the distributor circuit 36 will supply to the display device 42 signals which energise all the elements in that device except the upper left-hand upright element and the lower right hand upright element (as viewed in the drawing) so that the device 42 displays the numeral 2 as shown by shading in the drawing. All the devices 41 to 46 are similar and each comprises seven elements. By selecting different combinations of elements in any device for simultaneous energisation (this is done by the

signal distributors 35 to 40 under control, as herein described, by the dividers 3 to 8) any device may be caused to display any numeral. This is illustrated by shading in the figure, the time shown as displayed being 12 hours, 39 minutes, 56 seconds. The display device elements may be of liquid crystal or other suitable light emitting elements.

When the switch 30 is on the contact W a positive potential is also applied to the inverter 31 which accordingly applies a negative potential to AND gates 32. As will be seen information stored in a series of memory circuits 9 to 14 is fed to the gates 32 which are followed by OR gates 34. When the switch 30 is moved over to the contact B, the AND gates 33 are closed, the AND gates 32 become conductive, and the information in the memory circuits 9 to 14 is indicated by the display devices 41 to 46. This shows the time when an alarm is sounded as will now be described. There are two ganged switches 27 and 28. In order to set the time when the alarm buzzer 23 is to sound, the switch 30 is first switched over to contact B and the information in the memory circuits 9 to 14 is displayed. The switches 27 and 28 are then closed, a switch 29 is left connected to the memory circuit 9, and a push button switch 26 is then closed. The arrangement is such that the information in the circuit 9 is increased by one each time the switch 26 is closed. In this way, by repeatedly closing the switch 26, the circuit 9 is set to the required tens of hours of the desired time. The switch 29 is then moved to its next contact (that connected to circuit 10) and, by repeated closure of the switch 26 circuit 10 is set to the required hour of the desired time. In similar manner, by moving switch 29 to the successive contacts connected to circuits 11 to 14 these may be set, in each case by operating switch 26, until the required time is set up in the circuits 9 to 14. When the time setting for operation of the alarm buzzer has been thus set up, switch 30 is returned to contact W.

A switch 25 is provided for enabling the information in the memory circuits 9 to 14 to be reset to zero. This can be done by closing switch 25 momentarily to apply an earth to the memory circuits 9 to 14 which may be divider circuits like the divider circuits 3 to 8. Information in the memory circuits 9 to 14 and the divider circuits 3 to 8 are correspondingly sent to comparator circuits 15 to 20 each of which produces an output signal only if the input thereof from the appropriate memory circuit corresponds with that from the appropriate divider circuit. The outputs from the comparator circuits 15 to 20 are fed to an AND gate 21 so that if, and only if, 130

all the comparator circuits are producing an output, an output pulse occurs from the AND gate 21. This triggers a driving circuit 22 for the buzzer 23, and the buzzer therefore sounds. The driving circuit 22 is arranged, in any convenient manner known per se, to cause the buzzer to sound for a predetermined time—e.g. a few tens of seconds—each time a triggering pulse comes from the AND gate 21. A switch 24 enables operation of the driving circuit 22 to be stopped. The switch 24 may be arranged to be turned to the "off" position automatically when setting the alarm. Instead of a buzzer 23, a miniature speaker or other alarm may be used. The driving circuit 22 could be an amplifier amplifying signals of a selected frequency obtained from the time-standard pulses (from 1) and supplying the amplified signals to the alarm means. If all or some of the circuits employed are, as is preferred, complementary MOS integrated circuits, the invention may be embodied in a quite small timepiece i.e. a timepiece small enough to be conveniently carried on the body or in the clothing as in ordinary use e.g. as a wrist watch.

As will now be seen the invention provides a small-sized electronic timepiece having a numeric time display and provided with an alarm the time of operation of which can be accurately set to a second and the set time of which can be frequently checked at any time because the numeric display means can be caused to indicate the information in the memory circuits when setting the alarm. The time piece is therefore very useful as a truly portable numeric timepiece, particularly as a numerically indicating alarm wrist watch or travelling clock.

WHAT WE CLAIM IS:—

1. An electronic timepiece comprising a time-standard pulse generator adapted to supply a time-standard pulse output of relatively high frequency; numeric time display means; a plurality of frequency dividers adapted to produce from said time-standard output a plurality of time signals suitable for operating said time display means; an alarm control circuit adapted to be set to operate an alarm at a desired predetermined time;

memory means adapted to memorise said predetermined time; comparator means connected to compare the information in said frequency dividers with that in said memory means; and means, actuated automatically when the information fed to the comparator means from said frequency dividers and from said memory means is the same, for causing said alarm control circuit to operate the alarm, the means for setting said alarm control circuit to operate the alarm at said predetermined time being such as to enable the time memorised in said memory means to be adjusted.

2. A timepiece as claimed in claim 1 wherein the time-standard pulse generator includes a quartz oscillator.

3. A timepiece as claimed in claim 1 or 2 and comprising an alarm device constituted by a buzzer or a miniature speaker.

4. A timepiece as claimed in any of claims 1 to 3 wherein the numeric time display means consists of a plurality of devices composed of liquid crystal or other light emitting elements.

5. A timepiece as claimed in any of the preceding claims and comprising numeric time display means consisting of a plurality of numeric time display devices fed with operating signals from signal distributor circuits; logic gate circuits for transmitting to said distributor circuits time signal information from the dividers or information from the memory means in dependence upon the position of externally operable switch means; and externally operable means for setting up in said memory means information corresponding with any desired time.

6. A timepiece as claimed in claim 1 and having divider circuits and/or memory circuits and/or comparator circuits and/or signal distributor circuits and/or logic gate circuits in the form of complementary MOS integrated circuits.

7. Electronic timepieces substantially as herein described and illustrated in the accompanying drawing.

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