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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, that is to say timepieces of the kind in which the output from a stable time-standard oscillator, such for example as a relatively high frequency crystal oscillator, is divided down in frequency to provide lower frequency signals which, after suitable signal processing, are employed to drive time display means. More specifically the invention relates to electronic timepieces in which a digital time display is given by electro-optical means, such as display means of the liquid crystal type or of the light-emitting diode type, time being displayed numerically by means of figures. The display may also include other features—for example legends indicating the day of the week and/or figures indicating the date.

It is, of course, necessary in an electronic timepiece to provide means whereby the display can be corrected e.g. if a timepiece is re-started after it has been, for any reason, stopped, it is necessary to be able to correct the time displayed after re-starting so that the correct time is shown. In a timepiece displaying time numerically in hours, minutes and seconds, it may be necessary to correct the hour part of the display and/or the minute part and/or the second part. If the display includes further parts, such as day of the week and/or date, one or more of these parts may sometimes need correction. These requirements can be met in known manner by providing a plurality of switches each of which is operative to enable a different part of the display to be corrected. This expedient, has, however, the serious defect that such a plurality of switches, with their actuating push-buttons (assuming push-button actuated switches are used) necessarily occupy a considerable amount of room so that this way of satisfying the requirement of provision of correction is not suitable in cases where the need for compactness and small size is paramount, as in the case of a wrist-watch. The present invention seeks to overcome this defect and to provide improved, very compact electronic timepieces, small enough to be satisfactory even as wrist-watches, having efficient, reliable and easily operated display correction means.

According to the invention an electronic timepiece having a display including a numeric display of time comprises a selecting switch for selecting for correction a desired part of the display, means for indicating the part so selected, and a correcting switch operable to produce correction of the selected displayed part.

The selecting switch may be arranged, on successive operations thereof, to select in turn and in a predetermined order, different parts of the display.

The means for indicating the part selected may comprise means for causing that part of the display thereof to flicker visibly. Indicating the part selected by causing the display thereof to flicker visibly has two important practical advantages namely:

1) the nature of the indication given appeals strongly to the eye, and

2) indication is given without having to provide any extra electrodes in the display arrangement for the purpose of providing such indication.

Preferably the selection switch, the indicating means and the correcting switch are normally inoperative and a further switch, operable at will, is provided rendering said selection switch, indicating means, and correcting switch operative.

The display may take any of a variety of forms known per se, e.g. it may be of the liquid crystal type or of the light emitting diode type.

The more extensive the nature of the dis-

play provided, the more marked are the advantages of compactness and smallness which the present invention provides and, as will be seen later, the invention enables a small compact wrist-watch, displaying not only time numerically, but also day of the week and date, and having provision for stop-watch use and time-alarm use, to be made.

The invention is illustrated in and further explained in connection with the accompanying drawings, in which:—

Figure 1 is a face view of one form of electronic wrist-watch embodying this invention;

Figure 2 is a simplified block diagram showing the general circuitry of one form of electronic wrist-watch in accordance with this invention;

Figure 3 is a circuit diagram showing, in some detail, control circuitry employed in block 12 of Figure 2, Figure 3*a* being a table showing signal relations in Figure 3; and

Figure 4 is a voltage/time wave form diagram explanatory of the operation of the control circuit block 12 of Figure 2 and of Figure 3.

Figure 1 shows a typical display as given by wrist-watch in accordance with this invention and having a liquid crystal display. As shown in Figure 1, the watch provides for display of the date in the month, the day and the time in hours, minutes and seconds. There are two push buttons SA and SS on the front of the watch-case. The button SA operates a correcting switch for correcting the display, and the button SS operates a selecting switch for selecting a figure desired to be corrected at any time. As will be seen later the button SS is operated to select the part of the display to be corrected (the part selected flickers, thus indicating that it has been selected for correction) and the button SA is operated to perform the actual correction of the selected figure, a correction pulse being produced each time the button SA is operated. The correction pulses are thus arbitrarily spaced and of no set frequency of repetition, their occurrence depending on the action of the watch user in operating button SA. A further button or "crown" is provided on the side of the watch-case and operates a safety switch SL. When the crown is pushed in, a safety circuit is actuated and prevents the other push buttons from being operative even if they are pushed in. In order that said other push buttons may be operative, the safety circuit must be released by pulling out the crown.

Referring now to Figures 2, blocks 1 to 6 inclusive represent a group of counters. Block 1 includes oscillating and dividing circuits which produce an accurate output 1-second signal from the said block by counting the oscillations of a stable high frequency oscillator such as a crystal oscillator "X" having a frequency of, for example, 16 384 Hz. Block 2 is a counter which provides, from the 1-second signal, a 1-minute signal output, i.e. it divides the output frequency from block 1 by 60. Block 3 divides the output from block 2 by 60 and thus provides a 1-hour signal. Block 4 divides the output from block 3 by 24 and thus provides a 1-day signal. Block 5 divides the day signal from block 4 by 31 and block 6 divides the day signal from block 4 by 7. The input terminals of blocks 2 to 6 are referenced "IN" in Figure 2 and the above-mentioned output terminals of blocks 1 to 5 are referenced "CLD".

Blocks 7, 8, 9, 10 and 11 constitute a group of decoders which transform BCD code signals from the foregoing group of counters into signals suitable for providing displays of seconds, minutes, hours, dates in the month and days respectively. "LS", "LM", "LH", "LD" and "LW" represent liquid crystal or other numeric display elements by means of which seconds, minutes, hours, dates in the month and days are displayed. As shown in Figure 2 the signals for producing these displays are fed to the appropriate numeric display elements through NAND gates each of which has one input fed from the appropriate decoder. The decoder terminals supplying these inputs are referenced DEC in Figure 2.

Block 12, the circuitry of which is shown in Figure 3 is a control circuit unit which includes output terminals "Sb", "Mb", "Hb", "Db", and "Wb" which are connected each with a remaining input terminal of the appropriate NAND gate. Normally the terminals "Sb", "Mb", "Hb", "Db" and "Wb" are in the high level state and, when they are in this state, the gates are open and the liquid crystal display elements are driven normally by the signals from the output terminal DEC of the appropriate decoder. Block 1 is arranged also to provide a relatively low frequency signal, for example of a frequency between 20Hz and several Hz to the control unit 12. SS represents a selector switch for selecting a displayed figure to be corrected—for example the minute figure. If, for example, of a frequency between 20Hz and several Hz to the control unit 12. S represents a selector switch for selecting a displayed figure to be corrected—for example the minute figure. If, for example, this switch is actuated to select the minute figure for correction, the display element "LM" which normally displays minutes steadily receives an input at the aforesaid low frequency appearing at the terminal "F". The minute figure therefore visibly flickers, thus indicating that is has been selected for correction, the flickering of the selected display element (assumed to be the minute display) being thus clearly differentiated from the parts of the displays which remain steady.

If, when the switch SS has been operated

the switch SA is operated, there is produced, each time the said switch SA is operated, a correction pulse which is used to correct the selected part of the display (second, minute, hour, day or date in the month). These correcting pulse signals are supplied from the appropriate output terminal Sa, Ma, Ha, Da or Wa respectively of the control circuit unit to the adjusting signal input terminal (these are referenced "ADJ" in Figure 2) of the appropriate divider 2, 3, 4, 5 or 6. Thus if, as above assumed, the minute figure is selected for correction, a correcting pulse signal is sent from terminal Ma to divider 3 each time switch SA is operated, this pulse having the effect of increasing the figure displayed by the selected part of the display by one digit. SL is the above-mentioned safety switch and unless it is actuated the control circuit unit 12 is inoperative and the display elements continue to produce displays in the normal manner without flickering.

Figure 3 shows the control circuit unit circuitry. Referring to Figure 3 "FF_1", "FF_2" and "FF_3" are D-type flip-flops, constituting a hexadic Johnson counter. In the normal condition, when the crown SL is still pushed in, a positive potential is applied to the re-set terminals R, the counter being so constituted that, in this condition, the gates "G_1" to "G_{10}" which are NAND gates, are closed, As will be seen, the gates for transmitting the correction signals and the gates for transmitting the flickering signals operate in pairs (G_1—G_2 : G_3—$_4$: G_5—G_6 . . . and so on) and the arrangement is such that only that part of the display which has been selected for correction will flicker, indicating that said part is ready for correction. When the gates G_1 to G_{10} are closed, even if the push buttons "SA" and "SS" are actuated, they are inoperative and nothing happens. Since "FF_1", "FF_2" and "FF_3" form a hexadic Johnson counter, the relations between the "Q" outputs of the "FF"s, a figure selecting signal "S_S" and a common input of NAND gate "G_1" through "G_{10}" are as shown in Table 1 (Figure 3*a*).

It is thought that the tabular Figure 3*a* is largely self explanatory, but the following description will assist in understanding it:—

S_S . . . 0: S_L is "high" or, if S_L is "low" S_S has not yet been operated. No correction is possible.

S_S . . . 1: S_L is "low" and S_S has been operated once in the sequence "low" "high" "low". The seconds display can be corrected by SA.

SS_S . . . 2: S_L is "low" and S_S has been operated a second time in the sequence "low" "high" "low". The minutes display can be corrected.

S_S . . . 3: S_L is "low" and S_S has been operated a third time in the sequence "low" "high" "low". The hours display can be corrected.

S_S . . . 4: S_L is "low" and S_S has been operated a fourth time in the aforesaid sequence. The date display can be corrected.

S_S . . . 5: S_L is "low" and S_S has been operated a fifth time in the aforesaid sequence. The day display can be corrected.

If the crown is pulled out, negative electric potential is applied to the reset terminals "R". If now the selecting push button "SS" corresponding to switch "SS" in Figure 2 is depressed and then released so that it goes through the sequence "low" "high" "low", the seconds display will flicker and can be corrected by operating SA, each operation increasing the seconds display by one digit. On pushing the push button "SS" a second time so that the aforesaid sequence again occurs the gates "G_9" and "G_{10}" are opened, the minute figure is selected for correction and will flicker and the minute display can be corrected. By subsequent operations of the button "SS" and switches "SA" and "SL" the hours, day and date in the month may in turn be selected for correction and the appropriate display corrected. When the display is correct the crown SL is pushed in again.

In the condition in which what may be termed the "lock" signal "S_L" becomes high level and the lock is released, the first sequence operation of S_S will cause the gate for the seconds figure to be opened and the low frequency signal "F" transmitted to S_b so that the seconds display flickers and can be corrected by operation of SA. When S_S is again operated a signal "F" is transmitted to M_b and the minutes display will flicker and can be corrected. After the third operation of S_S the signal "FF" is transmitted to H_b so that the hour figure display flickers . . . and so on for each part of the display in turn.

Briefly recapitulating the action, when the the lock signal S_L is "high" the counter stages FF_1, FF_2 and FF_3 are in reset condition, are not operable by the selecting switch S_S, there is no flickering and no correction can be made. When S_L becomes "low" FF_1, FF_2 and FF_3 become operable. If now S_S is operated to become in turn "low", "high" and "low" gates G_3 and G_4 open and the seconds display flickers and is ready for correction. Each operation of switch SA now increases the seconds display by one digit. After a further operation of S_S through "low", "high" and "low", the minute display flickers and is ready for similar correction by SA.

It will be observed that, in the timepiece above described, the individual displayed figures can be selected for correction and

their displays corrected, by successive operations of one and the same switch button without the need to provide, as has been common hitherto, a separate switch for selection of each figure to be corrected. This elimination of a multiplicity of switches and operating buttons therefore results in a much more compact timepiece, the improvement, in this respect, enabling the invention to be readily applied to a timepiece small enough to be designed as a wrist-watch, even though it may provide extensive displays—such as a display of the month and year as well as of the time, date and day, and/or include means enabling it to be used, when required, as a stop-watch or as a time alarm watch.

Figure 4, which it is thought will be found largely self-explanatory from the references thereon, typifies the voltage waves occurring at the terminals indicated by said references, against time, horizontally.

The described embodiment assumes a liquid crystal display with DC activation thereof. However the invention is not limited to this and various modifications are possible. For example the display may be of the light-emitting diode type instead of the liquid crystal type. If a liquid crystal display is used it is, despite the assumption of a DC drive in the described embodiment, desirable to use AC voltage for driving it, because a liquid crystal has a comparatively short life if driven by DC voltage. A suitable frequency for the AC drive is about 32Hz since owing to persistence of vision, the display will then appear steady, or nearly so, and will therefore not be objectionable to the viewer. Moreover such a frequency is readily obtainable from a frequency divider circuit already provided in the timepiece. A frequency of 8Hz, also easily obtainable, is a suitable frequency for producing flickering of the selected part of the display to be corrected.

WHAT WE CLAIM IS:—

1. An electronic timepiece having a display including a numeric display of time and comprising a selecting switch for selecting for correction a desired part of the display, means for indicating the part so selected, and a correcting switch operable to produce correction of the selected displayed part.

2. A timepiece as claimed in claim 1 wherein said selecting switch is arranged, on successive operations thereof, to select in turn and in a predetermined order, different parts of the display.

3. A timepiece as claimed in claim 1 or 2 wherein the means for indicating the part selected comprise means for causing that part of the display to flicker visibly.

4. A timepiece as claimed in any of the preceding claims wherein the selection switch, the indicating means and the correcting switch are normally inoperative and a further switch, operable at will, is provided rendering said selection switch, indicating means, and correcting switch operative.

5. A timepiece as claimed in any of the preceding claims 1 to 4 wherein the display is of the liquid crystal type.

6. A timepiece as claimed in any of the preceding claims 1 to 5 wherein the display is of the light emitting diode type.

7. An electronic watch as claimed in any of claims 1 to 6 and having a display and control button arrangement substantially as herein described with reference to the accompanying Figure 1.

8. Electronic timepieces having selection, selection indicating, and correcting means substantially as herein described with reference to Figures 2, 3 and 4 of the accompanying drawings.

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7. An electronic watch as claimed in any of claims 1 to 6 and having a display and control button arrangement substantially as herein described with reference to the accompanying Figure 1.

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