

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO ELECTRONIC TIMEPIECES AND DISPLAY MEANS THEREFOR

(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 wholly electronic time-standard oscillator, solid state frequency dividing circuitry driven by output oscillations from said oscillator, and non-mechanical electro-optical display means, such as liquid crystal or luminous diode display means, controlled by signals derived from the frequency dividing circuitry, for displaying the time. By "non-mechanical" is meant having no mechanically moving parts.

Time pieces of the kind referred to are well known. In them time is commonly displayed numerically in figures, two for the hour, two for the minute and two for the second. Display devices for the numeric display of figures are well known. Such a device usually comprises a 7-segment matrix electrode system having segments of such shape and disposition that, by selective energisation of different combinations of segments, any selected numeral from 0 to 9 can be displayed. By the use of such devices, the date, hour, minute and second can be displayed. However, such devices are not suitable for the display of the name of the day of the week either in Japanese or in English.

The main object of the present invention is to provide improved electronic timepieces of the kind referred to which, in addition to giving numeric displays of the time and, if required, of the date, displays the day of the week but are nevertheless relatively simple and cheap to construct, give clear displays, do not involve the

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provision of expensive additional decoders and matrices for day name display and retain the advantages of the kind of timepiece referred to, namely the advantages of having no mechanically moving parts, of being capable of being made compact and of relatively small size, and of being of good accuracy and reliability.

According to this invention an electronic timepiece of the kind referred to also includes, for displaying information of a predetermined set, a plurality of individual non-mechanical electro-optical display means each for displaying a respective one of the items of information forming said set, and means for selectively controlling said display means to cause the items of information to be successively displayed. The said set is, in the preferred case, that of the days of the week, there being then seven display means, each appropriate to a different day of the week.

The word "individual" as applied to the electro-optical display means, is herein employed to distinguish from display means of the segmental type, such as alphabetic or numeric display means in which selective energisation of different combinations of electrodes in a display device is resorted to in order to display, by that device any one of a plurality of different numerals or letters.

In one way of carrying out the invention each of the display means carries a legend indicative of the item of information to which it is appropriate and has an area adapted to exhibit a change of visual appearance in response to an applied electrical signal to display its item of information. For example the area adapted to do this may be a peripheral line, either uninterrupted or interrupted so as to exhibit a line of dots or straight lengths or arcs. In another way of carrying out the invention each of the display means carries

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a legend indicative of the item of information to which it is appropriate and has an electro-optical screen which, when energised, screens said legend from being seen by a viewer viewing the display device.

Preferably the display means are of the liquid crystal or of the light-emitting diode display type.

The invention is illustrated in the accompanying drawings, in which:—

Figure 1(a) is a simplified block diagram of a timepiece in accordance with this invention, the electro-optical display device of the timepiece being, however, not shown in Figure 1(a).

Figure 1(b) shows typical output driving waveforms for day name display and obtained at the output of amplifier 6 of Figure 1(a).

Figure 2 is a face view of one form of display device of a timepiece in accordance with this invention.

Figure 3 shows a simple form of circuit for driving a day name display unit in the device of Figure 4, and

Figure 4 is a face view, somewhat simplified, of a modified display device which may be used.

Figure 5 shows, in simplified sectional view, a preferred form of display means as used in the device of Figure 4.

Figure 1(a) is a simplified block circuit diagram of an electronic timepiece in accordance with the invention. In this Figure, 1 is a highly stable oscillator serving as the time standard of the timepiece and comprising a crystal vibrator or oscillator the output from which is fed to a frequency divider 2 which provides one second, one minute, one hour and one day output signals. The time signals from which indications of hours, minutes and seconds are to be obtained are fed to a decoder 3 which derives therefrom hour, minute and second display driving signals which, after amplification by an amplifier 4, are used to drive the hours (h), minutes (m) and seconds (s), display sections of a display device, the display face of which is represented in Figure 2, but which is not shown in Figure 1. This display device provides seven information displays, six of them being numerals (two for the hour, two for the minute and two for the second) and the seventh being for the day of the week. In Figure 2 the display represented is 10h.53m.42sec. on Friday.

The divider 2 also provides a 24-hour output signal and this is divided by a factor of 7, by a divider 5, such as a ring counter, so that in this way signals representative of the day of the week are obtained. The signals representative of the days of the week are shown in Figure 1(b)

these signals appearing, on the respective days indicated in Figure 1(b) at the output of an amplifier 6.

Referring again to Figure 2, the day indicators such as *r*, are rings in the middle of each of which is a previously printed legend indicative of the day of the week to which the ring in question relates. The day is indicated merely by causing the appropriate ring to alter its visual appearance so that the day of the week is clearly indicated without any need to use a complicated matrix, or a complicated decoder for driving the latter. The electro-optical transducing means used for the rings are of the liquid crystal or light-emitting diode type. In the former case the application of the appropriate electrical signal causes a change in the light diffusing and reflecting properties of the liquid crystal: in the latter case the application of the appropriate electrical signal causes the diode to emit light.

A modified day indicating display arrangement is represented in Figure 4 and a driving circuit therefor is represented in Figure 3. In Figure 4 the display is given on circular areas on which legends indicating the different days have been printed and over which are liquid crystal screens. Six of the seven screens are energised at any one time so that the day names under them are not visible, only a selected one of the screens (for Fridays in Figure 4) being unenergised on any particular day. This day is therefore indicated. In Figure 4 three of the screens are indicated by the reference S. The circuit of Figure 3 is a simple one. The 24-hour signal from divider 2 (Figure 1) is fed to the divide-by-seven divider 5 as in Figure 5 but a polarity inverter 7 is interposed between the divider 5 and the driving amplifier 6. In the particular arrangement represented by the circuit of Figure 3 the polarity inverter is interposed to ensure that the amplifier 6 will receive the correct polarity signal for producing de-energisation of the selected screen. The display arrangement represented in Figure 4 also has numeric time display means as in Figure 2 but, for ease of drawing, this is not shown in Figure 4.

Figure 5 is a sectional view showing one of the seven day-display means in Figure 4. The front, i.e. the side viewed by a viewer, is uppermost in Figure 5 and consists of a circular upper glass plate 11 on the underside of which is an electrode 12. Opposite the plate 11 is a lower glass plate 15 on the upper side of which is an electrode 14. Between the two plates 11, 15 and filling the separating space between the electrodes 12, 14 is a liquid crystal layer 13. Letters indicative of one day of

the week are printed at 16 on the lower side of the plate 15 and, from the point of view of the viewer, these letters are covered completely by the electrodes which are thin enough to be transparent. If however a suitable electric field is applied between the electrodes the liquid crystal is disturbed, and the letters showing the day are no longer visible from the front of the display device.

As will now be seen the invention provides electronic timepieces of the kind referred to which, in addition to giving electro-optical displays of the time, also give electro-optical displays of the day of the week but are nevertheless simple, relatively cheap to construct, give clear displays and do not involve the provision of expensive additional decoders and matrices for day-name display.

WHAT WE CLAIM IS:—

1. An electronic timepiece of the kind referred to and which also includes, for displaying information of a predetermined set, a plurality of individual (as herein defined) non-mechanical electro-optical display means each for displaying a respective one of the items of information forming said set and means for selectively controlling said display means to cause the items of information to be successively displayed.

2. A timepiece as claimed in claim 1 wherein the set is that of the days of the week and there are seven display means, each appropriate to a different day of the week.

3. A timepiece as claimed in claim 1 or

2 wherein the display means are of the liquid crystal or of the light-emitting diode type.

4. A timepiece as claimed in any of the preceding claims wherein the selective control of the display means is effected by signals derived by frequency division from the time standard oscillator provided in the timepiece.

4. A timepiece as claimed in any of claims 1 to 4 wherein each of the display means carries a legend indicative of the item of information to which it is appropriate and has an area adapted to exhibit a change of visual appearance in response to an applied electrical signal to display its item of information.

6. A timepiece as claimed in claim 5 wherein said area is that of a peripheral interrupted or uninterrupted line.

7. A timepiece as claimed in any of claims 1 to 4 wherein each of the display units carries a legend indicative of the item of information to which it is appropriate and has an electro-optical screen which, when energised, screens said legend being seen by a viewer viewing the display device.

8. Electronic timepieces of the kind referred to and having display apparatus substantially as herein described with reference to the accompanying drawings.

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