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PATENT SPECIFICATION

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(54) ELECTRONIC TIMEPIECE

(71) We, KABUSHIKI KAISHA DAINI SEIKOSHA a Japanese Company of 6-31-1 Kameido Koto-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.

In some conventional electronic timepieces, a liquid crystal display device is driven by an alternating current having frequency of 32 Hz. However, such a conventional electronic timepiece has a relatively large power consumption.

According to the present invention there is provided an electronic timepiece comprising: a time standard signal generating means for producing a time standard signal; a digital display device; a display driving means for driving the display device; and a time information signal generating means arranged to receive the time standard signal and to provide an output to the display driving means, the display device having a segmented electrode and a common electrode, said display driving means being arranged, in operation, to keep the common electrode and one or more segments of the segmented electrode at the same electric potential so that no display is produced thereby and to apply to the remaining segment or segments intermittent pairs of consecutive pulses of opposite polarity so that a display is produced thereby.

In the preferred embodiment the display device is a liquid crystal display device.

Preferably the driving means is also connected to receive a control signal having a frequency which is a fraction of the frequency of the time standard signal.

The driving means may include logic means for passing the time standard signal when and only when the control signal is at a predetermined level.

The invention is illustrated, merely by

way of example, in the accompanying drawings, in which:—

Figure 1 illustrates the principle of construction of a liquid crystal display device;

Figure 2 illustrates the wave-forms of driving signals conventionally applied to the liquid crystal display device of Figure 1;

Figure 3 is a circuit diagram of a driving circuit of an electronic timepiece according to the present invention; and

Figure 4 illustrates the wave-forms of signals occurring in the driving circuit of Figure 3.

Referring first to Figure 1, a liquid crystal digital display device generally comprises a common electrode 1, a segmented electrode 2, consisting of a plurality of segments, and liquid crystal material 3 between the electrodes 1, 2.

Figure 2 shows the wave-form of conventional driving signals applied to the liquid crystal display device of Figure 1. A voltage wave-form 4 is applied to the common electrode 1 and a voltage wave-form 5 is applied to selected segments of the segmented electrode 2 which segments are not required to produce the display—these segments will be referred to hereinafter as "non-operated segments". Voltage wave-form 6 is applied to the segments of the segmented electrode 2 which segments are required to produce a display—these segments will be referred to hereinafter as "operated segments". A voltage wave-form 7 occurs between the common electrode 1 and the non-operated segments of the segmented electrode 2 when the voltage wave-form 5 is applied to the segmented electrode 2. A voltage wave-form 8 occurs between the common electrode 1 and the operated segments when the voltage wave-form 6 is applied to the segmented electrode 2. As will be seen an alternating current voltage $\pm V$ is applied to the liquid crystal material when it is desired to produce a display.

Figure 3 shows one embodiment of a driving circuit of an electronic timepiece

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according to the present invention. An input terminal 10 has a signal applied thereto, the signal having a voltage wave-form 10a (Figure 4) which is similar to the voltage wave-form 4 of Figure 2. The signal applied to the input terminal 10 is derived from a timekeeping circuit (not shown) of the electronic timepiece. The signal applied to the input terminal 10' is inverted by an inverter 14 and is applied to one input of each of two exclusive OR gates 19, 20.

An intermittent ratio control signal is applied to input terminal 11 for determining an intermittent period ratio. The intermittent ratio control signal is applied to one input of each of two AND gates 17, 18.

Segment control signals are applied to input terminals 12, 13. The segment control signal applied to the input terminal 12 is fed to the other input of the AND gate 17. The segment control signal applied to the input terminal 13 is applied to the other input of the AND gate 18.

Further, the output of the AND gate 17 is applied to the other input of the exclusive OR gate 19 and the output of the AND gate 18 is applied to the other input of the exclusive OR gate 20. The driving circuit has output terminals 15, 16 connected to the segmented electrode 2 of the liquid crystal display device.

The operation of the driving circuit of Figure 3 will be described with reference to Figure 4. The voltage wave-form 10a represents the signal applied to the input terminal 10 and to the common electrode 1 of the liquid crystal display device. The voltage wave-form 11a represents the intermittent ratio control signal applied to the terminal 11 and has an intermittent period ratio of 1/2. That is to say, the intermittent ratio control signal has a frequency which is one half the frequency of the signal applied to the input terminal 10.

The outputs of the AND gates 17, 18 are indicated by voltage wave-forms 17a, 18a, in Figure 4 when the segment control signal applied to the input terminal 12 is at a relatively high level and when the segment control signal applied to the input terminal 13 is at a relatively low level as indicated by wave-forms 12a, 13a respectively.

Therefore, the outputs at the output terminals 15, 16 are as illustrated by voltage wave-forms 15a, 16a these outputs being applied to the segmented electrode 2. Therefore, the voltages applied between the common electrode 1 and the segmented electrode 2 of the liquid crystal display device are equal to the potential differences between the input terminal 10 and the

output terminals 15, 16 as indicated by wave-forms 10—15a, 10—16a respectively. An operating signal having the wave-form 10—15a, i.e. consisting of spaced apart or intermittent pairs of consecutive pulses of opposite polarity, is applied between the operated segments and the common electrode whereby a preferred intermittent drive of those segments is obtained. A signal having the wave-form 10—16a is applied between the non-operated segments and the common electrode.

The power loss due to the charge and discharge of a liquid crystal condenser constituted by the common electrode 1, the segmented electrode 2 and the liquid crystal material 3 is thus reduced by a factor equal to:

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Intermittent period ratio

by driving the liquid crystal display device intermittently. Thus the life of a battery driving an electronic timepiece is prolonged and so the battery has to be replaced less frequently. Moreover, the display produced by the liquid crystal display device is improved.

WHAT WE CLAIM IS:—

1. An electronic timepiece comprising: a time standard signal generating means for producing a time standard signal; digital display device; a display driving means for driving the display device; and a time information signal generating means arranged to receive the time standard signal and to provide an output to the display driving means, the display device having a segmented electrode and a common electrode, said display driving means being arranged, in operation, to keep the common electrode and one or more segments of the segmented electrode at the same electric potential so that no display is produced thereby and to apply to the remaining segment or segments intermittent pairs of consecutive pulses of opposite polarity so that a display is produced thereby.

2. An electronic timepiece as claimed in claim 1 in which the display device is a liquid crystal display device.

3. An electronic timepiece as claimed in claim 1 or 2 in which the driving means is also connected to receive a control signal having a frequency which is a fraction of the frequency of the time standard signal.

4. A electronic timepiece as claimed in claim 3 in which the driving means includes logic means for passing the time standard



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according to the present invention. An input terminal 10 has a signal applied thereto, the signal having a voltage wave-form 10a (Figure 4) which is similar to the voltage wave-form 4 of Figure 2. The signal applied to the input terminal 10 is derived from a timekeeping circuit (not shown) of the electronic timepiece. The signal applied to the input terminal 10 is inverted by an inverter 14 and is applied to one input of each of two exclusive OR gates 19, 20.

An intermittent ratio control signal is applied to input terminal 11 for determining an intermittent period ratio. The intermittent ratio control signal is applied to one input of each of two AND gates 17, 18.

Segment control signals are applied to input terminals 12, 13. The segment control signal applied to the input terminal 12 is fed to the other input of the AND gate 17. The segment control signal applied to the input terminal 13 is applied to the other input of the AND gate 18.

Further, the output of the AND gate 17 is applied to the other input of the exclusive OR gate 19 and the output of the AND gate 18 is applied to the other input of the exclusive OR gate 20. The driving circuit has output terminals 15, 16 connected to the segmented electrode 2 of the liquid crystal display device.

The operation of the driving circuit of Figure 3 will be described with reference to Figure 4. The voltage wave-form 10a represents the signal applied to the input terminal 10 and to the common electrode 1 of the liquid crystal display device. The voltage wave-form 11a represents the intermittent ratio control signal applied to the terminal 11 and has an intermittent period ratio of 1/2. That is to say, the intermittent ratio control signal has a frequency which is one half the frequency of the signal applied to the input terminal 10.

The outputs of the AND gates 17, 18 are indicated by voltage wave-forms 17a, 18a, in Figure 4 when the segment control signal applied to the input terminal 12 is at a relatively high level and when the segment control signal applied to the input terminal 13 is at a relatively low level as indicated by wave-forms 12a, 13a respectively.

Therefore, the outputs at the output terminals 15, 16 are as illustrated by voltage wave-forms 15a, 16a these outputs being applied to the segmented electrode 2. Therefore, the voltages applied between the common electrode 1 and the segmented electrode 2 of the liquid crystal display device are equal to the potential differences between the input terminal 10 and the

output terminals 15, 16 as indicated by wave-forms 10—15a, 10—16a respectively. An operating signal having the wave-form 10—15a, i.e. consisting of spaced apart or intermittent pairs of consecutive pulses of opposite polarity, is applied between the operated segments and the common electrode whereby a preferred intermittent drive of those segments is obtained. A signal having the wave-form 10—16a is applied between the non-operated segments and the common electrode.

The power loss due to the charge and discharge of a liquid crystal condenser constituted by the common electrode 1, the segmented electrode 2 and the liquid crystal material 3 is thus reduced by a factor equal to:

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Intermittent period ratio

by driving the liquid crystal display device intermittently. Thus the life of a battery driving an electronic timepiece is prolonged and so the battery has to be replaced less frequently. Moreover, the display produced by the liquid crystal display device is improved.

WHAT WE CLAIM IS:—

1. An electronic timepiece comprising: a time standard signal generating means for producing a time standard signal; digital display device; a display driving means for driving the display device; and a time information signal generating means arranged to receive the time standard signal and to provide an output to the display driving means, the display device having a segmented electrode and a common electrode, said display driving means being arranged, in operation, to keep the common electrode and one or more segments of the segmented electrode at the same electric potential so that no display is produced thereby and to apply to the remaining segment or segments intermittent pairs of consecutive pulses of opposite polarity so that a display is produced thereby.
2. An electronic timepiece as claimed in claim 1 in which the display device is a liquid crystal display device.
3. An electronic timepiece as claimed in claim 1 or 2 in which the driving means is also connected to receive a control signal having a frequency which is a fraction of the frequency of the time standard signal.
4. A electronic timepiece as claimed in claim 3 in which the driving means includes logic means for passing the time standard



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signal when and only when the control signal is at a predetermined level.

5. An electronic timepiece substantially as herein described with reference to and as shown in Figures 3 and 4 of the accompanying drawings.

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