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Luce

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[54] **DIGITAL ELECTRONIC TIMEPIECE**

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[52] **U.S. Cl.** ..... **58/50 R,** 58/23 R

[51] **Int. Cl.** **G04c 3/00**

[58] **Field of Search** ... 58/50 R, 23 R, 23 A, 23 AC, 58/23 BA, 23 C, 23 D

[56] **References Cited**

UNITED STATES PATENTS

3,576,099	4/1971	Walton	58/23 R
3,630,015	12/1971	Lehovec	58/50 R
3,664,118	5/1972	Walton	58/50 R
3,701,249	10/1972	Bergey et al.	58/50 R
3,802,182	4/1974	Fujita	58/50 R

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[57] **ABSTRACT**

In a digital electronic wrist watch employing a liquid crystal display cell for indicating the time, there is included indicia which flashes once per second so as to allow the counting of seconds and to indicate operation of the display.

11 Claims, 3 Drawing Figures

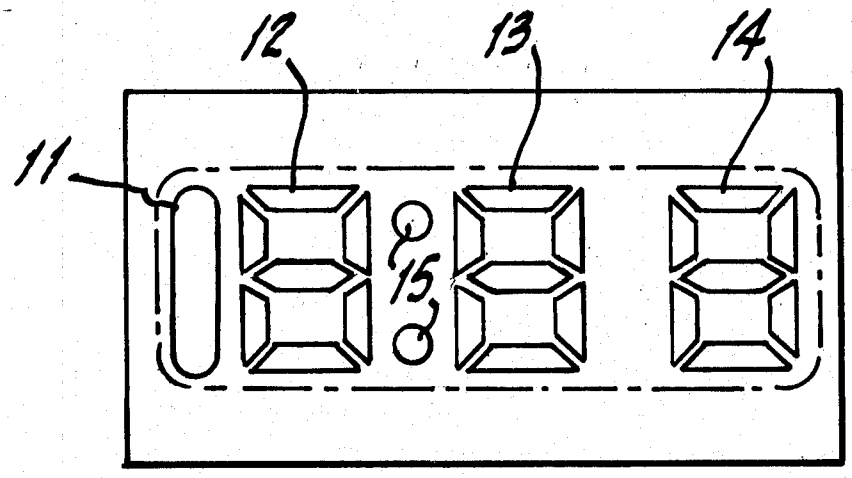
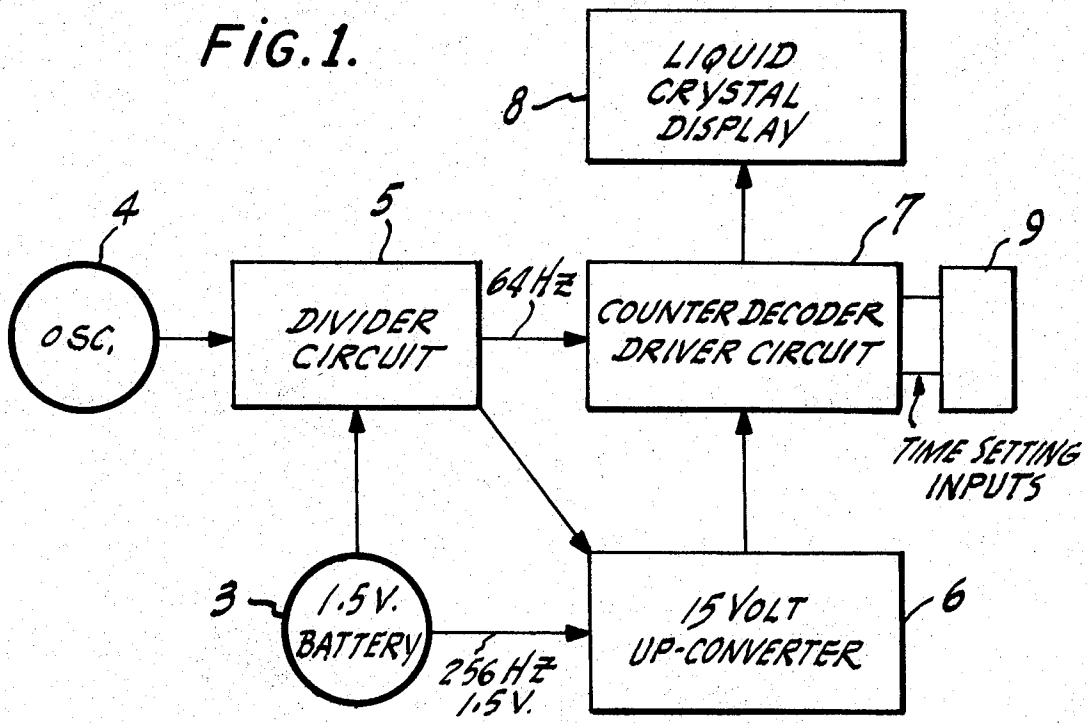


FIG. 1.


LIQUID CRYSTAL DISPLAY
8
4
5
7
9
OSC.
DIVIDER CIRCUIT
64 Hz
COUNTER DECODER DRIVER CIRCUIT
TIME SETTING INPUTS
3
1.5 V. BATTERY
256 Hz 1.5 V.
15 VOLT UP-CONVERTER
6

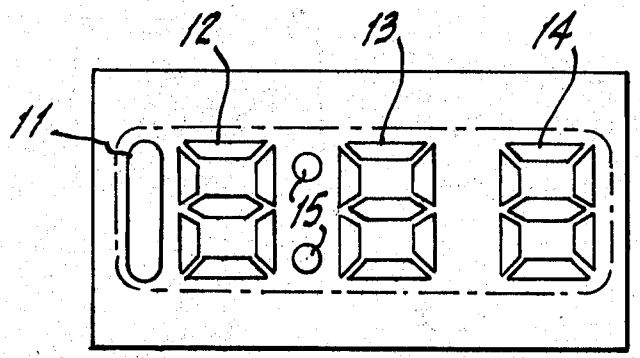

12
13
14
11
15

FIG. 2.

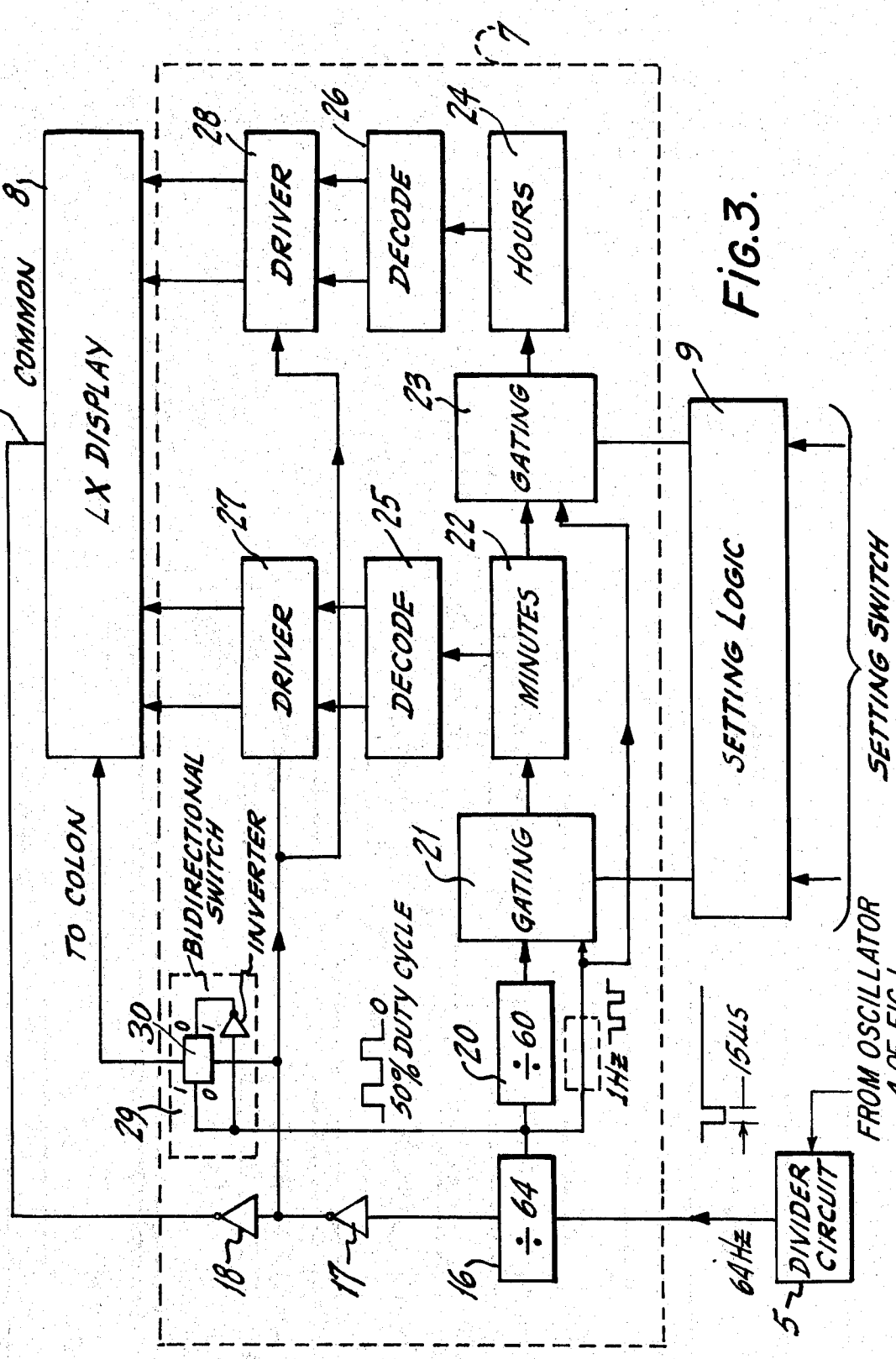

7
8
4 DIGIT DISPLAY
COMMON
19
DRIVER
28
DECODE
26
HOURS
24
GATING
23
9
SETTING LOGIC
SETTING SWITCH
FROM OSCILLATOR 4 OF FIG. 1
DRIVER
27
DECODE
25
MINUTES
22
GATING
21
÷60
20
1Hz
50% DUTY CYCLE
15US
÷64
16
64Hz
DIVIDER CIRCUIT
5
TO COLON
BIDIRECTIONAL SWITCH
INVERTER
30
29
18
17

FIG. 3.

DIGITAL ELECTRONIC TIMEPIECE

BACKGROUND OF THE INVENTION

This invention relates to an electronic timepiece and more particularly to an electronic wrist watch employing a liquid crystal display for indicating the time and which includes flashing indicia for counting seconds and indicating operation of the timepiece.

The digital electronic wrist watch is a new development made possible by recent technological advances. The movements of mechanical timepieces, though steadily improved and miniaturized over the centuries, still have the disadvantage of wear of moving parts associated therewith. This disadvantage is eliminated in an all-electronic wrist watch with no moving parts other than possibly a mechanical time setting switch used only when changing time zones or standards or replacing the power supply of the watch since other resetting will generally be unnecessary.

The main components of an electronic liquid crystal watch are a liquid crystal display cell, a power supply, typically a 1.5 volt miniaturized battery as is presently commerically available, a crystal oscillator for timekeeping, divider circuits for dividing the primary output frequency of the crystal oscillator, counter decoder and driver circuits for accumulating the minutes and hours and driving the liquid crystal display cell and an up-converter for transforming the 1.5 volts supplied by the power supply to, typically about 15 volts required for the counter, decoder and driver circuits and the liquid crystal display.

The advert of digital electronic wrist watches, such as the liquid crystal watch, offers improvements in accuracy, reliability and ease of reading time as compared with commonly available wrist watches. It's unavailability heretofore is due to the stringent demands upon combining a liquid crystal display and the required electronics into a single small package, available at reasonably low cost, and utilizing high efficiency electronics which do not require excessive power. In order to achieve this, it is important that the power requirements and size of each part of the electronics be minimized. If the digital display included separate digits for indicating seconds as well as minutes and hours, either the individual digit would have to be made smaller and hence less easily readable or the display size would have to be enlarged which is also undesirable. In addition, a greater number of circuit components would be required for decoding and driving of these digits. This would increase the cost of the display and the display would require additional power.

I have invented a simple means for counting the passage of seconds which simultaneously acts as an indicator for indicating that the timepiece is functioning. The novel second indicator does not require extra digits and hence can be included at practically no extra cost.

SUMMARY OF THE INVENTION

In an electronic digital timepiece comprising in combination, an electro-optical display cell, a power supply, a frequency source, and timekeeping and driver circuits, the improvement comprising means for causing indicia of the display cell to be pulsed at a rate of 1 Hertz so as to enable one to count seconds by counting the number of flashes or pulses of the indicia and to enable one to tell, with just a quick glance, that the timepiece is operating.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of the component parts of a liquid crystal watch;

FIG. **2** is a plan view of the face of a digital electronic watch; and

FIG. **3** is a more detailed block diagram of the counter portion of the counter decoder driver circuit of FIG. **1** including circuit means to cause indicia to flash at a rate of once per second.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. **1** there is shown a block diagram of the component parts of an electronic liquid crystal watch. These parts comprise: a power supply **3,** typically a compact type **1.5** volt battery; an oscillator **4,** and divider circuit means **5** driven by the battery **3** for dividing the resonant frequency of the oscillator **4**; voltage upconverter means **6** coupled to an output of the divider circuit **5** and to the battery **3** for increasing the voltage — typically from 1.5 Volts to 15 Volts; counter, decoder and driver circuit means **7,** the input of which is coupled to an output of the divider circuit means **5** and to the output of the upconverter means **6,** for timekeeping functions and for driving a liquid crystal display cell **8** which is coupled to the output of the driver circuit. Also included is time setting means **9** which provides an additional input to the counter, decoder, driver circuit means **7** for resetting indicated time when necessary.

A typical useful oscillator **4** is a quartz crystal oscillator having a 32,768 Hertz oscillator frequency. This frequency is divided down by the divider circuit **5** which may be a multi-stage, ripple carry binary counter. The outputs of the divider **5,** in the preferred embodiment, are 15 microsecond pulses at frequencies of 256 Hertz and 64 Hertz. The 256 Hertz pulses are utilized by the voltage upconverter **6** and may be driven by a low impedance C/MOS inverter. The 64 Hertz pulses output of the divider **5** is typically supplied to the counter decoder driver circuit **7** through an uncommitted P channel device connected to a resistive type load in the counter decoder driver circuit **7.** The upconverter transforms this 64 Hertz, 1.5 volt pulse to a 15 volt pulse for driving the first stage of the counter. The 64 Hertz pulse divided by 64 provides a 1 Hertz input to the flashing indicia of the display **8.** Preferably, a single integrated circuit chip contains the frequency divider circuits, the counters for time keeping, logic circuits for time setting and decoder driver circuits for driving the liquid crystal display.

The liquid crystal display **8** is preferably driven by a bi-directional current. Techniques useful for driving the display include A.C. switching and phasing and bi-directional switching directly from the decoder.

The liquid crystal display cell **8** is typically a multi-character segmented numeric digit display cell having at least four characters. The face of the cell **8** is shown in FIG. **2** and comprises four characters, two for indicating hours **11** and **12** and two for indicating minutes **13** and **14,** and includes indices, such as a colon **15,** between the hour digits **11** and **12** and the minute digits **13** and **14.** The first hour digit **11** need only portray the numeral one, 1, if a 12 hour cycle is used, or where a 24 hour cycle is used it need only portray a 1 or a 2.

The liquid crystal cell, as is well known in the art, typically comprises a hermetically sealed package consist-

ing of a liquid crystal composition between two electrodes, one electrode being a common electrode for all display characters and one electrode being segmented as shown in FIG. **2.** As an alternative, the display cell could be in the form of a usual watch face with digits or indicia around the periphery and a multiplicity of hour and minute arms selectively activated and extending radially from the central portion of the display cell. In addition, the display may also include indicia for indicating the date.

The voltage upconverter **6** is preferably a high Q, low voltage saturation, inductive charging type of device which can be made in the form of a monolithic integrated circuit chip which uses less than 5 μ watts of power per year under continuous operation. The high Q of the up-converter acts to minimize losses and increases efficiency, and the low saturation voltage characteristic acts to give a fast switching, low voltage input requirement circuit.

A feature of the novel digital watch is the fact that the colon **15** flashes at the rate of once per second allowing one to count seconds by counting flashes and readily indicating operation of the watch. It should be understood that while flashing the colon is preferred, the invention includes flashing of any indicia at the 1 Hertz rate. For example, one may flash the date at this rate or one may cause the hour and/or minute digits to flash at a 1 Hertz rate instead of or together with other indicia. Flashing of the date and not other numbers where date characters are included has the further advantage of making the date readily discernable. Where the watch is a 12 hour cycle watch and also contains date numerals, it is important to know for time-setting purposes whether the hours are A.M. or P.M. so that the date will change at the correct interval. The flashing indicia can also serve as an A.M./P.M. indicator by, for example, flashing one half of the colon **15** for the first 12 hours or the A.M. interval and flashing the other half of the colon **15** for the second 12 hours or the P.M. interval.

In FIG. **3** there is shown a block diagram of the counter, decoder driver circuit **7** which is coupled to the liquid crystal display cell and time setting means **9.** The input to this circuit is the 64 Hertz, 15 μ sec. pulse output from the divider circuit **5.** In order to obtain an output frequency of 64 Hertz from the divider **5,** one must divide the output frequency of the crystal oscillator, which, for example, may be selected to oscillate at 32,768 Hertz. In this example, the oscillator frequency is divided by 512, which is a binary number. Therefore, the dividing chain in divider module **5** can consist of a conventional binary counter comprising a plurality of cascaded bistable multivibrators. Such counting stages exist in the form of monolithic integrated circuits or as MOS devices and are readily available.

The 64 Hertz output of the divider **5** is applied to another divider **16** in the counter block **7.** The divider **16** divides the 64 Hz. signal by a factor of **64** to obtain a 1 Hz. output signal. Where the divider **16** is a series of six flip-flops, the 1 Hz. output will have a 50% duty cycle. This of course is indicative of seconds and can be utilized in conjunction with additional circuitry to perform timekeeping. A 32 Hz. signal is also provided in divider **16** and is applied via inverters **17** and **18** to a common terminal **19** of the segmented liquid crystal display **8.** Liquid crystals and their operation in electro-optical devices are known and need not be further discussed here. Such devices are available from Optel Corporation, Princeton, N.J., the assignee herein.

The one cycle output from the divider **16** is applied to still another divider **20** which performs a division by 60 to obtain at the output thereof a pulse train having a repetition rate of 1/60 sec. The 1 Hz. signal is applied to a gating circuit **21** which receives both the 1 Hz. signal and the 1/60 Hz. signal to provide at an output a signal indicative of minutes. This signal is applied to a minutes counter **22** which advances its count by one for each pulse applied via gating circuit **21.** The output of the minutes counter **22** is applied to a gating circuit **23** which also receives the 1 Hz. signal. The gating circuit **23** produces a pulse for every 60 pulses accumulated by the minutes counter **22.** This output pulse is synchronous to the 1 Hz. signal. Consequently, the output of the gating circuit **23** consists of one pulse per hour which is applied to an hours counter **24.** Both the minute counter **22** and the hours counter **24** are digital devices and operate according to a binary or binary coded decimal format which must be decoded to provide compatibility with normal time indications.

The block diagram shows a first and second decoder **25** and **26** associated respectively with the minutes counter **22** and the hours counter **24.** The outputs of these decoders are applied to respective driver circuits **27** and **28** which in turn are coupled to the segmented electrodes **11–14** of the liquid crystal display cell **8.**

The 1 Hz. pulse applied to the minute and hours gates **21** and **23** is preferably changed from a 50% duty cycle pulse to a small duty cycle, thereby giving a narrow pulse for the purposes of resetting the display. The setting logic circuitry **9** is used to set the timepiece for different times or for initial adjustment. The setting logic **9** operates by applying higher frequency pulses to the minute and hours gates **21** and **23** in order to set the timepiece in a relatively short time.

A feature of the novel timepiece is the inclusion of circuit means **29** for flashing indicia of the display cell **8** at the rate of 1 Hz., preferably with a 50% duty cycle. This can be accomplished by coupling the 1 Hz. pulse output of divider **16** to the indicia to be flashed via a bidirectional switching means **29.** FIG. **3** indicates the circuit for flashing of the colon **15** of the liquid crystal display cell **8** at the rate of 1 Hz. Here, the 1 Hz. output from the divider **16** is applied through bidirectional switching means **29** to the colon segments **15** of the liquid crystal display cell **8.** The bidirectional switching means **29** shown consists of a bidirectional switch **30** such as a symmetrical complimentary p-channel and n-channel device and an inverter **31** coupled across one device. The 1 Hz. input pulse to the switch represents an **0** and a **1** depending upon the portion of the pulse applied to the switch during any given time interval. The switch transmits a signal pulse to activate the colon **15** only when the switch **30** is conducting such as when the pulse to the p-channel device is in the 1 configuration and the pulse to the n-channel device is 0. Therefore, the colon is in the "on" state every other ½ second and hence flashes at the rate of once per second with a 50% duty cycle. It is understood that the choice of 0 and 1 is arbitrary and other bidirectional switching means can be employed. If one wished the whole display to flash at a 1 Hz. rate, the output of the bidirectional switching means could be coupled directly to the common electrode **19** of the display cell **8.**

Additionally, similar timesharing circuits are required where the display includes digital indicia for indicating the date. Where such indicia are present, the date can be flashed by coupling the output of the bidirectional switch **30** to the output of the driver circuit for such date indicia.

Where one desires the colon to act as an A.M./P.M. indicator as well by flashing respective halves of the colon for each 12 hour cycle, 12 hour timekeeping circuits would be required for each half of the colon and the output of the bidirectional switch **30** would be serially coupled to the driver circuit output of each half of the colon such that only the half of the colon being driven by the driver circuit at any particular time would flash.

What is claimed is:

1. In an electronic digital timepiece comprising in combination, an electro-optical display, display driver circuit means including, a power supply, a frequency source adapted to provide a frequency waveform of a relatively high frequency coupled to said power supply, timekeeping means coupled to said frequency source and a driver circuit coupled to said timekeeping means for driving the display so as to indicate the time in digital format, the improvement comprising means coupled to said frequency source for translating said waveform to a 1 Hz signal, a bidirectional switching circuit means the input of which is responsive to said 1 Hz signal and the output of which is coupled to a preselected indicia of said display for causing said preselected indicia of said display to be continuously pulsed at the rate of once per second in accordance with said lower frequency to provide a visual means to a user of said timepiece indicating the passage of one second.

2. In the electronic timepiece recited in claim **1,** wherein said display comprises indicia for the hours, indicia for the minutes, indicia in the form of a colon therebetween, the improvement comprising means for flashing at least part of said colon at the rate of 1 Hertz.

3. In the electronic timepiece recited in claim **1,** wherein said electro-optical display is a liquid crystal display.

4. In the electronic timepiece recited in claim **2,** wherein said display is a liquid crystal display.

5. In the electronic timepiece recited in claim **1,** wherein said means causes the whole colon to flash at a 1 Hertz rate.

6. In the electronic timepiece recited in claim **2,** wherein said means for flashing said colon at said 1 Hertz rate has a 50% duty cycle.

7. In the electronic timepiece recited in claim **2,** wherein said display indicates time on a 12 hour base and wherein said colon flashing means causes alternate portions of said colon to flash each 12 hour interval.

8. In the electronic timepiece recited in claim **1,** wherein said display includes indicia for the hours, indicia for the minutes and indicia for the date and wherein said means for pulsing display indicia causes said date indicia to be pulsed at a 1 Hertz rate.

9. In the electronic timepiece recited in claim **1,** wherein said display includes indicia for hours and indicia for minutes and wherein said timepiece includes means for flashing said hours indicia and minutes indicia at a 1 Hertz rate, each flash indicating the passage of one second.

10. In a digital electronic watch comprising an electro-optical display cell having indicia thereon, a power supply for supplying energy for operation of said display cell and accompanying circuits, a frequency source capable of providing a predetermined output waveform of a given frequency coupled to said power supply, frequency divider circuit means coupled to the output of said frequency source for generating lower frequencies, as compared to said given frequency, timekeeping circuit means coupled to the output of said divider means and display driver circuit means the input of which is coupled to said timekeeping means and the output of which is coupled to said display cell, the improvement comprising means responsive to one of said lower frequencies for providing at an output thereof a frequency of one cycle per second, bidirectional switching means including a bidirectional switch and an inverter coupled across an element of said switch, said switching means responsive to said one cycle per second signal to provide at an output of said bidirectional switching means a control signal in accordance with said one cycle per second rate and means coupling the output of said switching means to selected indicia of said display cell for pulsing said selected indicia at a rate determined by said one cycle per second signal.

11. In the digital electronic watch recited in claim **10,** wherein said display cell contains electrode patterns for forming hours indicia, minutes indicia and a colon therebetween, said output of said bidirectional switch being applied directly to at least one electrode for forming said colon.

* * * * *