

PATENT SPECIFICATION

(11) 1 536 982

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- (21) Application No. 11384/77 (22) Filed 17 March 1977
(31) Convention Application No. 51/030432
(32) Filed 19 March 1976 in
(33) Japan (JP)
(44) Complete Specification published 29 Dec. 1978
(51) INT CL² G04C 23/00//3/00 21/12
(52) Index at acceptance
G3T 604 608 609 611 S1



(54) IMPROVEMENTS IN OR RELATING TO ELECTRONIC ALARM TIMEPIECES

(71) We, KABUSHIKI KAISHA DAINI SEIKOSHA, a Japanese company, of 31-1, 6-chome, 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 alarm timepieces and more specifically to electronic timepieces of the kind which will give an alarm at a pre-set time and which are of the analogue type as regards their display of time, that is to say which display time by means of hands as distinct from timepieces which display time digitally, i.e. by means of displayed numerals. For the sake of brevity electronic timepieces of this kind will be herein termed "electronic analogue time display alarm timepieces".

Various different forms of alarm systems have been proposed for electronic analogue time display alarm timepieces but conventional general practice in such timepieces is to provide an extra, manually adjustable, hand, which may be termed the alarm setting hand, by means of which an alarm time can be set and which also serves, of course, to indicate on the dial of the timepiece an alarm time which has been set. This practice has, however, a disadvantage which is very serious for many purposes, the said disadvantage being that it is difficult almost to the point of practical impossibility to set the alarm to go off at a particular desired time with the time accuracy which is often desired—for example at 12^h 00^m 00^s.

The present invention seeks to overcome this disadvantage and to provide an analogue time display alarm timepiece which can be easily set to sound the alarm at any of a series of closely spaced times, e.g. times spaced apart by time intervals of 2 to 5 minutes, or even closer intervals, with the knowledge that the alarm will in fact, go off accurately at the chosen time.

Other objects of the invention are to

provide improved electronic time display alarm devices in which the alarm time can be easily and conveniently set by the user; in which synchronisation of the alarm means with the time measuring means is easily achieved; in which time correction is easily effectable, in which the alarm time set is clearly displayed with the required precision; in which provision is made for checking, at any time, that the alarm timepiece is in proper working order; in which alarm time setting, time correction and synchronisation of the alarm means with the time measuring means can be easily effected by manipulation of a single stem; in which the necessary mechanical parts are simple, reliable and compact; and in which the electrical circuitry is such as to lend itself to embodiment in a single chip monolithic integrated structure so that an alarm timepiece in accordance with the invention can be made small enough to be satisfactory as a wrist watch and be relatively inexpensively manufactured by mass production methods.

According to this invention there is provided an electronic analogue time display alarm timepiece having digital display means for displaying set alarm times.

Preferably the set alarm times are displayed by numerals appearing behind a window in the dial of the timepiece.

The set alarm times may be displayed by hour indicating numerals at 1-hour intervals and minute indicating numerals at intervals of a selected number of minutes. Preferably these intervals are selected in the range between 2 and 5 minutes.

Preferably also there is provided a pull out stem which, upon rotation when in one position, corrects the analogue display of time and; upon rotation when in the other position, changes the alarm time set.

The alarm time setting means may include a rotatable hour setting numeral bearing wheel and a rotatable minute setting numeral bearing wheel, each of said wheels, upon rotation, actuating signal

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generating means for generating a number of signals representative of the extent of rotation thereof.

The timepiece may include a time standard oscillator of relatively high frequency, a divider circuit for dividing the output of said oscillator to a predetermined lower frequency, time indicating hands moving over a dial, means for utilising said lower frequency to drive said hands, a time counting system including hour and minute counters and to which said lower frequency is fed, an alarm time counting system for memorising an alarm set time, a signal number counting circuit including a shift register for providing output to the alarm time counting system, means for taking output from an intermediate stage of said dividing circuit and feeding the same as clock pulses to said shift register, means actuated when setting an alarm time for re-setting said dividing circuit and the two counting systems, a coincidence detector for detecting coincidence between the contents of the two counting systems, and an alarm actuated by output from said detector for actuating said alarm when coincidence occurs. Preferably the circuitry of at least said oscillator, said frequency dividing circuit, the two counting systems, the signal number counting circuit and the coincidence detector is embodied in a monolithic integrated circuit structure.

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

Figure 1(a) shows the dial of one form of timepiece embodying this invention;

Figure 1(b) is a schematic diagram explanatory of the way in which an alarm time is set;

Figure 1(c) is a simplified cross sectional view of one form of setting mechanism used for setting the alarm time in a timepiece embodying the invention;

Figure 2 is a circuit diagram of one form of electronic timepiece embodying the invention; and

Figure 3 is a circuit diagram showing another embodiment of this invention.

Referring first to Figure 1(a), this shows a dial marked out in a 12-hour clock face over which move an hour hand H, a minute hand M and a second hand S. The timepiece is drawn in Figure 1(a) as displaying the time of 9^h 8^m. In the dial is an aperture or window W behind which a pre-set alarm time is displayed digitally—as drawn the alarm time of 9^h 10^m is displayed. This display can be set manually by means of the stem (not shown) of the timepiece, as will now be described.

Assume that the time is a few minutes before 9^h 10^m and that the user has available a source of time signal

information, such as a radio receiver or a telephone. The user of the timepiece rotates the stem ST thereof in the direction of the arrow A until the numeral 9, indicating 9 hours, appears in the window W. The user then rotates the stem in the opposite direction B until "10" appears in the window. He then pulls out the stem to an outer position (the stem has two positions either of which can be chosen by pulling it out or pushing it in) and in this position it can be rotated to adjust the time hands. A convenient arrangement is one in which the timepiece is stopped when the stem is pulled out to its outer position in which position rotation of the stem in one direction moves the hour hand and rotation in the opposite direction moves the minute hand. If, therefore, having set 9^h 10^m in the window W, the user pulls the stem into its outer position when the second hand indicates 00 secs, he can then set the hour hand at 9 and the minute hand at 10, while the timepiece is stopped. If he then pushes in the stem at the exact time he hears a time signal at 9^h 10^m, the timepiece will restart having been time-corrected and synchronisation between the alarm means and the time measuring means will have been achieved. Any alarm time can now be set in the window by rotating the stem without pulling it out, and the alarm will go off when the timepiece reaches the time set.

Suppose, for example, having time corrected the timepiece and synchronised the alarm means therewith (as just described), the user wishes to set the alarm to go off at 23^h 40^m. Without pulling out the stem, he rotates it in the direction of arrow A until 23 appears on the left in the window and then in the direction of arrow B until 40 appears on the right in the window. The alarm time shown in the window is now 23^h 40^m (see the right hand part of Figure 1(b)) instead of the previously set time of 9^h 10^m (see the left hand part of Figure 1(b)) and, assuming the timepiece is still correct, the alarm will sound at 23^h 40^m precisely.

As will be explained later, provision is made for ensuring that the contents of the time counters used for time counting in the timepiece and the contents of the memory counters used in the timepiece in connection with the alarm means are such that when the contents of the said time counters and memory counters will coincide at the pre-set alarm time and cause the alarm to sound.

Any means known per se may be provided for disabling the alarm means to prevent its sounding when a set time is reached and for stopping it after it has begun to sound.

Referring now to the alarm setting mechanism represented in Figure 1(c), the

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window W in the dial has, in its side wall, recesses in which are Hall elements 16a and 16b. Below the dial 11 are an hour setting toothed wheel 13 and a minute setting toothed wheel 14 which carry rings of figures which appear in turn in the window W to indicate preset alarm times in hours and minutes as shown in Figures 1(a) and 1(b). These wheels can be rotated by an hour and minute rotor 15 which is on the stem shaft (not shown) of the timepiece. The mechanical arrangement (not shown) is such that, when the stem is in its inner position and is rotated in the direction A of Figure 1(a) the toothed wheel 13 is rotated moving the figures on it in the direction indicated by the arrows adjacent those figures in Figure 1(b). Rotation of the stem in the opposite direction rotates the minute wheel 14 causing the figures thereon to move as indicated by the other arrow in Figure 1(b).

The wheel 13 carries a ring of inserts 17a of magnetic material, one corresponding to each hour, and the wheel 14 carries a ring of similar inserts, corresponding with minutes at chosen intervals—as shown in Figure 1(b) at 5-minute intervals, though some other desired interval may be chosen. When wheel 13 is rotated the inserts therein move past and co-operate in turn with the Hall element 16a and, similarly, when the wheel 14 is rotated the inserts therein move past and co-operate in turn with the Hall element 16b. In this way the elements 16a and 16b produce signals as the inserts on the appropriate wheel, 13 or 14, co-operate in turn with them, the number of signals produced by each element being a measure of the extent of rotation of the appropriate wheel.

Referring now to Figure 2, block 21 is a quartz crystal controlled time standard oscillator of relatively high frequency the output of which is frequency divided down to a 1Hz signal by a dividing circuit 22. This 1Hz signal is fed at OUT to a driving circuit 23 which drives the time indicating hands on the dial 11. The 1Hz signal at OUT is also applied to a time counter system 24 comprising a 60-counter 60SC for seconds, a 60-counter 60MC for minutes and a 24-counter 24HC for hours.

25 is a memory counter system comprising a 60-counter M60MC for minutes and a 24-counter M24HC for hours. In both counter systems 24 and 25 and in the divider 22 the terminals marked R are reset terminals.

The Hall element 16a of Figure 1(c) is represented in Figure 2 though it were a switch. This is the switch Sa which is connected to the input terminal of the 24-counter M24HC for memorising the hours. The effect, when one of the magnetic

inserts in the wheel 13 passes the Hall element 16a is to close equivalent switch Sa. This occurs every time a figure indication on the hour wheel 13 crosses the window W when the timepiece stem is rotated in the direction of arrow A in Figure 1(a).

The input terminal of the memorising 60-counter M60MC which stores the minute is connected to output of a pulse number selective circuit 29. This circuit receives as clock input, signals from an intermediate dividing stage in the divider circuit 22, signals from which are fed out over lead dj.

The switch Sb is representative of the Hall element 16b in the same way as that in which the switch Sa represents the Hall element 16a. Both switches Sa and Sb are represented as connected to a positive potential source.

If the stem of the timepiece is rotated in the direction of the arrow B in Figure 1(a) the equivalent switch Sb closes each time the Hall element 16b responds to the passage of a magnetic insert 17b (Figure 1(c)). Each time this happens a flip-flop constituted by a cross connected pair of NOR gates NOR₂ and NOR₃, inverts and provides an output signal to the data input terminal of a shift register SR the clock input terminal CL of which is fed from terminal dj of divider circuit 22.

The Q₁ and Q₂ output terminals of the shift register SR are connected respectively to the inputs of an OR gate OR the output of which is fed to one input of an AND gate A1. The second input to the AND gate A1 is supplied from the terminal dj and the output of said AND gate goes to the input of the 60-counter M60MC.

The arrangement is such that the minute memory counter M60MC receives two pulses every time the equivalent switch Sb closes, and therefore the successive figures carried by the minute wheel 14 should be at two minute intervals with this particular arrangement. This, of course, is not essential, and, for example, by modifying the circuitry as will be described later in connection with Figure 3, the minute figures on wheel 14 could be at some other interval, e.g. at 5-minute intervals as shown in Figure 1(b).

26 is a coincidence circuit which detects the occurrence of coincidence between the counts in the counters 60MC and M60MC and the counts in the counters 24HC and M24HC.

Output from the coincidence circuit 26 is fed to one input of an AND gate A2 the second input to which is constituted by an output signal taken at dk from a dividing stage of the dividing circuit 22. The output signal from the gate A2 constitutes a control signal controlling an audio

frequency oscillator OSC which actuates a speaker *Sp* to produce an audible alarm sound.

The switch *Sd* is a manual switch which can be closed at will to make the oscillator OSC oscillate to test the alarm at any time and the switch *Se* is another switch which can be actuated to disable the oscillator OSC at any time.

When the switch SWR connected to the reset terminal of the dividing circuit R is closed by pulling out the winding stem to its outer position the dividing circuit 22 and the counters in the time and alarm memory systems 24 and 25 are reset.

A switch for resetting the dividing circuit 22 may be a switch which is arranged independently of the switch for resetting the memory system 25, if desired—e.g. to allow for time error between an alarm setting time and the time the alarm actually sounds. Thus, for example, if the user sees the time shown by the hands on the dial to be 9^h 8^m he may rotate the winding stem so that an hour indication of 9 and a minute indication of 8 appear in the window W, reset the dividing circuit 22 (by the switch SWR) and reset the counters by the above mentioned resetting switch independent of the switch SWR.

The required alarm time (for example the time of 23^h 40^m) may then be set by operating the winding stem as already described.

If, as actually shown in Figure 2, the dividing circuit 22 and the counters in the systems 24 and 25 are reset by a common switch (SWR), the hour and minute alarm time indications would normally be set, as already described herein, at a near future time (e.g. 9^h 10^m) when a time signal is expected. Now, assuming the alarm time indication has been set to 9^h 10^m (in the particular example chosen for explanation) and the counter systems 24 and 25 have been reset by closing the common switch SR, the stem is pulled out to its outer position when the seconds hand reaches 00 seconds, the dial hands are set to 9^h 10^m and when the time signal is heard, the stem is pushed in to its inner position. The actual required alarm set time (e.g. 23^h 40^m) may then be set by the stem and, when this time is reached, the coincidence circuit 26 will respond and the alarm sound will be produced by the speaker *sp*.

In Figure 3 the oscillating circuit 21 is shown in more detail. As will be seen it is a Colpitt's type oscillating circuit comprising a quartz crystal vibrator Q an inverter *I*₁, capacitors *C*₁, *C*₂ and a resistance.

The dividing circuit 22 is also shown in more detail. It comprises a series of flip-flops FF₁ to FF_n.

The driving circuit 23 is also shown in

more detail. It comprises flip-flops FFD₁ and FFD₂ connected as shown to the dividing circuit 22 and supplies driving output to a motor M the energised winding of which is indicated at L.

The counter systems 24 and 25 are as in Figure 2 and the output from the dividing circuit 22 is fed to the counter system 24 as in Figure 2.

The hour memory circuit M24HC receives electric signals derived from the Hall element 16a (Figure 1(c)) and the minute memory circuit M60MC receives output from a pulse number selective circuit 29' which, in this case, includes a 5 bit shift register SR'.

The main differences between the embodiments of Figures 2 and 3 is that, in the embodiment of Figure 3 one input of the AND gate A₁ is supplied from the output of the OR gate OR' which has five inputs respectively fed from the five outputs Q₁ to Q₅ of the shift register SR', and five pulses appear at the output of said AND gate A₁ every time the Hall element equivalent switch *Sb* closes. Accordingly the alarm minute indications on the wheel 14 are at 5-minute intervals as shown in Figure 1(b).

Other differences lie in the provision, in the embodiments of Figure 3, of a transmission gate TG₁ controlled by output from the coincidence circuit 26 and the provision of transmission gate circuit 27.

The transmission gate TG₁ is arranged to become conductive in response to a coincidence signal output from the coincidence circuit 26. When this happens output signals at *d*₁ and *d*₁₊₁ from two successive intermediate flip-flops FF₁ and FF₁₊₁ in the dividing circuit 22 pass the transmission gates TG₁ and TG₂ in circuit 27 and also the transmission gate TG₃ and pass thence through the inverter *I*₁ to the speaker *sp* which accordingly produces the audible alarm sound.

Provision for preventing or stopping the production of audible alarm sound may be made by connecting a mono-stable multivibrator to the coincidence circuit 26 and arranging it to inhibit any output from said circuit as required.

In Figure 3 the coincidence circuit 26 is shown in more detail. It comprises two EXCLUSIVE-OR gates EX₁ and EX₂ and a NOR gate connected as shown. Inverters, referenced *I*₁ to *I*₇ are shown in various parts of the circuitry.

By closing the switch *Sc* the alarm may be made operative at any time for test purposes.

In the embodiments of Figures 2 and 3 the alarm time can be set correctly at any time by the winding stem if the counter systems 24 and 25 have been synchronised

and it is desirable to take advantage of this fact by effecting such synchronisation when correction of displayed time is effected.

5 Various modifications may be made in carrying out the invention. For example, in the embodiments described and illustrated so far, the hour toothed wheel (13) moves upwards (as seen in Figure 1(b)) and the minute wheel 14 moves downwards. 10 However the directions of movement of these two wheels may be arranged to be entirely independent of each other by using up/down counters for the counters M60MC and M24HC in the memory counting system 25. In this way the operation of setting the alarm time may be made very easy indeed. 15

The hour indication for alarm time setting may be in accordance with the 12-hour clock or in accordance with the 24-hour clock. In the illustrated embodiments the 24-hour clock type of indication is used. Similarly the timepiece dial may be a 12-hour dial or a 24-hour dial. 20

25 Although the intervals between successive minute indications for alarm setting may be selected as desired, it is preferred to choose them at some value between 2 minutes and 5 minutes, the latter being shown in Figure 1(b) although 2 minute intervals are also included in the preceding description. Of course, whatever interval value is chosen, the number of bits in the shift register SR in the circuit 29 must be correspondingly chosen. 30 35

The counter systems 24 and 25 and the circuit 29 in Figures 2 and 3 may be and preferably are embodied in field effect transistor circuits, and by incorporating these, together with the oscillating circuit 21, the dividing circuit 22 and the driving circuit 23 in an integrated monolithic structure, an extremely compact, low weight and readily mass produced construction of low power consumption and highly suitable for a wrist watch can be achieved. 40 45

An incidental practical advantage of the embodiments described is that, by setting the alarm to the time indicated at the moment by the hands of the timepiece, the user may cause the alarm to be sounded and thus check that the circuitry, including the coincidence circuit 26 is in proper working order. 50 55

The invention has important practical advantages. It is considered that the most important is that, by providing for an alarm time setting to be indicated digitally in an electronic analogue display alarm timepiece, the difficulties of setting an alarm time with a required degree of precision, and ensuring that it goes off at the pre-set time, again with a required degree of precision, are overcome. Another 60 65

advantage is that it is very easy for the user to set the alarm and ensure alarm and time synchronisation. Other advantages are the ease with which time correction and alarm synchronisation can be made; the mechanical and electrical simplicity—especially the former—of timepieces in accordance with the invention; and the ability to apply the invention to small timepieces, such as wrist watches, by reason of the fact that the circuitry lends itself to miniaturisation by integrated circuit techniques and the few mechanical parts required can also be made small. 70 75 80

WHAT WE CLAIM IS:—

1. An electronic analogue time display alarm timepiece having digital display means for displaying set alarm times.

2. A timepiece as claimed in claim 1 wherein set alarm times are displayed by numerals appearing behind a window in the dial of the timepiece. 85

3. A timepiece as claimed in claim 1 or 2 wherein set alarm times are displayed by hour indicating numerals at 1-hour intervals and minute indicating numerals at intervals of a selected number of minutes. 90

4. A timepiece as claimed in claim 3 wherein the intervals are selected in the range between 2 and 5 minutes. 95

5. A timepiece as claimed in any of the preceding claims wherein there is provided a pull out stem which, upon rotation when in one position, corrects the analogue display of time and, upon rotation when in the other position, changes the alarm time set. 100

6. A timepiece as claimed in any of the preceding claims wherein the alarm time setting means include a rotatable hour setting numeral bearing wheel and a rotatable minute setting numeral bearing wheel, each of said wheels, upon rotation, actuating signal generating means for generating a number of signals representative of the extent of rotation thereof. 105 110

7. A timepiece as claimed in any of the preceding claims and including a time standard oscillator of relatively high frequency, a dividing circuit for dividing the output of said oscillator to a predetermined lower frequency, time indicating hands moving over a dial, means for utilising said lower frequency to drive said hands, a time counting system including hour and minute counters and to which said lower frequency is fed, an alarm time counting system for memorising an alarm set time, a signal number counting circuit including a shift register for providing output to the alarm time counting system, means for taking output from an 115 120 125

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and it is desirable to take advantage of this fact by effecting such synchronisation when correction of displayed time is effected.

Various modifications may be made in carrying out the invention. For example, in the embodiments described and illustrated so far, the hour toothed wheel (13) moves upwards (as seen in Figure 1(b)) and the minute wheel 14 moves downwards. However the directions of movement of these two wheels may be arranged to be entirely independent of each other by using up/down counters for the counters M60MC and M24HC in the memory counting system 25. In this way the operation of setting the alarm time may be made very easy indeed.

The hour indication for alarm time setting may be in accordance with the 12-hour clock or in accordance with the 24-hour clock. In the illustrated embodiments the 24-hour clock type of indication is used. Similarly the timepiece dial may be a 12-hour dial or a 24-hour dial.

Although the intervals between successive minute indications for alarm setting may be selected as desired, it is preferred to choose them at some value between 2 minutes and 5 minutes, the latter being shown in Figure 1(b) although 2 minute intervals are also included in the preceding description. Of course, whatever interval value is chosen, the number of bits in the shift register SR in the circuit 29 must be correspondingly chosen.

The counter systems 24 and 25 and the circuit 29 in Figures 2 and 3 may be and preferably are embodied in field effect transistor circuits, and by incorporating these, together with the oscillating circuit 21, the dividing circuit 22 and the driving circuit 23 in an integrated monolithic structure, an extremely compact, low weight and readily mass produced construction of low power consumption and highly suitable for a wrist watch can be achieved.

An incidental practical advantage of the embodiments described is that, by setting the alarm to the time indicated at the moment by the hands of the timepiece, the user may cause the alarm to be sounded and thus check that the circuitry, including the coincidence circuit 26 is in proper working order.

The invention has important practical advantages. It is considered that the most important is that, by providing for an alarm time setting to be indicated digitally in an electronic analogue display alarm timepiece, the difficulties of setting an alarm time with a required degree of precision, and ensuring that it goes off at the pre-set time, again with a required degree of precision, are overcome. Another

advantage is that it is very easy for the user to set the alarm and ensure alarm and time synchronisation. Other advantages are the ease with which time correction and alarm synchronisation can be made; the mechanical and electrical simplicity—especially the former—of timepieces in accordance with the invention; and the ability to apply the invention to small timepieces, such as wrist watches, by reason of the fact that the circuitry lends itself to miniaturisation by integrated circuit techniques and the few mechanical parts required can also be made small.

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3. A timepiece as claimed in claim 1 or 2 wherein set alarm times are displayed by hour indicating numerals at 1-hour intervals and minute indicating numerals at intervals of a selected number of minutes.

4. A timepiece as claimed in claim 3 wherein the intervals are selected in the range between 2 and 5 minutes.

5. A timepiece as claimed in any of the preceding claims wherein there is provided a pull out stem which, upon rotation when in one position, corrects the analogue display of time and, upon rotation when in the other position, changes the alarm time set.

6. A timepiece as claimed in any of the preceding claims wherein the alarm time setting means include a rotatable hour setting numeral bearing wheel and a rotatable minute setting numeral bearing wheel, each of said wheels, upon rotation, actuating signal generating means for generating a number of signals representative of the extent of rotation thereof.

7. A timepiece as claimed in any of the preceding claims and including a time standard oscillator of relatively high frequency, a dividing circuit for dividing the output of said oscillator to a predetermined lower frequency, time indicating hands moving over a dial, means for utilising said lower frequency to drive said hands, a time counting system including hour and minute counters and to which said lower frequency is fed, an alarm time counting system for memorising an alarm set time, a signal number counting circuit including a shift register for providing output to the alarm time counting system, means for taking output from an



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- intermediate stage of said dividing circuit and feeding the same as clock pulses to said shift register, means actuated when setting an alarm time for re-setting said dividing circuit and the two counting systems, a coincidence detector for detecting coincidence between the contents of the two counting systems, and an alarm actuated by output from said detector for actuating said alarm when coincidence occurs.
8. A timepiece as claimed in claim 7 wherein the circuitry of at least said oscillator, said frequency dividing circuit, the two counting system, the signal number counting circuit and the coincidence detector is embodied in a monolithic integrated circuit structure.
9. A timepiece as claimed in any of the preceding claims and having circuitry substantially as herein described with reference to Figure 2 of the accompanying drawings.
10. A timepiece as claimed in any of claims 1 to 8 inclusive and having circuitry substantially as herein described with reference to Figure 3 of the accompanying drawings.
11. Electronic analogue time display alarm timepieces substantially as herein described and illustrated.
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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1978
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.



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