(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 May 2001 (10.05.2001)

PCT

(10) International Publication Number
WO 01/33178 A1

(51) International Patent Classification[7]: G01K 13/00

(21) International Application Number: PCT/GB00/04225

(22) International Filing Date:
3 November 2000 (03.11.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9925900.4 3 November 1999 (03.11.1999) GB

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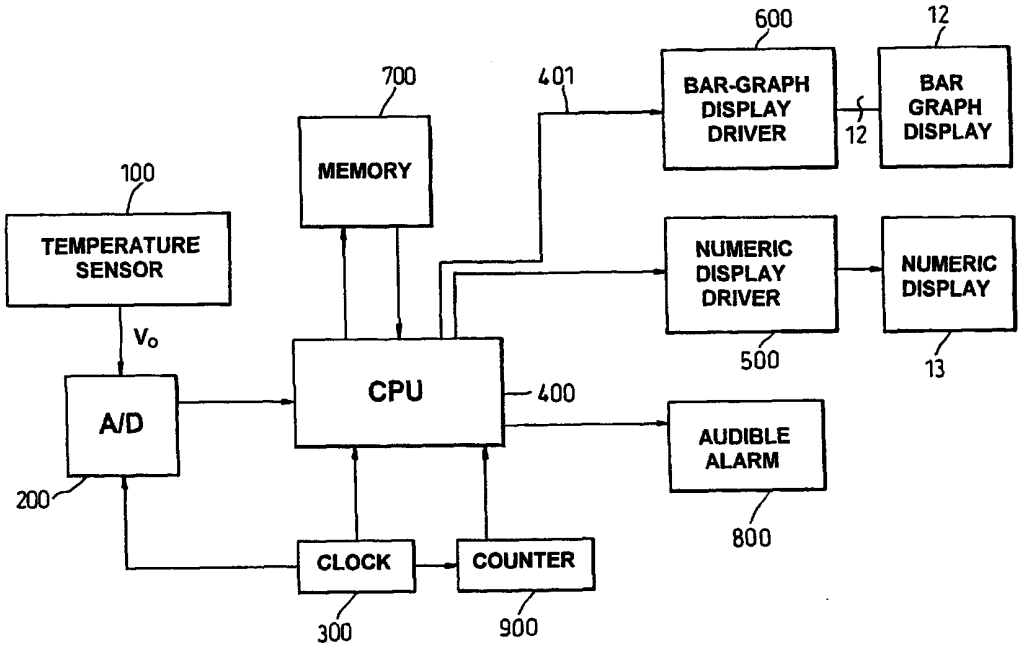
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A CLINICAL THERMOMETER



(57) Abstract: A clinical thermometer is disclosed which includes a visual indication of the temperature of the patient relative to normal body temperature. An alternative thermometer is also disclosed in which an alarm is triggered if the temperature of the patient rises (or falls) too rapidly. In a still further arrangement, a trend indicator is provided to represent changes in the measured temperature over time.

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A CLINICAL THERMOMETER

This invention relates to clinical thermometers, and in particular to an electronic clinical thermometer that is both simple and intuitive to use.

Clinical thermometers are designed to measure over a range of temperatures centred on the average body temperature of a normal patient. They can be used to check the temperature of a patient such as a child or elderly person as an indicator of possible virus or infection. Typical areas for taking measurements from a patient are the mouth (oral) and the under-arm (axilliary) area and guidelines have been established for relating the temperature measured at these locations into a measure of the patients core body temperature.

The most common device for taking the temperature of a patient has, until recently, been the mercury or alcohol thermometer. This device comprises a bulb, which contains a volume of coloured alcohol or mercury. A narrow tube extends from the bulb and as the alcohol or mercury heats up or cools it expands or contracts to rise up or fall down the tube. The tube must be transparent to allow the fluid to be viewed and also impermeable to the liquid. Glass is commonly used. Unfortunately, this makes the device dangerous to use as injury can occur if the glass breaks or the liquid is ingested. Young children in particular may bite upon the glass causing it to shatter.

A more recent development is the electronic clinical thermometer. This comprises a measuring tip or probe typically comprising a thermocouple or thermister or sensor chip located within a suitable shroud, an electronic processing circuit adapted to receive a signal produced by the measuring tip and located within a housing that supports the tip, and a visual display for providing a numeric temperature readout. The display

is commonly in the form of a numeric display panel, which shows the measured temperature in either degrees Centigrade or degrees Fahrenheit.

The applicant has appreciated that many clinical thermometers are used by untrained people, such as carers and parents, and so there is a need for the device to be both rugged in its construction and most importantly easy to use. Often, the difficulty for the user is not taking the temperature readings but interpreting the results. Indeed, if the results are not interpreted correctly much of the benefit of using the device is lost.

An object of the present invention is to ameliorate some of the problems associated with prior art electronic clinical thermometers.

According to a first aspect the invention provides a clinical thermometer comprising:

a temperature sensing portion adapted to produce a measurement signal indicative of temperature,

a body portion which contains an electronic circuit that has at least one input and one output, the input of the circuit receiving the measurement signal from the temperature sensing portion,

and a visual display, which is driven by the output of the electronic circuit to provide a visual indication of the temperature, measured by the temperature sensing portion relative to the normal body temperature.

By providing a graphical indication of temperature relative to a normal temperature it is easy for a user to tell if a person (patient) being measured is too hot or too cold. This is often of more use to an unskilled user than an absolute measurement of temperature, which is meaningless without knowledge of the temperature that they are expecting.

The display may include at least one light of a first colour and a second light of a different colour, with a different combination of the lights being illuminated or extinguished in accordance with the measured temperature. For example, a row of lights may be provided, with each light being illuminated to represent a different temperature or sub-range or temperatures selected from the total range of temperatures that can be displayed. One or more of the light towards the centre of the row may be illuminated to indicate that the patient's temperature is normal. As the temperature increases lights towards one end of the row may be illuminated and as it decreases lights towards the other end may be illuminated. Only one light may be illuminated at any one time.

The visual display may be arranged to define a bar graph with the illuminated light appearing to move up or down along the graph as the temperature rises or falls.

In one convenient arrangement, the display may include at least one red light and one blue light. For temperatures below a pre-determined normal body temperature of the patient the blue light may be illuminated whilst the red light is extinguished. Conversely, for temperature above the pre-determined normal body temperature the red light may be illuminated whilst the blue light is extinguished. The display may also include one or more yellow lights which may be illuminated to indicate caution, and one or more green lights to indicate a normal temperature. The lights may be arranged in the order blue, green, yellow, red. Optionally, one or more yellow lights may be provided between blue and green.

The or each light may comprise a coloured light emitting diode (LED). Alternatively, the lights may each comprise a white light source placed behind a coloured transparent panel. In a further alternative the lights

may all be of the same colour and a printed decal or other graphic may be provide alongside the lights. The decal may be blue at one point and red at another. In this case, the lights may be replaced by one or more segments of a liquid crystal display.

In use, the electronic circuit may be adapted to cause one or more of the lights to flash until a stable temperature reading has been obtained by the thermometer whereafter the display remains steady to provide a temperature reading. A trigger switch may be provided which can be operated by the user to commence a reading. After a reading has been taken it may remain displayed for a predetermined time, such as 30 seconds to allow the user to read the display.

A display of numerical data may additionally be provided in combination with the lights to provide an accurate temperature readout in either the Centigrade or Fahrenheit scales. This may comprise a liquid crystal display panel.

The temperature sensing portion may comprise a thermocouple or a set of series connected thermocouples. In this case the input to the electronic circuit will comprise a voltage generated across the thermocouple junction. Alternatively it may comprise a thermister, semiconductor sensor element or semiconductor integrated circuit.

The temperature sensor element may be encapsulated in an appropriate potting compound and a protective sleeve may surround this in turn. The sleeve may be hermetically sealed to the body portion or may even form an integral part of the body portion. The voltage supplied to the electronic circuit may be digitised by an analogue to digital converter prior to subsequent processing by a signal processing circuit.

According to a second aspect the invention provides a clinical thermometer comprising:

a temperature sensing portion adapted to produce a measurement signal indicative of temperature,

a body portion which contains an electronic circuit that has at least one input and one output, the input of the circuit receiving the measurement signal from the temperature sensing portion,

and in which the thermometer further includes a first measurement storage means for storing a first (previous) temperature reading obtained at a first point in time,

a second measurement storage means adapted to store a second (current) temperature measurement value at a second, later, point in time;

a rate of change calculation circuit for calculating the rate of change of temperature over the time between taking the first and second measurements, and

an alarm adapted to issue a warning signal in the event that the rate of change exceeds a predetermined allowable value corresponding to the onset of fever or other clinical conditions.

The alarm may be either an audible alarm or a visual alarm or a combination of both.

By producing an alarm if the rate of change of temperature exceeds a predetermined value the user is given valuable feedback which can help determine the severity of the temperature change. If the alarm sounds the user may for example telephone a doctor for medical assistance. If it has no sound the user will know that the change is within normal bounds and that there is no need to involve a doctor.

The thermometer may be adapted to store more than one first temperature reading, each one corresponding to a different patient. The second

measurement circuit may also be adapted to store more than one second temperature measurement reading-again each one for a different patient.

The rate of change calculation circuit may be adapted to calculate the rate of change for a respective patient by processing corresponding first and second stored measurement values for that patient.

The storage means may comprise an area of electronic memory, such as random access memory.

The thermometer may include at least one selector switch or button or other user operated input device. The input device may be set by a user to a first position when using the thermometer with a first patient, a second position for a second patient and so on. The position of the switch is used by the thermometer to decide which area of memory to store the readings in.

A further trigger input may be provided which is operated by a user to initiate the calculation of a temperature measurement value.

The alarm signal may be calculated from the following expression:

Previous reading- current reading/ elapsed time = rate of change.

The alarm may be raised if the temperature has increased by an amount greater than 1 degree centigrade/hour. This corresponds to 2 degrees in 2 hours, with a 2 degree rise being indicative of the onset of a fever. Alternatively, or additionally it may be raised if the temperature has fallen by an amount greater than 1 degree centigrade/hour.

Additionally or alternatively, the alarm may be raised to indicate the onset of specific clinical conditions, such as meningitis or febrile convulsions, where the rate is selected to be appropriate to the symptoms of that condition.

According to a third aspect the invention provides a clinical thermometer comprising:

a temperature sensing portion adapted to produce an output signal indicative of temperature,

a body portion which contains an electronic circuit that has at least one input and one output, the input of the circuit receiving the output signal from the temperature sensing portion,

and a display which is driven by the output of the electronic circuit to provide a visual indication of the temperature measured by the temperature sensing portion,

a first measurement storage means for storing a first (previous) temperature reading obtained at a first point in time,

a second measurement storage means adapted to store a second (current) temperature measurement value at a second, later, point in time;

and in which the display includes a trend indicator which provides a visual indication of the overall change in the measured temperature between the first reading and the second reading.

The trend indicator may provide a first visual indication if the temperature measurement has increased since the first reading and a second different indication if the temperature has decreased since the first reading.

As may be provided in respect of the second aspect of the invention the thermometer may be arranged to provide a separate trend indication for more than one patient. For example, it may be adapted to permit two

patients to be monitored, or more than two, and provide a display of the trend for each patient by comparing previous and current readings for each patient.

It will, of course, be appreciated that a thermometer may be provided that includes a combination of one or more of the features of the first, second or third aspects of the invention.

In one convenient arrangement, the measured temperature value supplied by the temperature sensor may be normalised to take into account that different people or groups of people have different normal core body temperatures. By normal we mean the core body temperature of a healthy individual.

The normalised value may be used to drive the trend indicator as well as the visual display so that the display correctly indicates a normal temperature for a respective patient.

Conveniently, an average of the measured temperatures obtained for a patient when in normal health is used as the basis of a compensation routine performed by the electronic circuit. If a measured value exceeds this average that person is considered to have an elevated temperature. A red light or an upward arrow or other sign may then be displayed. This feature ensures that any patient will produce a normal indication when at his or her own normal temperature.

For more than one patient-where a selector input switch is provided, a separate compensation value is applied for each patient. These values may be stored in an area of memory.

In another arrangement the measured value may be adjusted by the electronic circuit to provide an estimate of the actual core body temperature of the patient. The estimated value may be displayed by the thermometer.

The estimated value will differ from the measured value, and the amount of the difference will depend on the point of measurement. For oral measurement the core body temperature may be approximately 1°C higher than the measured value. For an underarm (auxiliary) measurement it may be approximately 2°C higher.

The thermometer may adjust the measured value by an amount depending on the type of measurement made. A means may be provided for selecting between two or more adjustment values. This may comprise a switch operated by the user whereby the position of the switch is set to indicate the type of measurement being taken.

In one arrangement, the probe tip may be movable between a first position in which oral measurements can be taken and a second position in which axilliary measurements can be taken. The electronic circuit may then be adapted to detect the position of the probe tip and select the appropriate adjustment.

For convenience, the thermometer may be battery operated. Two AAA type batteries may be used. This is convenient where blue LED's are used as they have a higher operating voltage than other colour LED's.

Alternatively a single battery may be used either alkali or lithium or rechargeable. In this case a voltage converter circuit may be provided to increase the voltage to drive the display. In the event of a rechargeable

battery being used a form of recharging circuit inside the thermometer or in the form of an external unit may be provided.

The thermometer housing may be made of plastic, and may be impregnated with an anti-bacterial agent such as that sold under the trademark MICROBAN.

It is preferred that the thermometer automatically switches off at least the visual display after a pre-determined time period has elapsed since a reading was taken. An elapsed time of 10 minutes has been found to be a suitable time period. This helps to preserve battery power. A low battery indicator may also be provided on the thermometer.

The housing may be small enough to allow the complete thermometer to be hand-held and may conveniently comprise a hollow body closed at one end by the temperature tip cover and at the other by a removable battery cover.

The sensor tip may have a soft feel and may be at least partially flexible. It is preferably tapered towards its free end where it terminates in a bite portion suitable for being placed in the mouth. The thermocouple (or other sensing device) may be located at the bite portion, and may be encapsulated in a suitable potting compound.

The display may be adapted to present a measure of the last temperature reading when the thermometer is initially switched on. An on switch may therefore be provided to activate the thermometer. This can be shrouded to prevent it being accidentally switched. An audible signal, such as a single short bleep or set of bleeps, may be generated when the thermometer is switched on.

Where a counter is provided for use in calculating the rate of change of temperature it will of course be appreciated that the counter should be allowed to run between readings.

In a further refinement, an alarm may be provided which generates an audible and/or visual alarm when the temperature exceeds a predetermined value. The alarm may be raised if temperature is more than 2 degrees above normal body temperature.

In accordance with a fourth aspect, the invention provides a kit comprising a thermometer in accordance with the first, second or third aspects of the invention and an instruction manual.

The manual may include advice to the user on how to contact the emergency services if an alarm is generated or the temperature reaches the extreme of the measuring range.

The kit may also include a case for protecting the thermometer when in transit or in storage. The case may also accommodate the manual.

There will now be described, by way of example only, one embodiment of the present invention with reference to the accompanying drawings of which:

Figure 1(a) is a plan view of a clinical thermometer in accordance with one aspect of the invention;

Figure 1(b) is an elevation view in section of the thermometer of Figure 1(a);

Figure 1(c) is an end sectional view of the thermometer; and

Figure 2 is a schematic diagram of an electronic circuit and ancillary component parts of the clinical thermometer.

As shown in Figure 1(a), 1(b) and 1(c) of the accompanying drawings a clinical thermometer device 1 for taking the temperature of a patient/person in the mouth or under the arm is provided which can be easily held in the hand and is safer to operate than conventional mercury or alcohol thermometers.

The thermometer 1 comprises a hollow main body 2 of generally tubular form. A first end of the body is hermetically sealed to a hollow probe cover 3 of soft material. The probe cover 3 is tapered towards its free end and terminated with a small metallic bite portion 4 or tip which is made of a material that conducts heat towards the inside of the probe cover. Inside the metallic bite portion 4 is provided a temperature sensing device such as a thermocouple (not shown) encapsulated in a suitable heat transfer compound. The thermocouple has two electrically conductive leads 5 and 6 that extend from the probe cover 3 into the main body.

The main body 2 accommodates the electronic circuitry 7 as well as additional user operable switches 8, 9, 10 and 11 and displays 12 and 13. It houses a planar substrate, which carries conductive tracks (not shown) that interconnect components defining the electronic circuit. The conductive tracks define two input nodes; each connected by solder to a respective one of the conductive leads 5 and 6 of the thermocouple. The conductive tracks also define electrical contacts, which connect to the different push-type switches 8, 9, 10 and 11 mounted onto the housing.

A first switch 8 can be operated by the user of the thermometer when a reading is to be taken. The switch is normally open but when pressed

activates the electronic circuit and starts the measurement process. For example, the user would place the thermometer in the mouth and when happy it is located correctly would depress the switch.

The second switch 9 enables the user to instruct the thermometer about the type of reading being taken from which the thermometer calculates an adjustment value or factor that enables an estimate of the patients core body temperature to be indicated. For example, in a first position of the switch the thermometer may be used to take oral readings, whilst in a second position it may be used to take under-arm (axilliary) temperature readings. These are typically 1°C and 2°C, typically, below core body temperature.

In an alternative (not shown) the second switch may be omitted and the probe shroud 3 may be arranged to be rotated through 90 degrees to take axilliary readings. The rotation of the shroud can, in that case, be used to tell the thermometer which compensation value to use.

The third switch 10 allows the user to select between two different sets of temperature data. In a first position, corresponding to patient A, a first set of temperature readings can be taken which the thermometer allocates to a first patient. In a second position, a different set of readings can be taken which are allocated to a second patient - patient B. This feature is important for some of the advanced diagnostic features incorporated into the electronic circuit as will become apparent.

The main body 2 also houses a liquid crystal display panel 13 arranged to display both alphanumeric data and optional graphical symbols. Conductive pads (not shown) on a face of the display panel 13 are placed in contact with corresponding pads (not shown) defined by the tracks on

the circuit board. The display 13 is visible through a clear panel 14 inset into an opening in an upper face of the main body 2.

A second display 12 in the form of a bar graph comprised of a set of light emitting diodes 12a, 12b and 12c is also provided, again exposed through an opening in the main body and electrically connected to the tracks on the circuit board. Twelve segments are provided - four red 12a, four green 12b and four blue 12c - although other numbers and colours can be provided. These are arranged in a single row with the blue at one end, the green in the centre and the red at the other end.

Finally, the housing 2 accommodates two AAA type batteries 14 and 15, which are connected in series and arranged to drive the electronic circuit. An optional power switch 13 may also be provided, although the first switch may function as a power switch that automatically "wakes-up" the circuit whenever the user takes a measurement. The batteries are secured in place by an end cap 16 on the housing.

The function of the electronic circuit is best described with reference to Figure 2 of the accompanying drawings.

As shown in Figure 2, the output voltage taken from the temperature sensor 100 is connected to the electronic circuit. A wide variety of thermocouples could be employed. For use as a clinical thermometer a thermocouple that is most sensitive over the range of 32°C to 42°C (89.6°F-107.6 °F) is preferred.

The input voltage fed to the electronic circuit is (optionally) amplified before being passed to an analogue to digital converter 200 where it is converted to a digital value representative of temperature. A variety of analogue to digital converters suitable for processing the output of a

thermocouple are known, and that illustrated is driven by a clock 300. This digital value is subsequently passed to the input of a signal processing circuit or central processing unit 400.

After the user initiates a reading, the digital output value from the analogue to digital converter 200 may take some time to settle. To allow for this settle period and prevent the display of erroneous temperature readings, the signal processing circuit 400 generates an output signal 401 that is passed to a display driver circuit 500 for the bar graph display 12 such as to cause the lights of the display 12 to illuminate one by one in sequence. This provides the illusion of a light moving up and down across the twelve light display. This continues either for a predetermined period (i.e. a preset number of cycles of the clock 300) or until a steady reading is obtained.

Once a steady reading is obtained, the digitised value from the A/D 200 is processed to a format suitable for being passed by the signal processing circuit 400 to a drive circuit 500 for the alphanumeric liquid crystal display 13. The drive circuit 500 generates characters indicative of the measured temperature which are displayed to the user.

The temperature is also displayed graphically by the bar graph display 12. For normal temperatures one of the green lights is lit. For above-normal temperatures one of the red light is lit and for below normal temperatures one of the blue lights is lit. A display driver 600 is used to convert the measured valve to a suitable drive for the display.

In a modification many of the functional components of the apparatus may be embodied by a single microelectronic circuit including the clock 300, display drivers 500 and 600 and the memory 700.

In addition to the basic functionality described above, the signal processing circuit is configured to provided several addition features:

TREND INDICATOR

The last measured temperate reading is stored by the signal processing unit 400 in an area of memory 700. Whenever a new reading is taken it is compared with the last stored previous reading. If the value has increased indicating that a patients temperature has increased then a suitable graphic (such as an up arrow) can be displayed on the display panel. If the current value is lower than the stored value an alternative graphic (such as a down arrow) can be displayed. This allows the user quickly to determine the change of the temperature. If no change has occurred a different graphic may be displayed.

MULTI-USER READINGS.

The thermometer 1 can be configured for use with more than one patient. Whenever a reading is obtained the digitised value is written to an area of random access memory 700 by the processing unit 400. Depending on the position of the second switch, the measured value may be stored in one of two areas of memory 400. When a reading is taken and the second switch is set for use on patient A the measured value is allocated to one area of the memory. When the switch is set for patient B the measured value for patient B is allocated to the second area. This produces two sets of values-one per patient.

To reduce the amount of memory required, only a single reading needs to be stored for each patient. Whenever a current reading has been compared with a previous stored reading the new reading may overwrite the stored reading. Only the last reading obtained need therefore be stored.

RATE OF CHANGE ALARM

An optional feature of the thermometer is the rate of change alarm, which generates a warning signal if the temperature of the patient has risen or fallen too quickly over time. This functions by processing the current reading for a patient with the stored previous reading for the same patient (i.e. patient A or patient B) as well as an elapsed time signal.

The elapsed time signal is a measure of the time that has elapsed between readings and is generated by counting the cycles of the clock 300 connected to the signal processing unit 400. An oscillating crystal or resistor/capacitor network drives the clock, and the cycles of the clock are used to drive a continuously functioning counter circuit 900. The counter circuit 900 is reset to zero when a reading is taken and the counter is then set running. It continues to count, at intervals of 1 second (or another time period) until the next reading for the same patient is taken when the counter is stopped. The value reached by the counter when it is stopped is used together with the difference between the current and previous readings to determine the rate of (or fall of) of temperature of the patient. If this exceeds a pre-determined safe rate an alarm is raised and an alarm signal is generated. The signal alarm comprises a voltage, which is applied by the processing unit to a piezo-electric buzzer 800 provided on the circuit board. A visual alarm may also be provided.

It is important that only the current and previous readings for a single patient are used to calculate the rate of change alarm signal. For example, if the current reading is for patient A it must only be compared with the previous reading for patient A and the time elapsed between those readings.

In this case, two internal counters may be provided to allow two counts to run simultaneously. The same clock may drive each the two counters. Of course, if the thermometer is configured for use with more than two patients the number of counters may be increased.

More elegantly, a single counter that runs continuously may be provided. Whenever a temperature reading is stored the counter value at the time of reading may be stored with it in the memory. When two temperature readings are subsequently compared, the difference in the respective stored counter values can then be used to calculate the elapsed time between readings.

BAR-GRAPH DISPLAY

In addition to the numerical display of temperature a bar-graph array 12 of light emitting diodes is provided which gives the user a simpler to understand temperature reading. This is especially important for non-skilled users such as parents or carers.

The bar graph is driven by a drive circuit, which receives signals from the signal-processing unit in order to provide an easy to read indication of temperatures. The lights are aligned in a linear array in three sets - four red lights, followed by four green lights, followed by four blue lights. A yellow light is also provided between the red and green lights. If the temperature reading is normal, one of the green lights will be lit. As the temperature increases, the light "moves" first to yellow to show that caution is needed and then towards the red lights and finally on to the outermost red light at very high temperatures. As the patients temperature drops below normal the temperature will be shown by illumination of one of the blue lights until at extreme cold temperatures the outermost blue light is lit.

The use of colour lights provides an easy to read display. Most users intuitively associate blue with cold and red with hot.

PATIENT NORMALISATION

It has been found that variations exist between the normal body temperatures of different patients. For thermometers which can be used to take readings for more than one patient (i.e. patient A and patient B) the signal processing circuit may be arranged to normalise the temperature readings.

To accommodate the variations, the average of several "normal" temperature readings - taken when a patient is known to be in good health are stored in the memory alongside the measurements for that patient (i.e. for patient A or patient B). The averaged value is used to derive a scaling factor such that when a measured value is passed to the drive circuit for the display the middle of the four green lights is always lit for that patient when they are in good health. Thus, for patient A the middle light may be illuminated at a temperate of 36°C, whereas for patient B this may be lit at a temperature of 38°C if they are generally warmer when in good health. This is similarly used to ensure that the up arrow and down arrow graphics are only lit when the temperature s above or below the normal temperature for an individual patient.

Of course, although as described the electronic circuit is predominantly embodied as an integrated electronic circuit mounted on a substrate it could be entirely from solid state components if desired, and many different physical embodiments within the scope of the invention are envisaged. It is, however, preferred to integrate the design as far as

possible to reduce both overall package size and power consumption to a minimum.

CLAIMS

1. A clinical thermometer comprising:
a temperature sensing portion adapted to produce a measurement signal indicative of temperature,
a body portion which contains an electronic circuit that has at least one input and one output, the input of the circuit receiving the measurement signal from the temperature sensing portion,
and a visual display which is driven by the output of the electronic circuit to provide a visual indication of the temperature measured by the temperature sensing portion relative to the normal body temperature.

2. A clinical thermometer according to claim 1 in which the display includes at least one light of a first colour and a second light of a different colour, with a different combination of the lights being illuminated or extinguished in accordance with the measured temperature.

3. A clinical thermometer according to claim 2 in which a row of lights is provided, with each light being illuminated to represent a different temperature or sub-range or temperatures selected from the total range of temperatures that can be displayed.

4. A clinical thermometer according to claim 3 in which one or more of the lights towards the centre of the row are illuminated to indicate that the patients temperature is normal, and in which the temperature increases lights towards one end of the row are illuminated and as it decreases lights towards the other end are illuminated.

5. A clinical thermometer according to any one of claims 2 to 4 in which only one light is illuminated at any one time.

6. A clinical thermometer according to any one of claims 2 to 5 in which the display includes at least one red light and one blue light whereby at temperatures below a pre-determined normal body temperature of the patient the blue light is illuminated whilst the red light is extinguished and for temperatures above the pre-determined normal body temperature the red light is illuminated whilst the blue light is extinguished.

7. A clinical thermometer according to any one of claims 2 to 6 in which the or each light comprises a coloured light emitting diode (LED).

8. A clinical thermometer according to any preceding claim in which the electronic circuit is adapted to cause the display to flash until a stable temperature reading has been obtained by the thermometer whereafter the display remains steady to provide a temperature reading.

9. A clinical thermometer according to any preceding claim in which a display of numerical data is provided to give an accurate temperature readout in either the Centigrade or Fahrenheit scales.

10. A clinical thermometer according to any preceding claim in which the measured temperature value from the temperature sensor is normalised to take into account that different people or groups of people have different normal core body temperatures.

11. A clinical thermometer according to claim 10 in which the normalised value is used to drive the visual display so that the display correctly indicates a normal temperature for a respective patient.

12. A clinical thermometer according to claim 10 or claim 11 in which an average of the measured temperatures obtained for a patient when in

normal health is used as the basis of a compensation routine performed by the electronic circuit.

13. A clinical thermometer comprising:

a temperature sensing portion adapted to produce a measurement signal indicative of temperature,

a body portion which contains an electronic circuit that has at least one input and one output, the input of the circuit receiving the measurement signal from the temperature sensing portion,

and in which the thermometer further includes a first measurement storage means for storing a first (previous) temperature reading obtained at a first point in time,

a second measurement storage means adapted to store a second (current) temperature measurement value at a second, later, point in time;

a rate of change calculation circuit for calculating the rate of change of temperature over the time between taking the first and second measurements, and

an alarm adapted to issue a warning signal in the event that the rate of change exceeds a predetermined allowable value corresponding to the onset of fever or other clinical conditions.

14. A clinical thermometer according to claim 10 adapted to store more than one first temperature reading, each stored reading corresponding to a different patient.

15. A clinical thermometer according to claim 10 or claim 11 adapted to store more than one second temperature measurement reading, each stored second reading corresponding to a different patient.

16. A clinical thermometer according to claim 11 or claim 12 in which the rate of change calculation circuit is adapted to calculate the rate of

change for a respective patient by processing corresponding first and second stored measurement values for that patient.

17. A clinical thermometer according to any one of claims 10 to 13 in which the storage means comprises an area of electronic memory, such as random access memory.

18. A clinical thermometer according to any one of claim 10 to 14 which includes at least one selector switch or button or other user operated input device that may be set by a user to a first position when using the thermometer with a first patient and a second position for a second patient.

19. A clinical thermometer according to any one of claims 10 to 15 in which the alarm signal is calculated by subtracting the first stored reading from the second stored reading and dividing the result by the elapsed time between readings.

20. A clinical thermometer according to any one of claims 10 to 16 in which the alarm is raised if the temperature has increased by an amount greater than 1 degree centigrade/hour.

21. A clinical thermometer according to any one of claims 10 to 17 in which the alarm signal is raised if the temperature has fallen by an amount greater than 1 degree centigrade/hour.

22. A clinical thermometer comprising:

a temperature sensing portion adapted to produce an output signal indicative of temperature,

a body portion which contains an electronic circuit that has at least one input and one output, the input of the circuit receiving the output signal from the temperature sensing portion,

and a display which is driven by the output of the electronic circuit to provide a visual indication of the temperature measured by the temperature sensing portion,

a first measurement storage means for storing a first (previous) temperature reading obtained at a first point in time,

a second measurement storage means adapted to store a second (current) temperature measurement value at a second, later, point in time;

and in which the display includes a trend indicator which provides a visual indication of the overall change in the measured temperature between the first reading and the second reading.

23. A clinical thermometer according to claim 22 in which the trend indicator provides a first visual indication if the temperature measurement has increased since the first reading, and a second different indication if the temperature has decreased since the first reading.

24. A clinical thermometer according to claim 23 in which a separate trend indication is provided for each one of a number of patients.

25. A clinical thermometer comprising a combination of feature as recited in a combination of the preceding claims.

26. A clinical thermometer according to any preceding claim which is battery operated.

27. A clinical thermometer according to any preceding claim in which the housing is made of plastic which is impregnated with an anti-bacterial agent.

28. A clinical thermometer according to any preceding claim in which the thermometer automatically switches off at least the visual display after a pre-determined time period has elapsed since a reading was taken.

29. A clinical thermometer according to any preceding claim in which the measured value is adjusted by the electronic circuit to provide an estimate of the actual core body temperature of the patient and the estimated value is displayed by the thermometer on the display.

30. A clinical thermometer according to claim 29 in which the thermometer adjusts the measured value by an amount depending on the type of measurement made and in which a selection means is provided for selecting between two or more adjustment values.

31. A kit comprising a thermometer in accordance with any one of the preceding claims and an instruction manual.

32. The kit of claim 31 in which the manual includes advise to the user on how to contact the emergency services if an alarm is generated or the temperature reaches the extreme of the measuring range.

33. The kit of claim 31 or claim 32 which also includes a case for protecting the thermometer when in transit or in storage.

34. A clinical thermometer substantially as described herein with reference to and as illustrated in the accompanying drawings.

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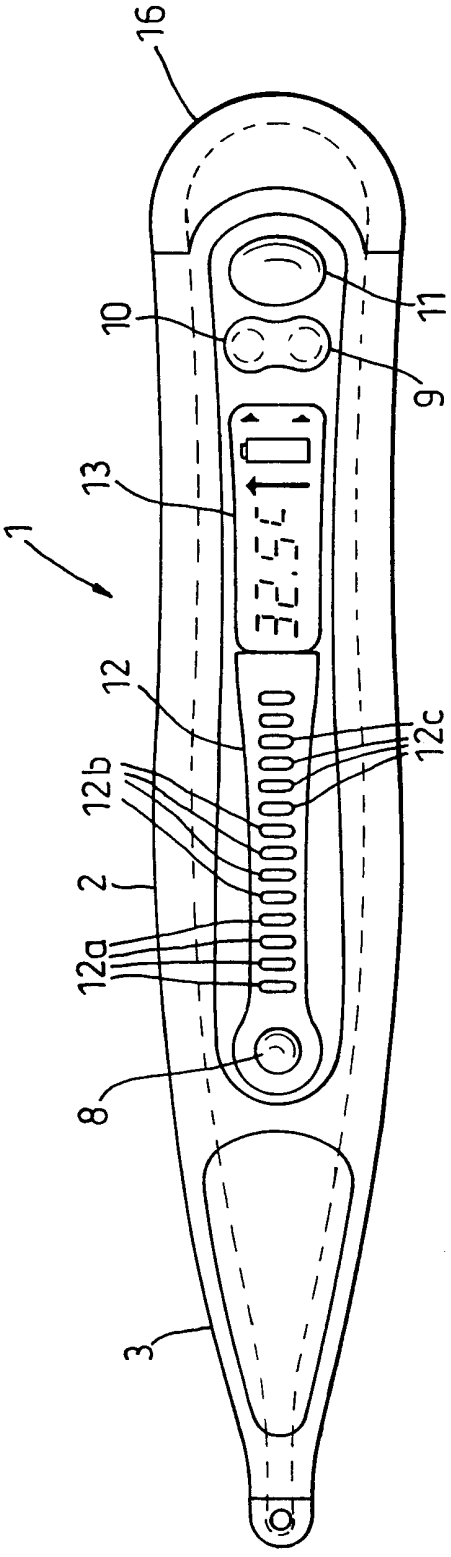

Fig. 1(a)

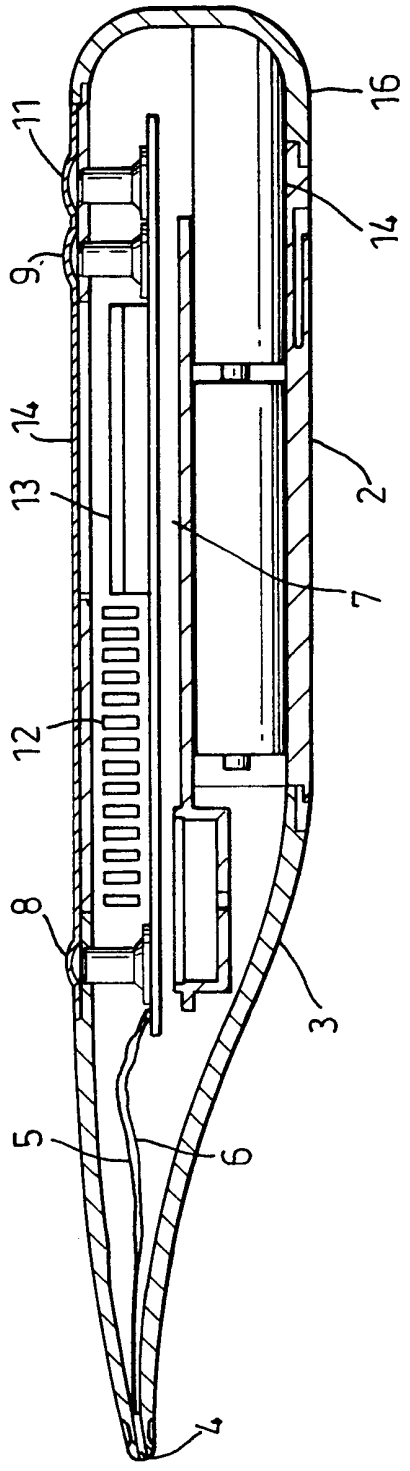

Fig. 1(b)

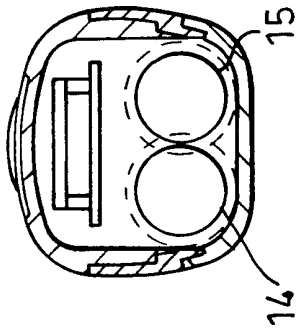

Fig. 1(c)

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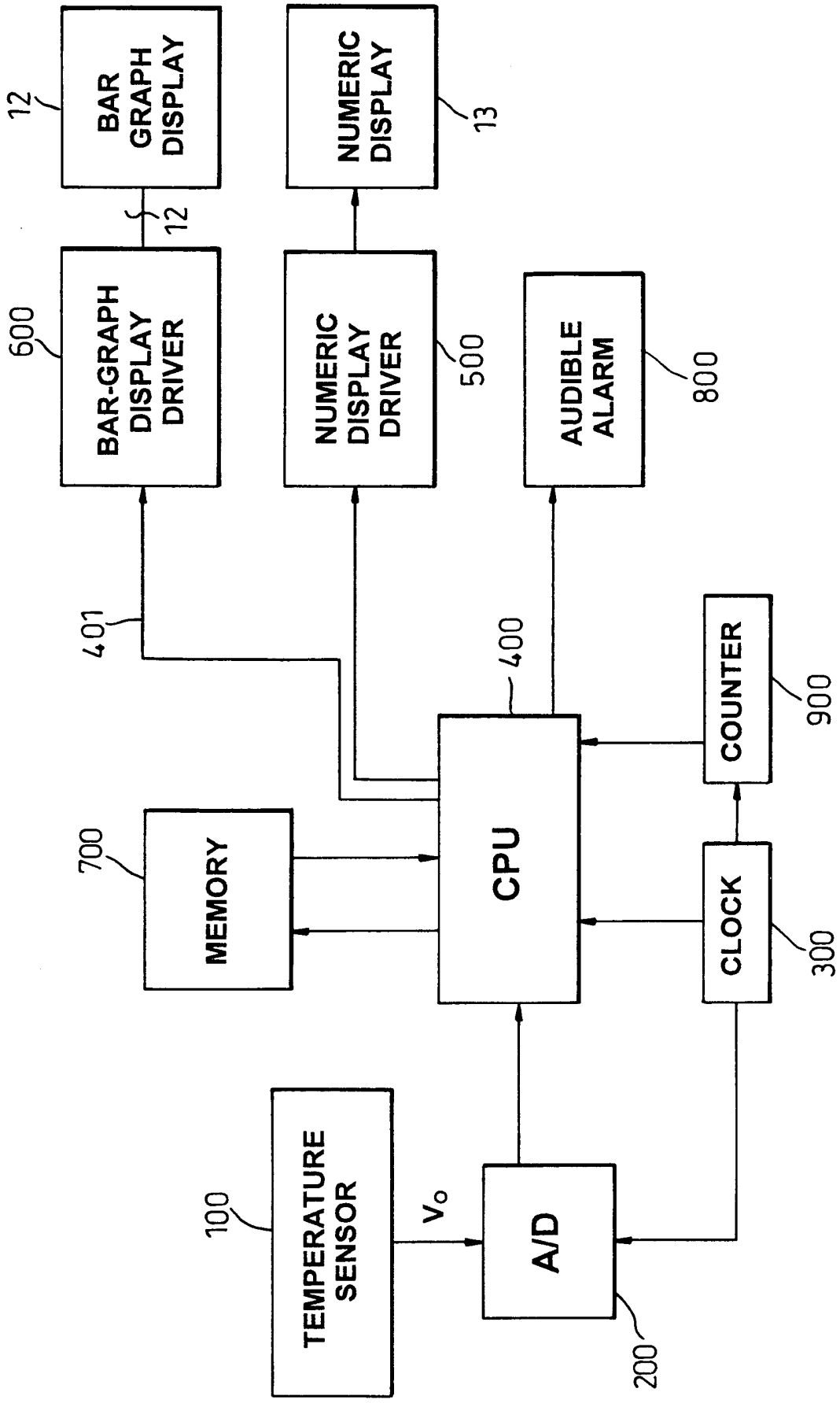
BAR GRAPH DISPLAY
12
12
NUMERIC DISPLAY
13
BAR-GRAPH DISPLAY DRIVER
600
NUMERIC DISPLAY DRIVER
500
AUDIBLE ALARM
800
401
400
COUNTER
900
MEMORY
700
CPU
CLOCK
300
TEMPERATURE SENSOR
100
V_o
A/D
200

Fig. 2

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB 00/04225

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01K13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 801 37 537 U (KÄFERLEIN) 12 September 1985 (1985-09-12) the whole document ---	1,3,5,7, 26,34
X	US 4 151 831 A (LESTER ROBERT W) 1 May 1979 (1979-05-01) the whole document ---	1-5,7,34
X	PATENT ABSTRACTS OF JAPAN vol. 009, no. 167 (P-372), 12 July 1985 (1985-07-12) & JP 60 042625 A (MATSUSHITA DENKI SANGYO KK), 6 March 1985 (1985-03-06) abstract ---	1,10-12, 14,15,34
X	DE 44 41 228 A (GUHR UWE) 23 May 1996 (1996-05-23) the whole document ---	1,13,16, 17,34
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 January 2001	14/02/2001

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB 00/04225

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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A	W. KORELL: "BATH THERMOMETER" ELEKTOR ELECTRONICS., vol. 6, no. 12, December 1980 (1980-12), pages 1207-1208, XP002158827 ELEKTOR PUBLISHERS LTD. CANTERBURY., GB ISSN: 0268-4519 the whole document -----	1-5,7

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