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Rubinstein

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(54) **FEVER ALARM SYSTEM**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**⁷ **A61B 5/00**

(52) **U.S. Cl.** **600/549; 374/100**

(58) **Field of Search** **600/300, 474, 600/549; 374/100, 141, 152**

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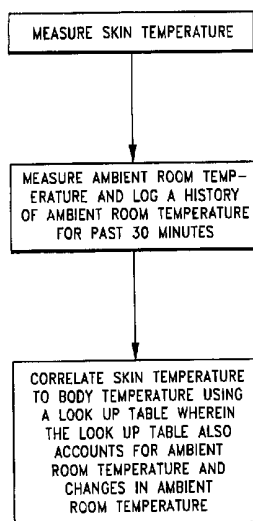
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(57) **ABSTRACT**

A body temperature measurement device includes a unit that continually measures body temperature and transmits the measurement through an RF transmitter to a display unit. The display unit includes an RF receiver, a processor, and a display that shows the temperature. The display unit includes an adjustable threshold alarm circuit that turns on an alarm whenever the temperature rises above a defined threshold.

12 Claims, 4 Drawing Sheets



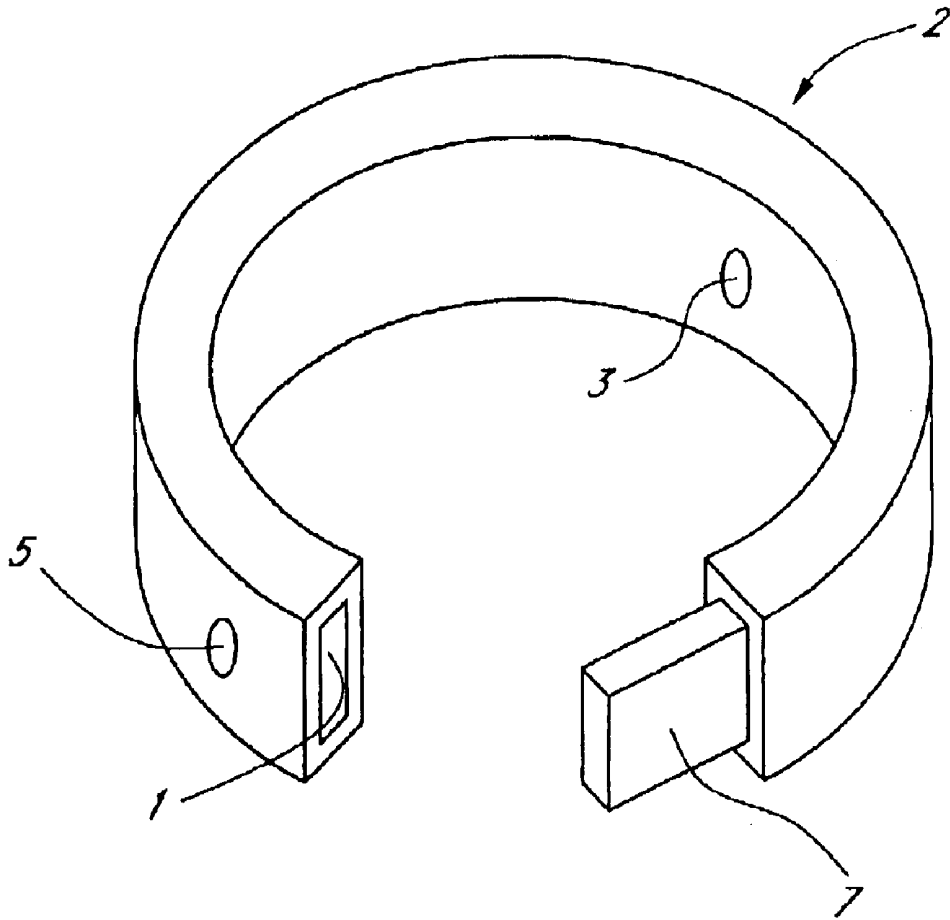


FIG. 1

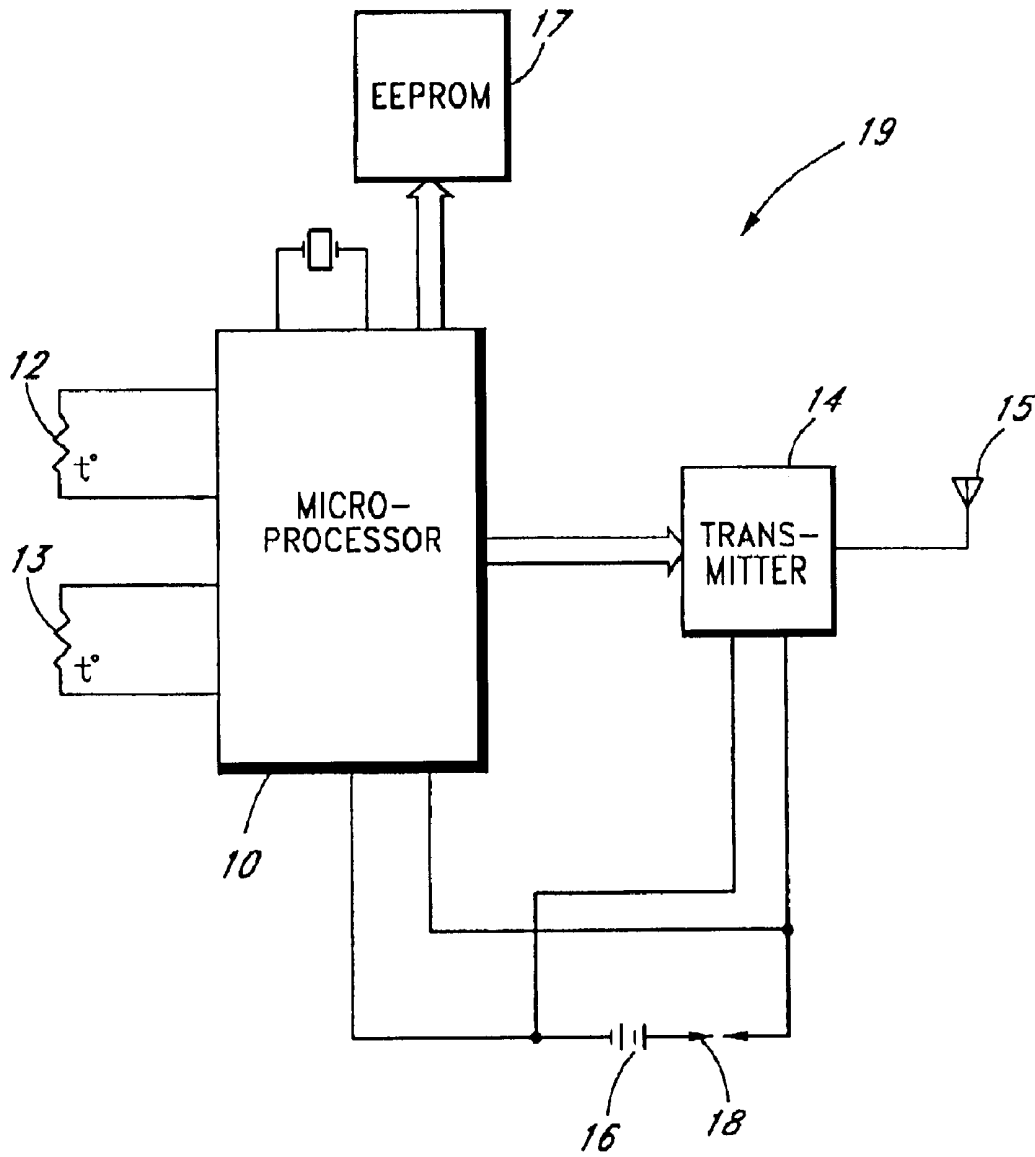


FIG. 2

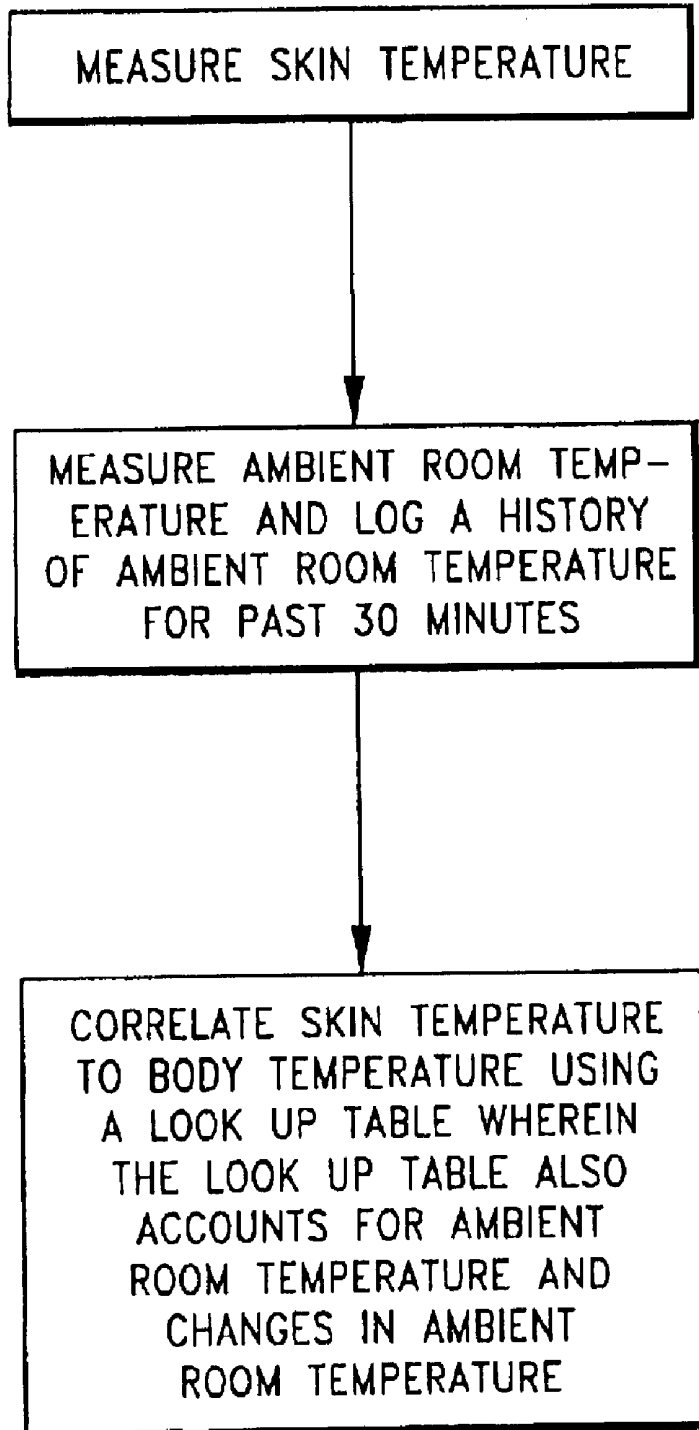


FIG. 5

FEVER ALARM SYSTEM

CLAIM OF PRIORITY

This application is a continuation application of, and claims priority from U.S. patent application Ser. No. 09/602, 232, filed Jun. 23, 2000 now U.S. Pat. No. 6,547,745, which is incorporated in its entirety by reference herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is related to a clinical thermometer, and more particularly to a skin thermometer, which performs calculation of oral or rectal temperature. The thermometer is connected to an RF transmitter/receiver system to display the temperature in a remote place and to raise an alarm when the temperature is above a predetermined threshold.

2. Description of the Related Art

Numerous devices for body temperature measurement are known. Some devices measure temperature continuously. U.S. Pat. Nos. 4,509,533, 4,333,477, 4,232,684, 4,030,483 describe skin fever thermometers, but the disclosed thermometers use liquid crystal which changes color according to temperature range. The prior art does not suggest a method for accurate reading and calculation of body (oral and rectal) temperature. The prior art also does not provide a solution for remote reading and remote alarm system when the fever rises above a certain threshold.

SUMMARY OF THE INVENTION

It is the first objective of this invention to provide a solution for accurate, continuous measurement of skin temperature and to accurately calculate body temperature. The temperature measurement device preferably comprises two thermistors. The first thermistor is attached to the skin and is thermally isolated from the surroundings. The other thermistor is thermally isolated from the skin and measures the room ambient temperature. A look-up correlation table in the processor correlates the temperature readings to oral or rectal temperature while taking into consideration the room temperature.

Another objective of this invention is to provide a remote reading of the temperature through a wireless communication link and to sound or activate an alarm whenever the temperature rises above a predetermined threshold.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a drawing of the wrist temperature measurement device of the preferred embodiment.

FIG. 2 is a schematic electronic drawing of the measurement unit of the preferred embodiment.

FIG. 3 is a schematic electronic drawing of the intermediate unit of the preferred embodiment.

FIG. 4 is a schematic electronic drawing of the remote display and monitoring unit of the preferred embodiment.

FIG. 5 illustrates a method for calculating body temperature.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates the general construction of the part of the skin temperature measurement device attached to the body. According to the preferred embodiment, this unit 2 has the shape of the wrist and is made of a soft material with a

very low thermal conductivity, such as foamed polyurethane. The unit incorporates a flexible electronic board 1 with a connector 7 that turns the unit on when it closes. Two thermistors 3, 5 are assembled on the electronic board. The thermistor 3 faces the skin side and is attached to the skin while being thermally isolated from the ambient room temperature by the polyurethane. The thermistor 5 faces away from the wrist and is thermally isolated from the skin in order to measure the immediate ambient temperature surrounding the skin. The flexible printed board 1 also has an RF antenna printed on the board itself. A soft disposable pad can be attached to the inner side of the unit in order to keep the unit hygienically clean.

FIG. 2 shows a schematic circuit diagram of the electronic unit 19 of the device attached to the skin. A microprocessor or processing unit 10 preferably includes two resistance-to-frequency converters, such as series 6200 made by Epson, Japan. The two thermistors 12 and 13, which respectively correspond to the thermistors 3 and 5, are preferably directly connected to the microprocessor. The thermistor 12 measures the skin temperature continuously and is thermally isolated from the surrounding ambient temperature. The thermistor 13 continuously measures the ambient surrounding temperature and is thermally isolated from the skin. The microprocessor 10 continuously reads the values of the thermistors and calculates oral or rectal body temperature, taking into consideration the skin temperature and the temperature of the ambient surroundings. There is typically a delay between the change of the ambient temperature and the sensing of this change by the thermistor 12 due to the isolation of the thermistor 12 from the ambient temperature and the thermal mass of the device. The length of this delay has been measured and can be up to 30 minutes. In order to improve measurement accuracy, the microprocessor stores the ambient temperature changes measured by thermistor 13 and takes into consideration the changes of ambient temperature, or in other words, the history of the ambient temperature measurements, while calculating the body temperature. An EEPROM 17 contains look-up tables taken out of experimental data of body temperature versus skin temperature, ambient temperature and changes of ambient temperature over time. The microprocessor 10 uses the look-up tables in calculating body temperature based upon the measured parameters. A method for calculating body temperature is illustrated in FIG. 5. The calculated body temperature is transmitted through a transmitter 14 (FIG. 2) and a printed antenna 15, to a remote circuit. The unit is powered by a battery 16, which is preferably a lithium battery that has a stable voltage and a long life. The battery power supply is connected to the circuit through connector 18.

FIG. 3 is a schematic electronic diagram of an intermediate transmitter/receiver unit 28 incorporated in the apparatus according to the preferred embodiment. The intermediate unit 28 is preferably placed close to the subject whose temperature is to be measured. The intermediate unit is used in order to save power of the measurement unit, which transmits the data to the intermediate unit. The data transmitted from the skin temperature measurement unit (shown in FIG. 2) is received through an antenna 26 and a receiver 20. The receiver 20 is connected through a buffer 21 to a transmitter 22 and an antenna 23 that transmit the data to a display and a monitoring unit (shown in FIG. 4). The intermediate unit 28 may also include a microphone 25 and an amplifier 24 to collect and transmit vocal data, in which case the system can also operate as a "Baby Monitor." All the electronic components such as the receiver 20, the buffer

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21, the transmitter 22, the amplifier 24 and the microphone 25 are standard electronic components used for baby monitoring devices and are known to persons skilled in the art.

FIG. 4 shows the electronic schematic diagram of the display and monitoring unit 30. The unit 30 receives body temperature data and vocal data from the intermediate unit (shown in FIG. 3) through an antenna 31 and a receiver 37. The receiver 37 is connected to a microprocessor 33 through a buffer 32. The microprocessor 33 processes the data and displays the temperature on the liquid crystal display (LCD) 35 and also activates the speaker 36 in case of vocal data. Two momentary push-buttons 34 are connected to the microprocessor 33 to adjust the required temperature level for an alarm. When the temperature measurement is above the alarm level, an alarm will sound through the speaker 36. The LCD 35 preferably continuously displays the subject's temperature and the alarm threshold level.

In one alternative embodiment, the microprocessor or processing unit 10 that calculates temperature can be incorporated into either the intermediate transmitter/receiver unit 28 or the monitoring unit 30. The transmitter 14 in this case can transmit raw data obtained from the sensors 12 and 13.

In one alternative embodiment, the transmitter 14 can be configured to transmit data directly to the monitoring unit 30. In this case, the intermediate unit 28 is not necessary.

Although the invention has been described in terms of certain preferred embodiments, other embodiments that are apparent to those of ordinary skill in the art, including embodiments which do not provide all of the features and advantages set forth herein, are also within the scope of this invention. Accordingly, the scope of the invention is defined by the claims that follow.

What is claimed is:

1. A method of calculating body temperature, the method comprising:

contacting a patient's skin with a temperature sensing unit;

measuring skin temperature using the temperature sensing unit;

obtaining a plurality of ambient temperature measurements over a time period substantially before measuring the skin temperature, the plurality of ambient temperature measurements obtained while the sensing unit is in contact with the skin; and

correlating at least the measured skin temperature and the plurality of ambient temperature measurements to a body temperature using empirical data stored in look-up tables.

2. The method of claim 1, wherein the plurality of ambient temperature measurements comprises a history of changes in ambient temperature.

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3. A temperature measurement system comprising:

a sensing unit configured to be attached in contact with the skin of a patient, wherein the sensing unit comprises a first transmitter configured to transmit a first signal carrying data related to a temperature of the patient;

an auditory sensing unit comprising a microphone and an amplifier, the auditory sensing unit configured to collect sound and to transmit an audio signal corresponding to the sound;

an intermediate receiving and transmitting unit configured to receive the first signal and further configured to transmit a second signal carrying data related to the temperature of the patient wherein the data carried by the second signal is based at least upon the data carried by the first signal, the intermediate receiving and transmitting unit comprising the auditory sensing unit; and
a monitoring unit configured to receive the second signal and the audio signal, and further configured to display the temperature of the patient based at least upon the data carried by the second signal, the monitoring unit comprising a speaker configured to reproduce the sound in response to the audio signal.

4. The system of claim 3, wherein the data carried by the second signal comprises the data carried by the first signal.

5. The system of claim 3, wherein the data carried by the first signal comprises the temperature of the patient.

6. The system of claim 3, wherein the data carried by the second signal comprises the temperature of the patient.

7. The system of claim 3, wherein the intermediate receiving and transmitting unit is configured to transmit the second signal over a greater distance than the first transmitter is configured to transmit the first signal.

8. The system of claim 3, further comprising a processing unit configured to determine the temperature of the patient.

9. The system of claim 8, wherein the sensing unit comprises the processing unit.

10. The system of claim 8, wherein the intermediate receiving and transmitting unit comprises the processing unit.

11. The system of claim 8, wherein the monitoring unit comprises the processing unit.

12. A method of calculating a body temperature of a patient, the method comprising:

measuring a plurality of ambient room temperatures to which the patient is exposed over time;

measuring a skin temperature of the patient; and

determining the body temperature based at least upon the plurality of measured ambient room temperatures and the measured skin temperature.

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摘要(译)

体温测量装置包括连续测量体温并通过RF发射器将测量值传输到显示单元的单元。显示单元包括RF接收器，处理器和显示温度的显示器。显示单元包括可调节的阈值警报电路，当温度上升到高于限定的阈值时，该电路接通警报。

