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(54) Title: ELECTRONIC THERMOMETER

(57) Abstract: The invention relates to body temperature measurement of humans and animals. More particularly, the invention provides a clinical electronic thermometer provided with a vocal output and transmitting means. The invention comprises an elongated housing, a thermistor being located at one end thereof and a piezoelectric speaker located adjacent to a grill in the housing and an electronic processing system connected to apply a known voltage to the thermistor for measuring the electrical resistance thereof, and to process this measurement and to send corresponding electrical pulses to the speaker to produce a vocal output of the measured temperature, the system further includes an analog/digital converter and ohmmeter connected to said thermistor, a microprocessor connected to said ohmmeter, a RAM memory connected to said microprocessor to retain at least the latest temperature measurement, a ROM memory connected to said microprocessor to permanently store pre-recorded analog data required for speech generation of words needed for producing temperature announcements, and at least one amplifier connected to said microprocessor; and finally a retaining device inside the housing for an electric storage battery, the device having connections to power said electronic processing system.

ELECTRONIC THERMOMETER

Field and Background of Invention

The present invention relates to body temperature measurement of humans and animals. More particularly, the invention provides a clinical electronic thermometer provided with a vocal output. Some embodiments relate to a system for transmission of the output to a remote party.

Body temperature measurements are usually made when a person feels unwell or is in the care of a clinic or hospital, in order to determine if further diagnosis is needed. In humans an under-tongue temperature measurement of over 37.3 degrees C indicates that a patient may have an infection or illness which needs attention. A temperature of over 41 degrees signals a life-threatening situation. Body temperatures of animals differ, but any substantial rise above normal also provides indication that a health problem requires investigation and treatment.

Body temperature measurements can also be used for tracking the monthly cycle of females for purposes of either increasing or decreasing the probability of conception at certain times in said cycle.

Measurement of body temperature may be carried out by mercury-in-glass thermometers or by colored alcohol thermometers. Thermometers provided with a digital liquid crystal display are now also in widespread use.

A drawback of conventional thermometers is that the user cannot observe the temperature display while the thermometer is in use. Consequently users tend to remove the thermometer periodically from under the tongue, from the rectum or from under the arm in order to see whether the temperature reading has stabilized in the expected range. Removal and subsequent replacement prolong the time needed for correct measurement.

It is axiomatic that people with severe vision defects, the blind, and those needing to take temperature measurements under poor lighting conditions are unable to use a visual display of any type.

A thermometer providing an audible output could however enable users who are unable temporarily or permanently to use a visual display to receive the needed data.

The following US Patents indicate the state of the art in the fields relating to the present invention.

Patent 3,800,082 discloses an auditory display for the blind. Tones are generated and heard in both ears, the intensity and frequency thereof relating to a pattern being scanned by a TV camera.

An announcement system for data including temperature recorded by a temperature sensor is described in Patent 4,389,646. The invention is directed at making program changes by use of a remote telephone. There is no indication that the system could be miniaturized in order to fit inside a clinical thermometer.

Patent 4,400,582 is directed at reducing the storage space needed by a speech synthesizer, which it proposes to do by interconnecting voiceless phonemes. Similarly, Patent 5,038,337 achieves the same end by accessing non-distinguishable data through a multilevel address system. Patent 5,621,891 again has the same object, and uses a multiplexer for combining natural and synthetic speech information As will be shown, the ROM memory of the present invention needs to store only a small number of sounds, so that the problem of memory storage space is of little concern.

The electronic fever thermometer disclosed in Patent 4,536,851 is primarily an accurate temperature sensor. There is no audible output.

An audible tone is however produced by the electronic clinical thermometer described in Patent 4,579,464. Voice output is not provided.

Patent 5,259,389 describes an electronic clinical thermometer including a memory for storage of temperature readings. The invention includes a prediction method for obtaining high accuracy. No audible output is provided.

The audible output provided by the electronic thermometer disclosed in Patent 5,626,425 merely indicates a rising temperature, but gives no audible indication of the temperature value.

Patent 5,640,162 is primarily concerned with improvements in digital to analog conversion for use in telecommunications equipment. Outputs in the form of thermometer code are described, but there is no reference to the construction of a clinical thermometer.

A high-precision thermometer using an electric bridge is described in Patent 5,655,305. There is no mention of an audible output.

A speech synthesizer is included in the traffic information apparatus disclosed in Patent 5,970,456. The apparatus does not refer to temperature measurement.

Patent 6,000,845 describes a temperature sensing and indicating device wherein varying lengths of a probe can be exposed by a movable arm. The device has visual displays only.

The Sensorsoft company markets a digital environmental thermometer which can be connected to the RS232 serial port of a remote computer for monitoring temperature in warehouses, pharmacies, cold storage, greenhouses etc. Output is visual.

Objects of the Invention

It is therefore one of the objects of the present invention to utilize recent advances in miniaturizing electronic components and to provide a free-standing clinical electronic thermometer which outputs results in vocal form.

It is a further object of the present invention to provide a clinical electronic thermometer which outputs results to a computer for possible processing and transmission thereby.

It is yet a further object of the present invention to provide an electronic thermometer which could be connected to data transmission means such as a cellphone, computer Internet and the like.

Summary of the Invention

The present invention achieves the above objects by providing an electronic thermometer with vocal output, comprising

a) an elongated housing having a first extremity and an opposite second extremity, a thermistor being located at said first extremity;

b) a piezoelectric speaker located adjacent to a grill in said housing;

c) an electronic processing system connected to apply a known voltage to said thermistor for measuring the electrical resistance thereof, and to process this measurement and to send corresponding electrical pulses to said speaker to produce a vocal output of the measured temperature, said system including an analog/digital converter and ohmmeter connected to said thermistor, a microprocessor connected to said ohmmeter, a RAM memory connected to said microprocessor to retain at least the latest temperature measurement, a ROM memory connected to said microprocessor to permanently store pre-recorded analog data required for speech generation of words needed for producing temperature announcements, and at least one amplifier connected to said microprocessor; and

d) a retaining device inside said housing for an electric storage battery, said device having connections to power said electronic processing system.

In a preferred embodiment of the present invention there is provided an electronic thermometer wherein said electronic system further includes a circuit to generate audible tones for alerting a user that the thermometer is ready for use, is ready to announce, or is to be switched off.

In a most preferred embodiment of the present invention there is provided an electronic thermometer further including a digital/analog converter connected between said microprocessor and a connector for an electric cable, said connector being located at said second extremity, for enabling analog data transfer representing a tone of a frequency related to the measured temperature from said thermometer to the sound card in a computer and to any other data transmission means such as cellphone or the like.

Yet further embodiments of the invention will be described hereinafter.

It will thus be realized that the novel thermometer of the present invention, using state-of-the-art miniature electronic components, will be little larger than the well-known digital display thermometer. The voice storage ROM need only store a total of about 13 - 15 sounds - "Thirty", "Forty" "Point" and the ten numerals for a Celsius read out, while for a Fahrenheit thermometer "Ninety" and "Hundred" would be used instead of Thirty and Forty. The thermometer could readily be constructed to give both readings.
The latest reading is stored on a RAM memory contained in the thermometer, so the vocal output - if not heard clearly a first time - can be repeated as often as desired.
In the free-standing embodiment of the thermometer all the power required is provided by a button cell, similar to that used in electronic watches and calculators. In the computer-connectable embodiment it is possible to dispense with the power cell and to draw power from the computer using the same cable transferring data from the thermometer to the computer. Analog data representing a tone of a frequency related to the temperature measurement is received by the computer. Temperature is announced by the computer using the computer sound card. After the computer has received the readings any additional desired form of processing is possible. Results can be printed out as a report, recorded on a spreadsheet, as a graph, or sent by fax, e-mail or by internet to

wherever needed. An appropriate computer program is supplied together with the embodiment intended for computer connection.

The thermometer of the present invention will obviously be of most benefit to blind people, and by decreasing their dependence on others will contribute to improving their quality of life. People with impaired vision unable to read a standard visual display would also benefit. Another application could be use by a medic at night on the field of battle where use of a light source could betray his location.

The thermometer of the present invention is designed and will be constructed to give an accuracy to 0.1 degrees C, this being suitable for clinical purposes.

For descriptive purposes, electronic components such as the RAM and ROM memories are described as discrete items. It is however to be understood that these and other components are in practice likely to be physically integrated and readily available in a commercial microprocessor which, after programming, controls all functions of the thermometer.

Short description of Drawings

The invention will now be described further with reference to the accompanying drawings, which represent by example preferred embodiments of the invention. Structural details are shown only as far as necessary for a fundamental understanding thereof. The described examples, together with the drawings, will make apparent to those skilled in the art how further forms of the invention may be realized.

In the drawings:

FIG. 1 is a perspective view of a preferred embodiment of the thermometer according to the invention;

FIG. 2 is a block diagram representing the same embodiment;

FIG. 3 is a perspective view of an embodiment provided with a numeric display, tone generation means, and push-buttons, and is shaped for insertion into a body cavity;

FIG. 4 is a block diagram representing the embodiment shown in FIG. 3;

FIG. 5 is a non-detailed perspective view of an embodiment where the thermometer is connected to a computer, shown at a much reduced size;

FIG. 6 is a block diagram representing the embodiment shown in FIG. 5;

FIG. 7 is a block diagram showing the operation of a two-way data control center; and

FIG. 8 is a diagrammatic view of the thermometer connected to a telephone for purposes of data transfer.

Full disclosure of the Invention

There is seen in FIGS. 1 and 2 an electronic thermometer 10 with vocal output. The thermometer has an elongated housing 12 having a first extremity 14 and an opposite second extremity 16. The housing 12 is made of a break-resistant plastic which can be sterilized, for example ABS or polycarbonate.

A thermistor 18 is located at the first housing extremity 14. An inert coating is added to the thermistor head If the sintered mixture of metallic oxides comprising the device is unsuitable for insertion into the mouth.

A piezoelectric speaker 20 is located adjacent to a grill 22 in the housing 12. The speaker 20 is used to announce temperature in a synthetic human voice.

An electronic processing system 24 is connected to apply a known voltage to the thermistor 18. An ohmmeter 26 measures the resulting current and calculates the electrical resistance of the thermistor 18. Such resistance is very high in comparison to the resistance of the leads 28 and connections, so the latter has practically no adverse effect on accuracy of the results.

The electronic system 24 processes the resistance measurement and sends corresponding electrical pulses to the speaker 20 to produce a vocal output of the measured temperature.

The electronic system 24 includes an analog/digital converter 30 to process readings received from the ohmmeter 26.

A microprocessor 32 is connected to the ohmmeter 26 through the A/D converter 30. The microprocessor 32 is pre-programmed to control all functions of the thermometer 10.

A RAM memory 34, connected to the microprocessor 32, retains the latest temperature measurement.

A ROM memory 36, also connected to the microprocessor 32, permanently stores pre-recorded analog data required for speech generation of words needed for producing temperature announcements. Typically storage comprises analog representation of the words "Thirty", "Forty" "Point" and the ten numerals for a Celsius read out, while for a Fahrenheit thermometer "Ninety" and "Hundred" is used instead of Thirty and Forty.

An amplifier 38 is connected between the microprocessor 32 and the speaker 20 for increasing the sound volume.

A retaining device 40 inside the housing 12 holds an electric storage battery 42, of the button type. The battery retaining device 40 has connections (not seen) to transfer power to the electronic processing system 24. A housing door 44 allows access for battery replacement; in the present embodiment the door 44 has three positions: Fully closed, to switch on; slightly open 46 to switch off; and fully open 48 to provide access for replacement of an exhausted battery 42.

In operation the user switches on power and contacts the thermometer 10 with the body, for example by inserting the thermometer under the armpit. Power from the battery 42 is sent through the thermistor 18 to produce a small current which does not significantly heat the thermistor 18. The thermistor 18 being at room temperature is heated by contact with the body of the user, and its electrical resistance falls by a predetermined factor; usually about 3 - 6% for each degree C of heating. The drop in resistance is measured by the ohmmeter 26 and after conversion to digital form the result is sent by the microprocessor 32 to the RAM memory 34. In the present embodiment each new reading erases the previous reading. When the microprocessor 32 detects that temperature has stabilized, it combines the stored reading in the RAM 34 with a selection of pulses representing appropriate sounds (for example: "Thirty" "Eight" "Point" "Six") from the ROM memory 36. The result, in analog electrical form, is sent to the amplifier 38, and is converted by the speaker 20 into a reproduction of a human voice.

With reference to the rest of the figures, similar reference numerals have been used to identify similar parts.

FIGS. 3 and 4 illustrate an electronic thermometer 50 further including a number of additional features.

A numeric visual display 52, preferably of the liquid crystal type, is provided with a display driver 54 which is connected to the microprocessor 56. A four-digit readout 58 is provided so that the display 52 is suitable for both Celsius and Fahrenheit and includes one figure after the decimal point. The numeric display 52 thus forms an optional addition which is useful where the thermometer 50 serves the needs also of those who can read such display.

A "TALK" push-button 60 on an outer face of the housing 62 is used for activating the temperature announcement. As the latest temperature reading is stored in the large RAM memory 64, the audible announcement can be repeated as often as needed if not heard properly at first. In the present embodiment the RAM memory 64 has an enlarged storage capacity sufficient to store all temperature measurements normally taken during a single use. The RAM memory 64 can be cleared by pressing simultaneously on the "TALK" and "ON" push-buttons 60, 66.

An "ON" push-button 66 located on an outer face of the housing 62 is used for connecting power to the electronic system 68. An optional circuit 70 including a timer effects automatic power cut-off at a predetermined time after last user actuation of a push-button 60, 66 to prevent battery 42 exhaustion if the thermometer 50 is left switched on.

The electronic system 68 further includes a circuit 72 to generate audible tones for alerting a user that the thermometer is ready for use, is ready to announce, or is to be switched off. The speaker 20 used to announce temperature is also used to sound these tones.

The first housing extremity 74 is shaped for convenient insertion into a body cavity, for example the rectum. The housing 62 of the thermometer is oval in section, this being the shape which users expect to find in a thermometer.

Referring now to FIGS. 5 and 6, there is depicted an electronic thermometer 76 which is used in combination with a standard Personal Computer 78 and is provided with a disk 80 carrying a data processing and output generation program 82. The thermometer 76

requires fewer components than embodiments described previously, as the computer program 82 which is part of the present embodiment utilizes components existing in the computer 78. Such components include the computer power source, visual display, amplifier and speaker.

The thermometer 76 includes a digital/analog converter 84 connected between microprocessor 86 and a connector 88, such as a plug or socket, for an electric cable 90 leading through the MIC port 92 to the sound card 94. The connector 88 is located at the housing second extremity 96.

In operation analog data representing tones of defined frequency is transferred electrically to the sound card 94 of the computer 78. Each tone frequency represents a different temperature reading. For example, a temperature reading of 36.0 Celsius is represented by a frequency of between 100 and 120 hertz. A 36.1 reading is represented by a frequency of between 121 and 140 hertz, and so on. The highest frequency required, rising in steps of a tenth of a degree, is about 1500 hertz. After the transfer of a tone of a frequency related to the measured temperature from the thermometer 76 to the sound card 94 in the computer, the data is stored by the computer 78 on its hard disk as a WAV file 98. Then data is converted to digital form 100 and is processed, and the resulting temperature reading is determined 102.

The data is then presented to the user in three modes:

1. Using electronically stored human speech elements, stored in ROM 104 in one or several languages (German, French, English etc.) as needed, the computer identifies the file 106 to be announced and by use of the sound card 94 announces the temperature reading 107.
2. A TXT file 108 is opened and temperature readings are stored therein, together with the date, allowing the user to order, print, prepare a graph, send or record the data.
3. Using ROM stored numerical figures 110, and finding the file 112 containing data to be displayed, the temperature reading is shown visually 114 on the computer monitor 116.

FIG. 7 represents an electronic thermometer 118 being used in combination with a data control center 120. Center 120 is arranged to accept and transmit through the internet

122 medical data between the computer 124 of a user of thermometer 118 and the computer 126 of a remote medical authority (RMA), for example a doctor located at a clinic. The RMA receives data on a monitor 128, usually as e-mail, which can be printed if needed. Advantageously the RMA doctor is provided with means 130 to respond, if necessary, primarily to the patient computer screen 131. The data control center 120 allows the sending of data by the RMA to the computer 124 of the thermometer user. Temperature measurements are accurate to within 0.1 0C so that the results can be used for fertility control purposes.

Input and output access of the data control center 120 are protected by programs 132 and 134. The figure illustrates transfer of thermometer output; however the center is arranged to allow transfer also of data generated by other instruments (not shown), for example those monitoring heart rate, blood pressure and glucose level.

Passing now to FIG. 8, there is seen an arrangement allowing patient temperature measurements to be transferred in analogue format. Thus, in the present embodiment the electronic thermometer 76 includes a digital/analog converter 84 connected between the microprocessor 86 and a connector 88 for an electric cable 90, as in FIG. 5. The arrangement enables analog data transfer representing a tone of a frequency related to the measured temperature from the thermometer 76 to a telephone 136. The telephone 136 is either a line phone or a radio phone as illustrated.

It would be within the scope of the Invention to transmit the data by any other suitable means.

The scope of the described invention is intended to include all embodiments coming within the meaning of the following claims. The foregoing examples illustrate useful forms of the invention, but are not to be considered as limiting its scope, as those skilled in the art will readily be aware that additional variants and modifications of the invention can be formulated without departing from the meaning of the following claims.

WE CLAIM:

1. An electronic thermometer with vocal output, comprising

a) an elongated housing having a first extremity and an opposite second extremity, a thermistor being located at said first extremity;

b) a piezoelectric speaker located adjacent to a grill in said housing;

c) an electronic processing system connected to apply a known voltage to said thermistor for measuring the electrical resistance thereof, and to process this measurement and to send corresponding electrical pulses to said speaker to produce a vocal output of the measured temperature, said system including an analog/digital converter and ohmmeter connected to said thermistor, a microprocessor connected to said ohmmeter, a RAM memory connected to said microprocessor to retain at least the latest temperature measurement, a ROM memory connected to said microprocessor to permanently store pre-recorded analog data required for speech generation of words needed for producing temperature announcements, and at least one amplifier connected to said microprocessor; and

d) a retaining device inside said housing for an electric storage battery, said device having connections to power said electronic processing system.

2. The electronic thermometer as claimed in claim 1, further including a numeric display and driver connected to said microprocessor.

3. The electronic thermometer as claimed in claim 1, further including a "TALK" push-button on an outer face of said housing for activating said temperature announcement.

4. The electronic thermometer as claimed in claim 1, further including a "ON" push-button on an outer face for connecting power to said electronic system.

5. The electronic thermometer as claimed in claim 1, wherein said electronic system further includes a circuit to generate audible tones for alerting a user that the thermometer is ready for use, is ready to announce, and is to be switched off.

6. The electronic thermometer as claimed in claim 3, further including a circuit for automatic power cut-off at a predetermined time after last user actuation of a push-button.

7. The electronic thermometer as claimed in claim 1, wherein said first housing extremity is shaped for convenient insertion into a body cavity.

8. The electronic thermometer as claimed in claim 1, wherein said RAM memory has a storage capacity sufficient for all temperature measurements normally taken during a single use.

9. The electronic thermometer as claimed in claim 1, further including a digital/analog converter connected between said microprocessor and a connector for an electric cable, said connector being located at said second extremity, for enabling analog data transfer representing a tone of a frequency related to the measured temperature from said thermometer to the sound card in a computer.

10. The electronic thermometer as claimed in claim 9, when used in combination with a data control center arranged to accept and transmit through the internet medical data between a user of said thermometer and a remote medical authority.

11. The electronic thermometer as claimed in claim 10 wherein said data control center additionally allows the sending of data by said remote medical authority to the computer of the thermometer user.

12. The electronic thermometer as claimed in claim 1, further including a digital/analog converter connected between said microprocessor and a connector for an electric cable,

said connector being located at said second extremity, for enabling analog data transfer representing a tone of a frequency related to the measured temperature from said thermometer to a telephone.

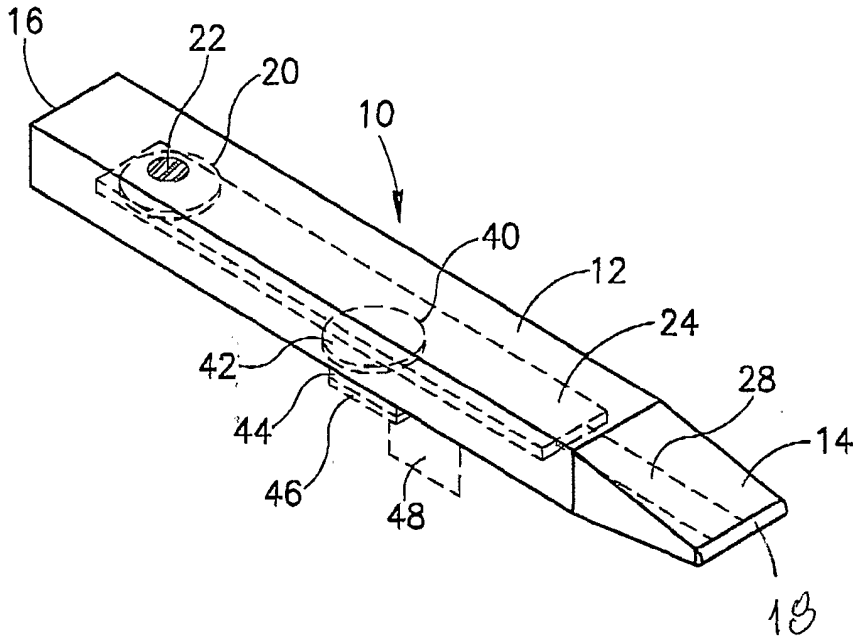
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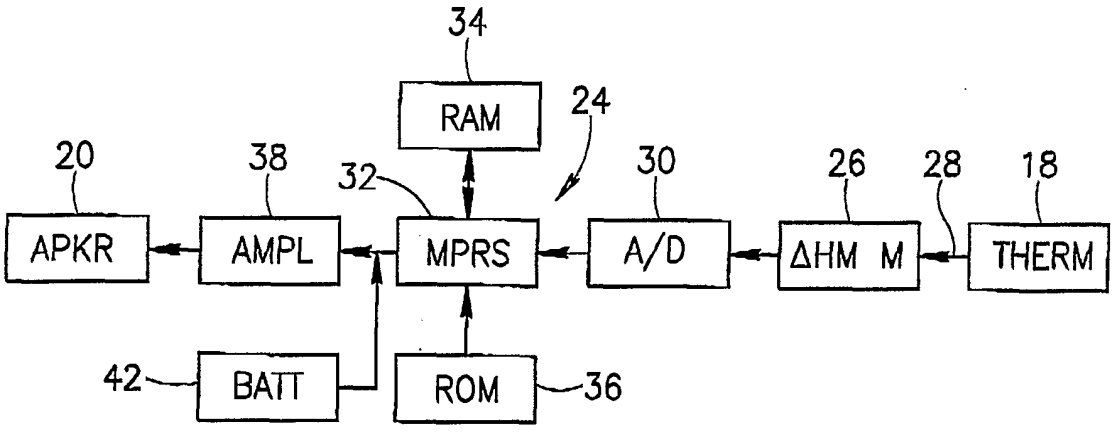
FIG.1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ROM
36

FIG.2

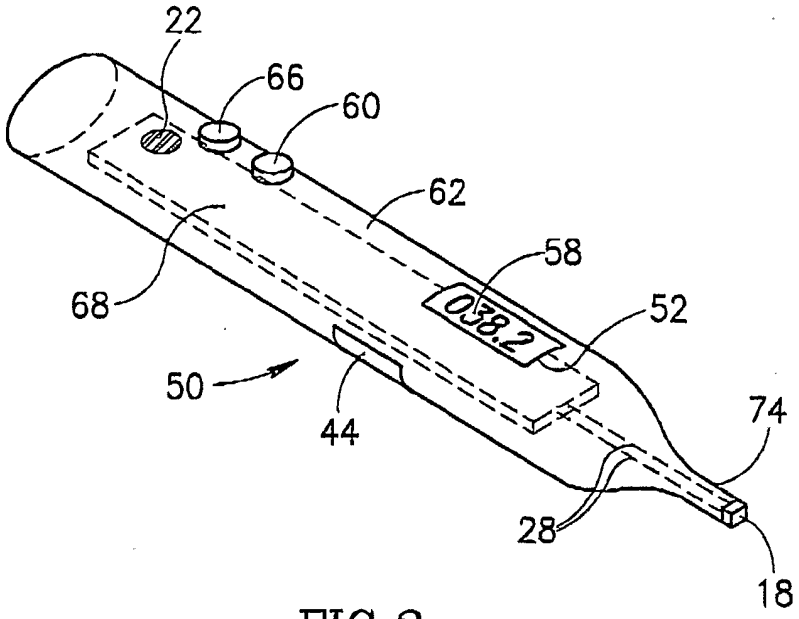
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FIG.3

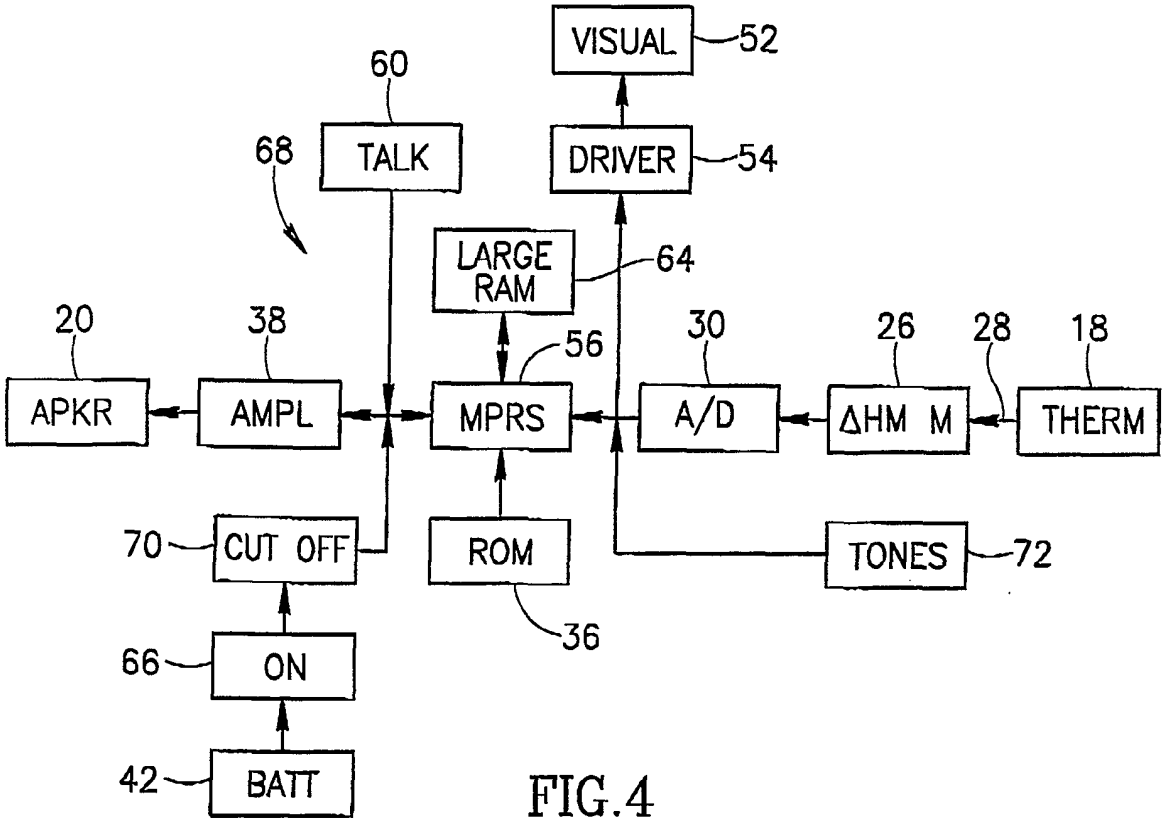
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FIG.4

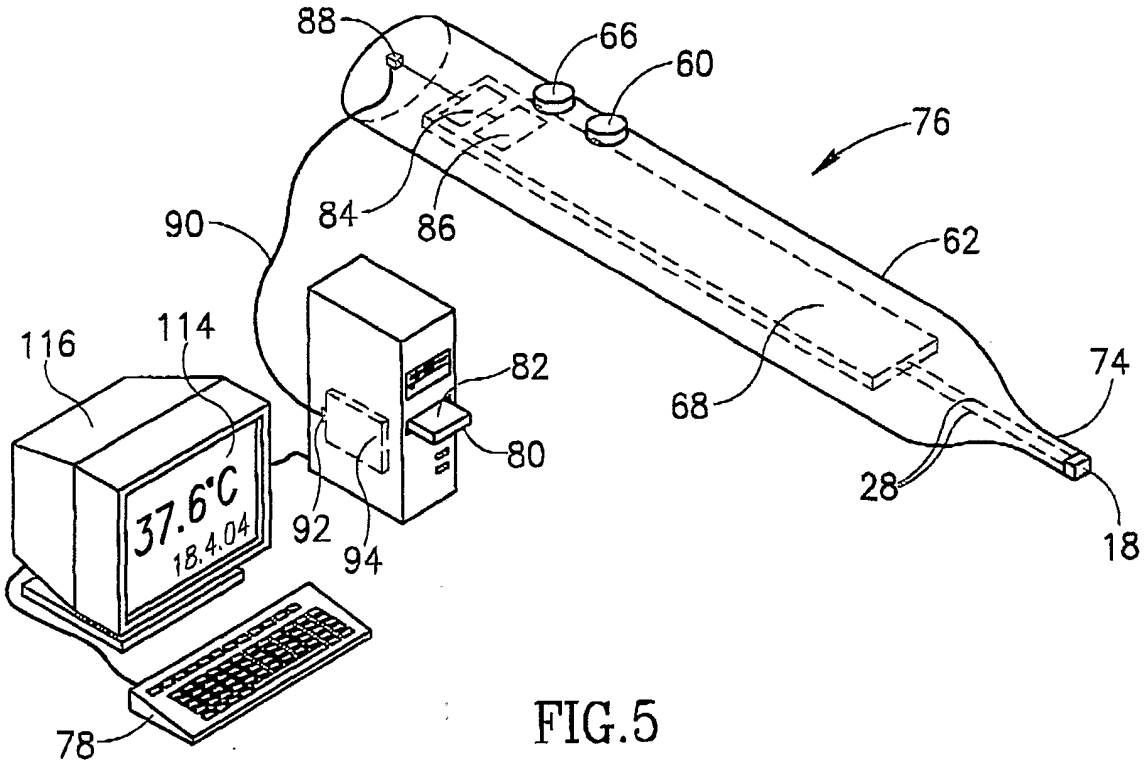
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FIG.5

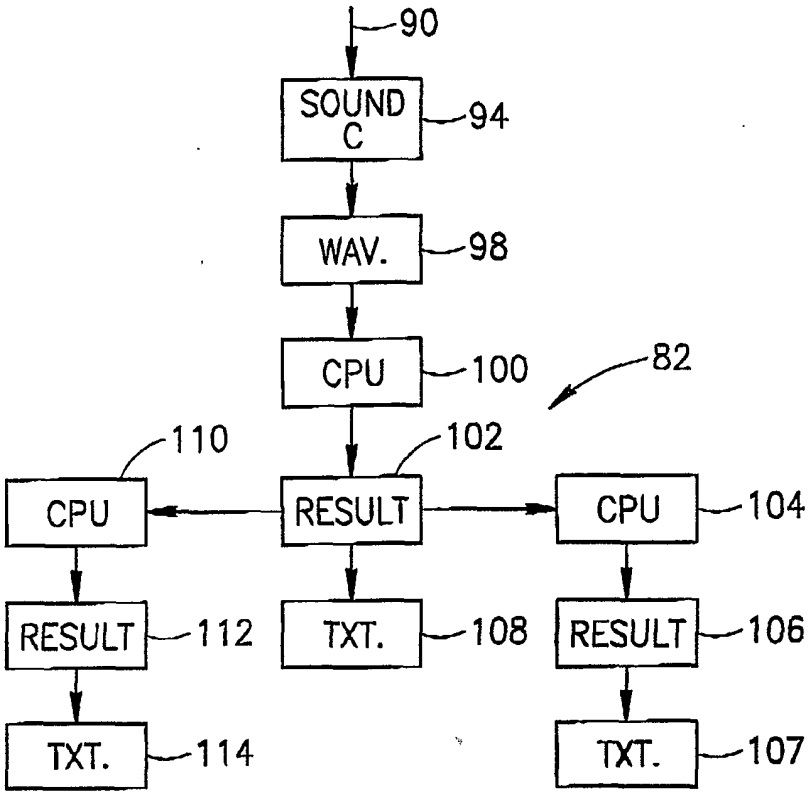
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FIG.6

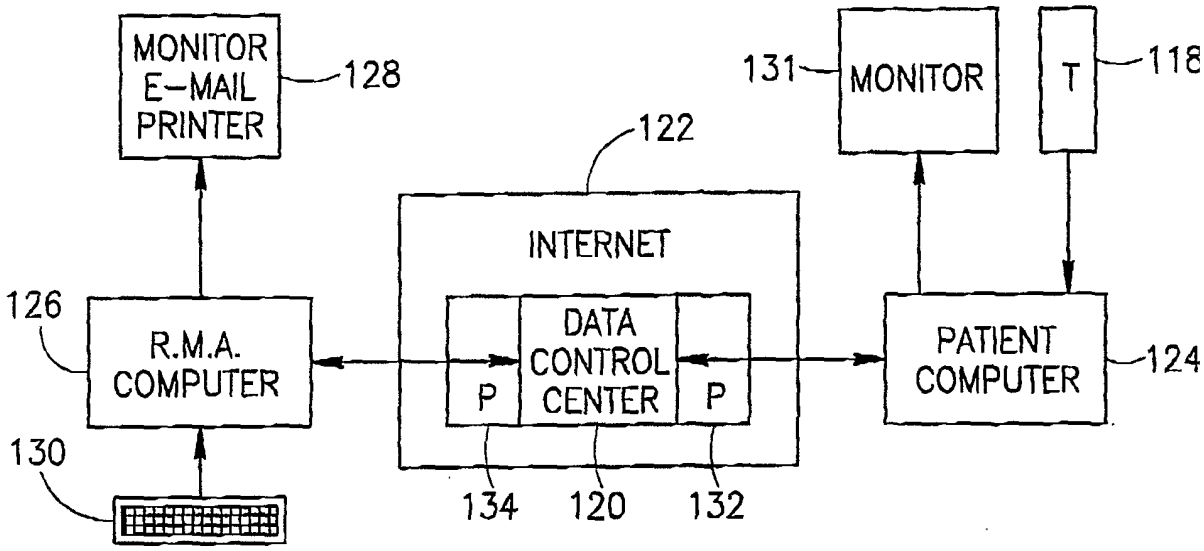
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FIG.7

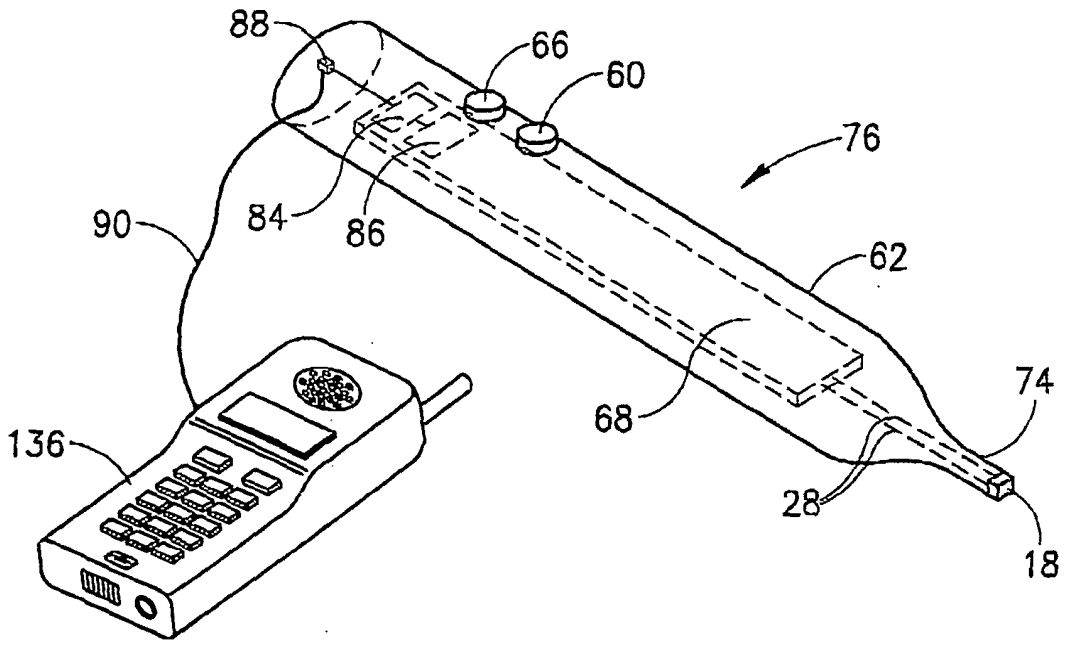
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FIG.8