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(56) Documents Cited
GB 0906006 A EP 0476730 A1 US 5033864 A
US 4676254 A US 4651137 A US 4515167 A

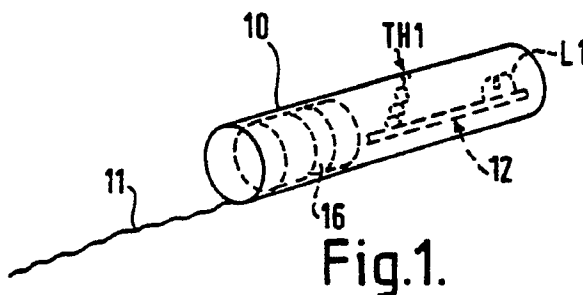
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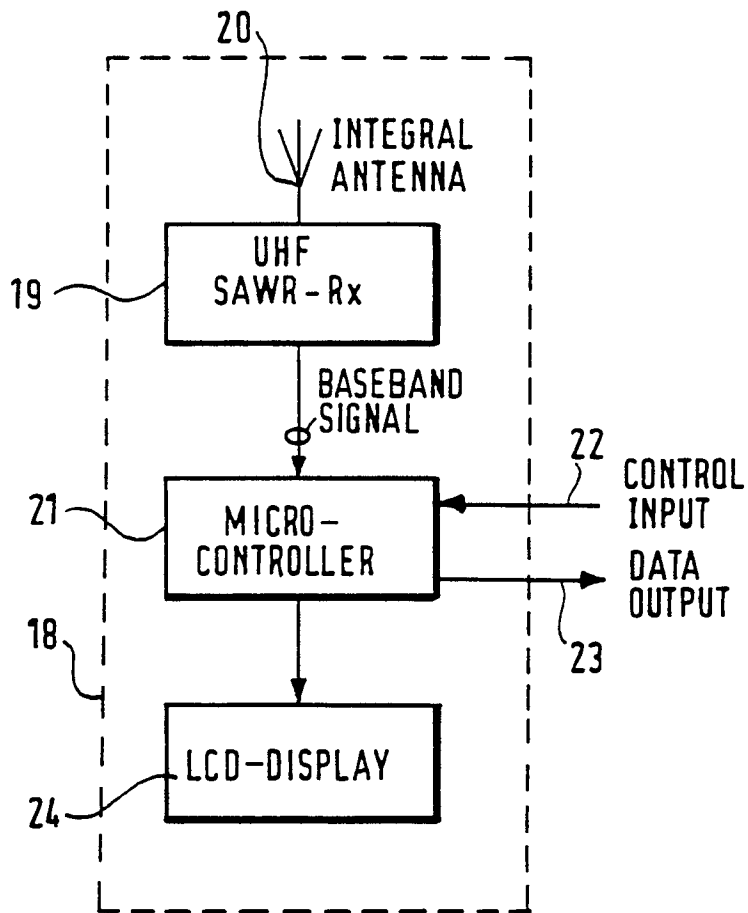
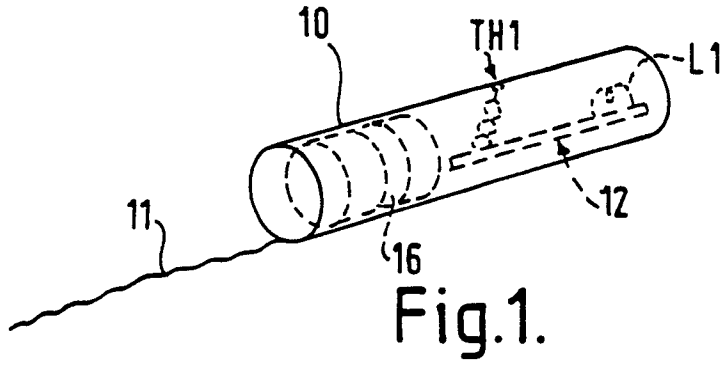
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(54) **Monitoring body temperature**

(57) An apparatus for monitoring body temperature includes a transmitter unit for insertion into a body cavity and a physically separate receiver unit. The transmitter unit includes a housing 10 containing a thermistor TH1 and a radio transmitter 12 for transmitting a radio signal in which variations in the resistance of the thermistor are encoded as a modulation of the signal eg by varying the interpulse interval of a pulse train. The receiver unit has a radio receiver for detecting and demodulating the radio signal.



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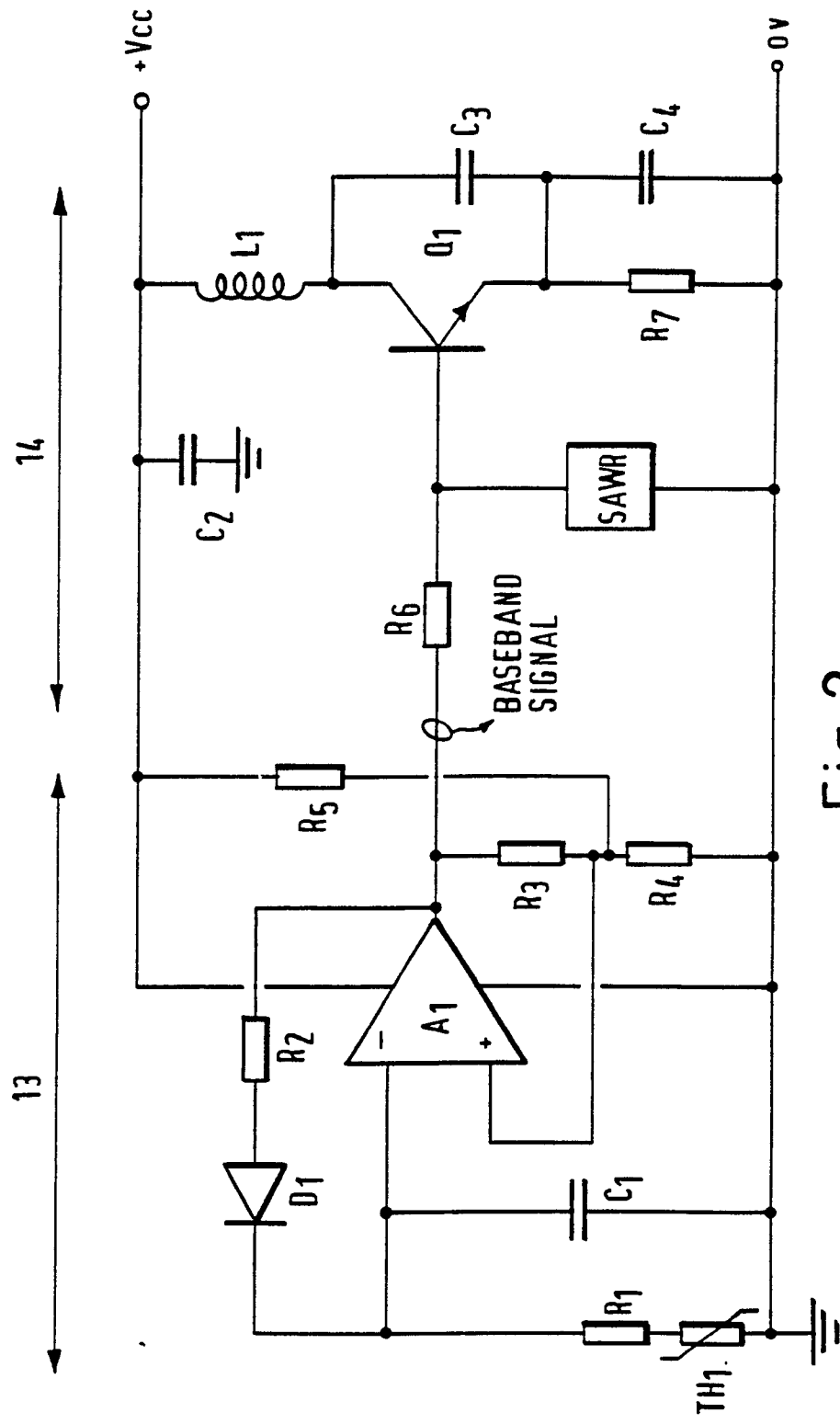


Fig.2.

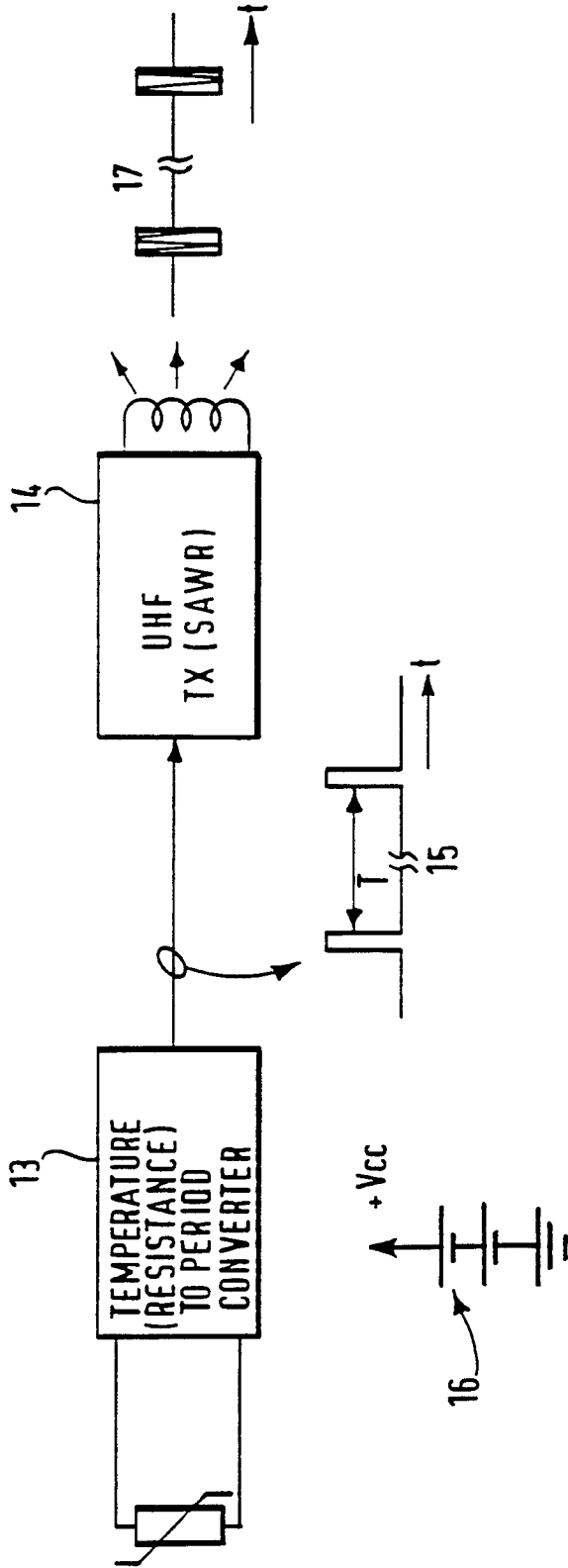


Fig.3.

APPARATUS FOR MONITORING TEMPERATURE

5 This invention relates to an apparatus for
monitoring temperature, especially but not limited to
temperature monitoring in female humans.

10 Temperature monitoring in females is an established
method of indicating ovulation, and hence the likelihood
of the subject to conceive. The information obtained is
valuable for both in-vitro fertilisation and
contraceptive advice. The temperature measurements are
made by the subject at home, usually with an oral
thermometer or, for greater accuracy, a rectal or
15 vaginal sensor.

20 Temperature records of this type are often difficult
for an untrained observer to take accurately. Research
has shown that women do not make measurements at the
same time every day and the manual logging of a single
reading is prone to error. Also, the data obtained is
more reliable if semi-continuous readings are taken, for
example overnight, but this is not practical using
conventional thermometers.

It is an object of the invention to provide an apparatus for monitoring a physiological parameter, such as temperature, which can be "worn" for long periods to permit multiple readings to be taken and logged.

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According to the present invention there is provided an apparatus for monitoring temperature, comprising a transmitter unit including a housing for insertion into a body cavity, the housing containing a component having an electrical characteristic which varies in dependence upon the value of the temperature to be measured and a radio transmitter for transmitting a radio signal in which variations in the electrical characteristic are encoded as a modulation of the signal, and a physically separate receiver unit for detecting and demodulating the radio signal.

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An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

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Figure 1 shows the transmitter unit of the embodiment;

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Figure 2 is a diagram of the electrical circuit within the transmitter unit;

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Figure 3 illustrates the nature of the signals at various points in the transmitter unit electrical circuit; and

Figure 4 is a block circuit diagram of the receiver unit of the embodiment.

The apparatus shown in the drawings is for monitoring the temperature of a female human, and in essence comprises a transmitter unit (figures 1, 2 and 3) which monitors the temperature and transmits it as an amplitude modulated radio signal, and a physically
5 separate receiver unit (figure 4) which detects and demodulates such signal.

The transmitter unit comprises a tampon-like housing
10 10, figure 1, in the form of a hollow, sealed, non-metallic cylinder with approximate dimensions 10 mm diameter by 30 mm long. In use the housing 10 is inserted in the subject's vagina, for which purpose it is made of, or coated with, a suitably inert medically
15 approved barrier coating. A draw cord 11 facilitates removal of the housing.

The subject's temperature is detected by a thermistor TH1, and this is located in the wall of the
20 housing 10, just below the exterior surface, to ensure good thermal transfer from the body tissues. As is well known, the resistance of the thermistor varies as a function of its temperature.

Within the housing 10 there is a printed circuit
25 board 12 carrying the circuit shown in figure 2. This circuit comprises a baseband generator 13 which converts the temperature as measured by the thermistor TH1 into a pulse train whose interpulse period is dependent upon
30 the measured temperature, and a keyed RF oscillator circuit 14 in which the pulse train amplitude modulation a UHF radio signal which is transmitted, by the tank inductor L1 serving as an antenna, to the receiver unit.

The baseband generator 13 is essentially a relaxation oscillator built around a low power CMOS operational amplifier A1. The circuit produces a baseband signal 15 (figure 3) in the form of an output pulse train whose interpulse period T is directly proportional to the resistance of the curve-matched thermistor TH1. T may therefore be easily related to the thermistor's temperature, using published manufacturer's tables.

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The oscillator has two operational time constants, set by the capacitor C1 and either the resistor R2 (for charge up via the steering diode D1) or the series combination of R1 and TH1 (for capacitor discharge). Resistors R3, R4 and R5 form the positive feedback path in the circuit and determine the comparator switching thresholds during the oscillatory cycle. Suitable component values result in an output 15 with a low duty cycle, suitable for keying an active RF source in a low power consumption mode.

20

The RF oscillator circuit 14 is built around the transistor Q1 as the active gain element in a common-base, Colpitts configuration. Resistors R6 and R7 set the bias currents in the oscillator, with R6 also providing ON/OFF control. Capacitors C3 and C4 provide feedback and resonate (in combination with the transistor's parasitic capacitances) with inductor L1 at the desired UHF operating frequency of 418 MHz as determined by a surface acoustic wave resonator SAWR. Such resonators are available which allow circuits to be built over the frequency range 200 - 2000 MHz. The capacitor C2 decouples the power supply rail +Vcc,

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nominally set at between 3 and 6 V DC by an internal battery source 16 (figure 1).

5 The radiated output from the inductor L1, which is a radiating inductor or printed loop antenna, consists therefore of a pulse amplitude modulated (PAM) waveform 17 (figure 3) with a duty cycle set by the baseband generator 13. This is the signal detected by the receiver unit.

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The receiver unit (figure 4) is contained within a housing 18 to provide a compact, portable unit which may be carried unobtrusively on the body of the subject, similar for example to a radio pager.

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In the receiver unit, the transmitted PAM waveform is recovered by a suitable low power receiver 19 with integral antenna 20. The receiver 19 is preferably a superregenerative detector using a SAWR for 20 centre-frequency control. The output from this mimics the original baseband waveform 15 generated at the transmitter unit and so contains the temperature information.

25

A microprocessor 21 processes the baseband signal to extract the temperature data (using a look-up table, for example) and stores it for trend indication as and when required. The microprocessor has a control input 22 to enable the receiver unit to be programmed to carry out 30 specific functions, for example, to set the timing of temperature sampling operations and the number of samples stored per session. Thus, although the transmitter unit is continuously monitoring the temperature and transmitting a corresponding PAM signal,

the receiver unit only samples and processes this signal at times determined by the program. The control input data may be provided from a plug-in keyboard or from another computer. A data output 23 is also provided, to
5 enable the microprocessor's memory to be interrogated as appropriate, for example, at the end of a 10-day measurement period.

Finally, an LCD display 24 provides a status
10 indicator, having outputs such as "ACTIVE", "LAST TEMPERATURE READ", "BATTERY LOW", etc.

The receiver unit is powered by a rechargeable battery pack (not shown) and the microprocessor
15 preferably incorporates a realtime clock and the ability to enter a "sleep" mode to conserve battery power.

Although the receiver unit is normally worn on the body, the range of the signal transmitted by the
20 transmitter unit is about 1 - 2 meters to permit the receiver unit to be removed during sleep periods.

The apparatus can be used in animals or humans. Naturally, the housing 10 of the transmitter unit will
25 be adapted in size and shape to the appropriate cavity into which it is to be inserted.

CLAIMS:

- 5 1. An apparatus for monitoring temperature, comprising
a transmitter unit including a housing for insertion
into a body cavity, the housing containing a
component having an electrical characteristic which
varies in dependence upon the value of the
10 temperature to be measured and a radio transmitter
for transmitting a radio signal in which variations
in the electrical characteristic are encoded as a
modulation of the signal, and a physically separate
receiver unit for detecting and demodulating the
15 radio signal.
2. An apparatus as claimed in claim 1, wherein the
housing contains an electrical circuit for providing
a pulse train whose interpulse period is dependent
20 upon the value of the electrical characteristic, the
radio signal being amplitude modulated by the pulse
train.
3. An apparatus as claimed in claim 2, wherein the
25 electrical circuit comprises a relaxation oscillator
having the component as a timing element.
4. An apparatus as claimed in claim 2 or 3, wherein the
radio transmitter comprises a SAWR-controlled
30 oscillator operating in the UHF band.
5. An apparatus as claimed in claim 2, 3 or 4, wherein
the receiver unit comprises a radio receiver for
recovering the pulse train and means for determining
the value of the temperature therefrom.

6. An apparatus as claimed in claim 5, wherein the radio receiver comprises a superregenerative detector using a SAWR for centre frequency control.
- 5 7. An apparatus as claimed in claim 5 or 6, wherein the means for determining the value of the parameter comprises a microprocessor.
- 10 8. An apparatus as claimed in any of claims 1-8, wherein the component is a thermistor.
- 15 9. An apparatus as claimed in any preceding claim, wherein the housing is of cylindrical form for insertion into a vagina.
- 20 10. An apparatus for monitoring body temperature, substantially as described herein with reference to the accompanying drawings.

Patents Act 1977
 Examiner's report to the Comptroller under Section 17
 (The Search report)

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Relevant Technical Fields

- (i) UK Cl (Ed.N) G1N (NENT, NESS); H4L (LCAX, LCX)
- (ii) Int Cl (Ed.6) A61B 5/00; G01K 13/00

Search Examiner
 MR S CLARK

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 28 FEBRAURY 1995

Databases (see below)

- (i) UK Patent Office collections of GB, EP, WO and US patent specifications.
- (ii) ONLINE: WPI

Documents considered relevant following a search in respect of Claims :-
 1

Categories of documents

- X:** Document indicating lack of novelty or of inventive step.
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- P:** Document published on or after the declared priority date but before the filing date of the present application.
- E:** Patent document published on or after, but with priority date earlier than, the filing date of the present application.
- &:** Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
X	GB 0906006 A (NAGUMO) pages 3 and 4	1, 2, 3, 5, 8
X	EP 0476730 A1 (HOLLANSE) whole document	1, 2, 3, 5, 7
X	US 5033864 (LASECKI ET AL) whole document	1
X	US 4676254 (FROHN) whole document	1
X	US 4651137 (ZARTMAN) particularly Figure 4c	1
X	US 4515167 (HOCHMAN) lines 57-68 Column 8	1, 8
	EP 0195207 A2 is equivalent to US 4676254	

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