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(54) **METHOD AND APPARATUS FOR DETERMINING FLOW RATES OF EXCRETED OR SECRETED BODY FLUIDS**

Publication Classification

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(57) **ABSTRACT**

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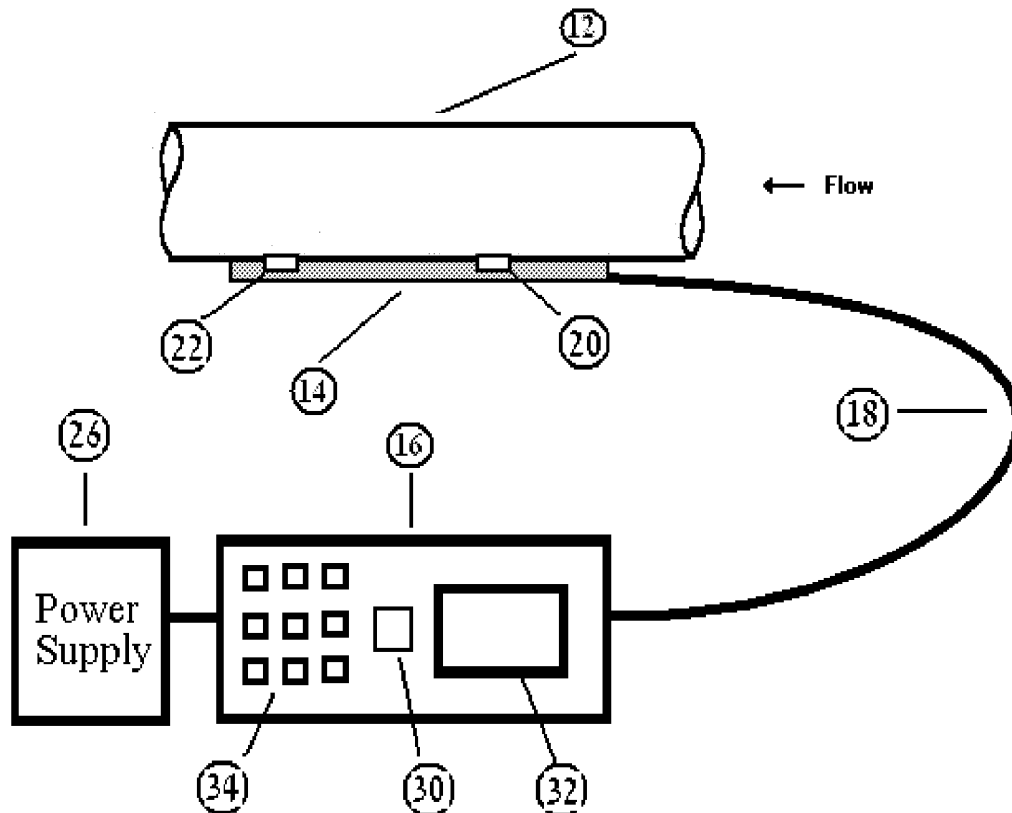
The invention relates to an apparatus and method to determine and monitor the flow rates and volume of fluids excreted or secreted by the body. The apparatus includes: a measuring unit comprising a conduit made of a material having a low thermal conductivity and supporting at least two thermistors that includes an upstream thermistor serving as a compensation thermistor and a downstream thermistor located as far downstream as possible from the upstream thermistor and pre-heated to and kept at pre-defined temperature which is warmer than the fluid temperature to be metered. The apparatus further includes a power supply for applying small electric voltages to the thermistors to enable generation of an electric signal; and a control and display unit being operatively connected to the measuring unit.

Related U.S. Application Data

(63) Continuation of application No. 14/643,379, filed on Mar. 10, 2015, now abandoned, which is a continuation-in-part of application No. 13/636,718, filed on Dec. 19, 2012, now abandoned, filed as application No. PCT/IL2011/000232 on Mar. 10, 2011.

Foreign Application Priority Data

(30) Mar. 25, 2010 (IL) 204752



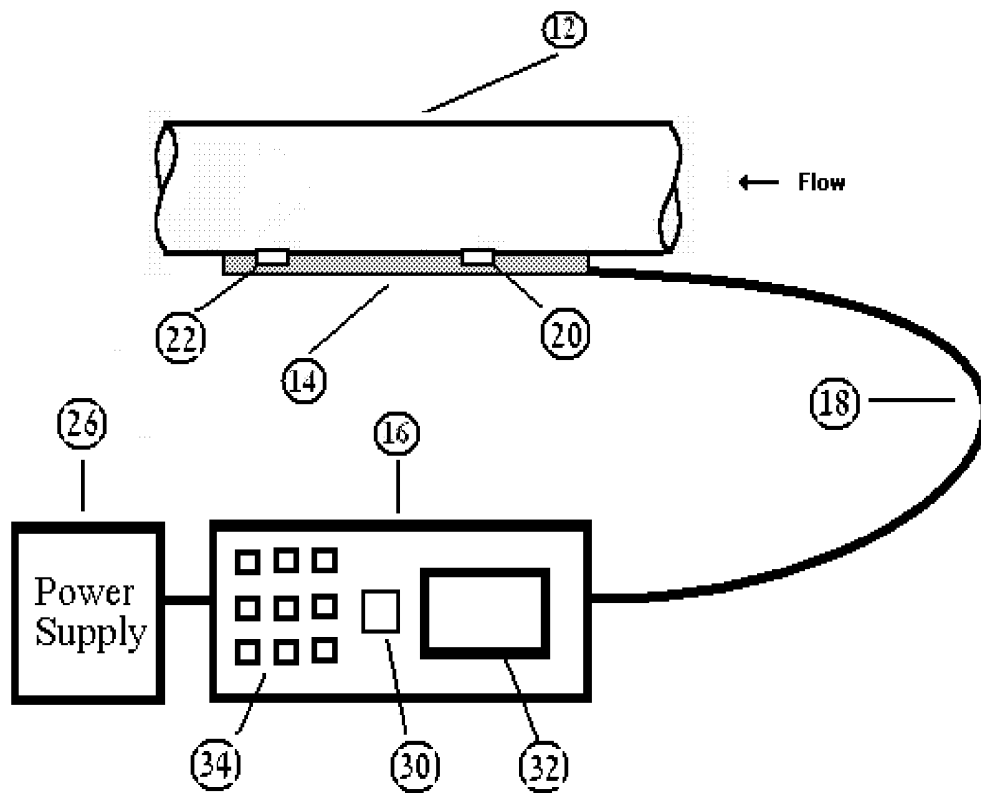


Figure 1

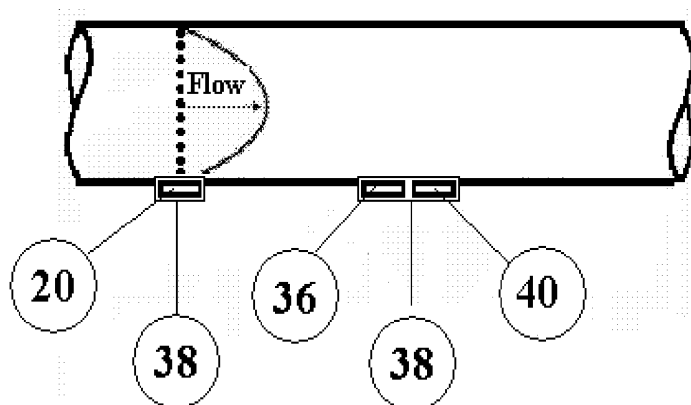


Figure 2

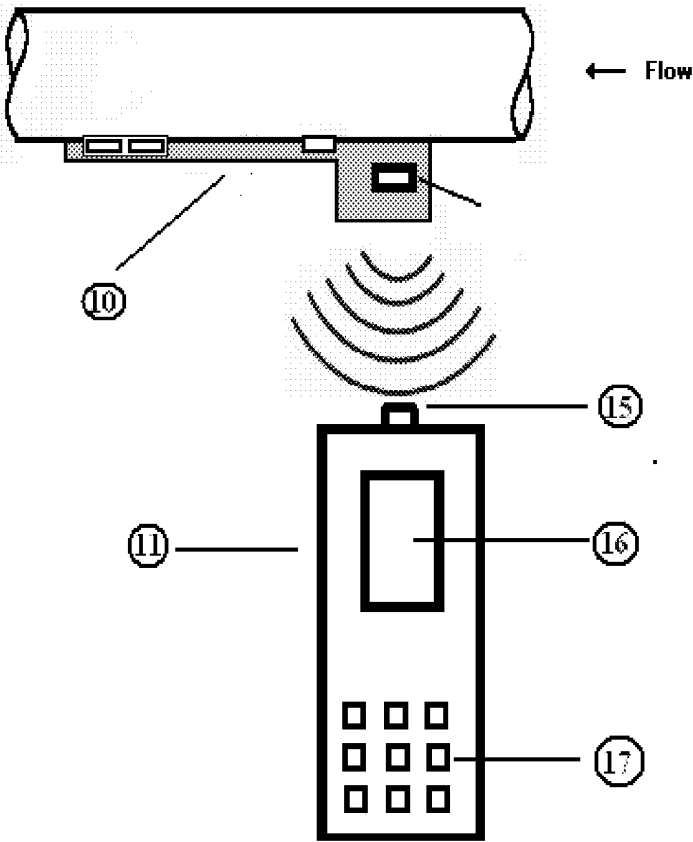


Figure 3

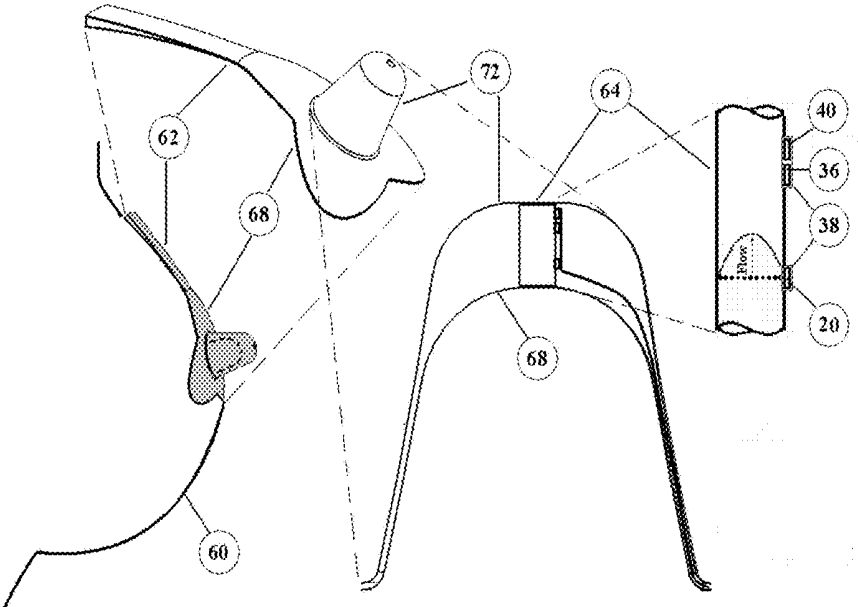
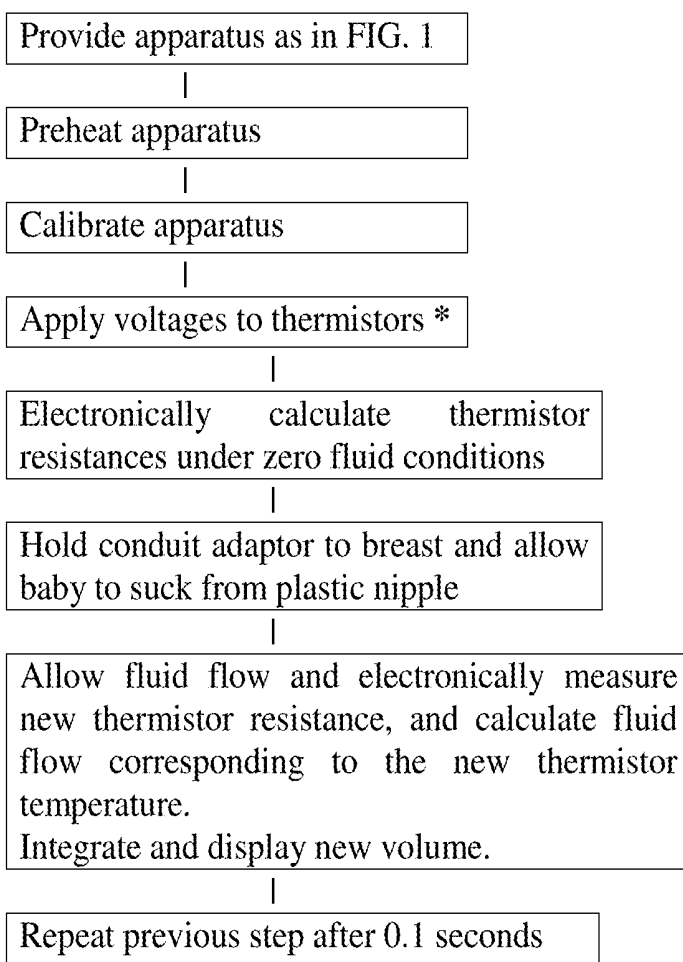


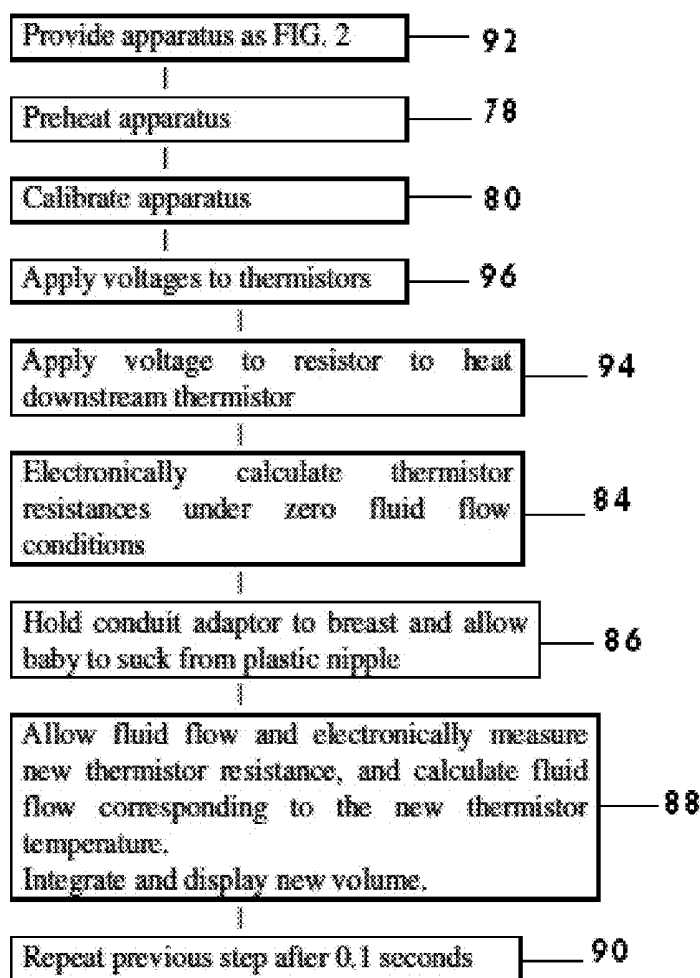
Figure 4

FIG. 5



*Apply voltage over 15 volt to heat downstream thermistor

FIG. 6



*Apply voltage over 15 volt to heat downstream thermistor

**METHOD AND APPARATUS FOR
DETERMINING FLOW RATES OF
EXCRETED OR SECRETED BODY FLUIDS**

**CROSS REFERENCE TO RELATED
APPLICATIONS**

[0001] This application is a Continuation Application of U.S. patent application Ser. No. 14/643,379, filed on Mar. 10, 2015, which is a Continuation Application of U.S. patent application Ser. No. 13/636,718, filed on Dec. 19, 2012, which is a National Phase Application of PCT International Application No. PCT/IL2011/000232, International Filing Date Mar. 10, 2011, entitled “Method and Apparatus for Determining Flow Rates of Excreted or Secreted Body Fluids”, which claims the benefit of Israel Patent Application No. 204752, filed Mar. 25, 2010, all of which are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to health care products and methods and more particularly to an apparatus and method to determine and monitor the flow rates and volume of fluids excreted or secreted by the body.

DESCRIPTION OF THE RELATED ART

[0003] Body fluids are liquids that are inside the bodies of humans and animals. They include fluids that are excreted or secreted from the body as well as body water that is normally retained inside the body. Excretion is the process of eliminating waste products of metabolism and other superfluous substances. It is an essential process in all forms of life. In contrast is secretion, where the fluid may have specific tasks after leaving the cell or organ.

[0004] An example of excretion can be found in the urinary system, where the urinary bladder is the excreting organ and the urine is the excreted fluid. An example of secretion can be found in lactation, where the mammary glands are the secreting organ and the fluid is milk ideally suited to babies.

[0005] The functioning of organs that perform the secretion and excretion of fluids can be diagnosed and studied by measuring the flow rate of the fluid. Current devices and methods for measuring flow rates of e.g., urine and breast fluid are based on weighing the accumulated fluid in a defined unit of time (1 minute, 24 hours, etc.). Urine flow rate is measured by uroflowmeters and lactation is measured by test weighing of babies.

[0006] These current procedures require rather sensitive and thus expensive scales. They also require the presence of the subject in a clinic—test-weighing, for instance, is done by weighing the subject (a baby) before a breastfeeding session as well as during and immediately after the session, for a period of 24 hours.

[0007] There are many fluid flow-meters on the market, but none are known which can be used to meet the exceptional challenges posed by lactation. A first difficulty lies in the direct transfer of the fluid from the breast of the woman nursing directly to the mouth of a baby, leaving no room for instrumentation. A second difficulty is the intermittent nature of the flow. Thirdly the actual flow rate is of little interest—the data required is usually the volume of milk drunk by a baby under special care.

[0008] A search of U.S. patents and patent applications produced patents U.S. Pat. No. 5,571,226 to Palmer and U.S. Pat. No. 6,358,226 to Ryan which disclose electrically operated means for lactation, the milk being received in a container. Measuring a baby’s consumption could be effected by pouring the extracted milk from these devices into the widely used graduated baby bottle, which allows convenient monitoring of the baby’s fluid intake.

[0009] These devices require considerable power, the bulk of the apparatuses is cumbersome in mobile use, and the transfer of the milk from a first container to a second container is less hygienic than direct fluid passage from the woman to the baby.

OBJECT OF THE INVENTION

[0010] An object of the present invention is therefore to solve the above discussed problems and to provide an inexpensive device and method of measuring the rate and quantity of fluids secreted or excreted by the body, particularly milk being ingested from the breast by an infant.

[0011] It is a further object of the invention to provide a device which can be operated by non-medical persons in a private home without expert medical help.

SUMMARY OF THE INVENTION

[0012] The present invention achieves the above objects by providing an apparatus for determining the flow rate and amount of a selected secreted or excreted body fluid, comprising:

[0013] a) a measuring unit comprising a conduit made of a material having a low thermal conductivity and supporting at least two thermistors; an upstream thermistor serving as a compensation thermistor and a downstream thermistor located as far downstream as possible from said upstream thermistor and pre-heated to and kept at pre-defined temperature which is warmer than the fluid temperature to be metered;

[0014] b) means for applying small electric voltages to said thermistors to enable generation of an electric signal, said electric voltages flowing through said upstream thermistor being sufficiently low to prevent substantial heating of said thermistor; and

[0015] c) a control and display unit being operatively connected to said measuring unit, said control unit including means for calculating the difference between the electrical resistance of said upstream and said downstream thermistors and then calculating the flow rate based on the electrical resistance difference being a function of the body fluid flow rate and then calculating the accumulated amount of fluid based on the internal cross section of said conduit in which said fluid flows; and comprising a display for displaying the flow rate (optionally) and displaying the accumulating volume of body fluid being metered.

[0016] In a preferred embodiment of the present invention there is provided an apparatus further comprising a heating element, thermally coupled to said downstream thermistor and distant from said upstream compensation thermistor, said heating element heating said downstream thermistor and maintaining said downstream thermistor in a pre-defined temperature range.

[0017] An alternative embodiment of the apparatus further comprises a heating element, thermally coupled to said downstream thermistor and distant from said upstream com-

pensation thermistor, said thermistors and heating element being supplied with a fixed constant regulated level of electric power.

[0018] In a further preferred embodiment of the present invention there is provided an apparatus wherein said heating element has a low electrical resistance and is powered by a low voltage power supply, the combination of which is sufficient to maintain said downstream thermistor at said constant pre-defined temperature.

[0019] In another preferred embodiment of the present invention there is provided an apparatus wherein said heating element is thermally coupled to said downstream thermistor by means of a heat conducting material.

[0020] In a further preferred embodiment of the present invention there is provided an apparatus wherein said connector means for interconnecting said control and display unit to said measuring unit comprises a connection selected from the group comprising electronic circuitry, a data and power communication cable, and an electromagnetic transmitter/receiver.

[0021] In a further preferred embodiment of the present invention there is provided an apparatus for determining the flow rate and amount of milk passing from the breast of a woman to a baby, comprising

[0022] a) a measuring unit having a short conduit containing at least two thermistors;

[0023] b) an adaptor arranged to fit and retain contact with the nipple area of the breast, said adaptor being attached to an upstream extremity of said short conduit;

[0024] c) a baby nipple attached at a downstream extremity of said conduit; and

[0025] d) a control and display unit as seen in FIG. 1 operatively connected to said measuring unit.

[0026] In another preferred embodiment of the present invention there is provided a method for determining the flow rate and amount of secreted or excreted body fluid, comprising the following steps:

[0027] step a) providing an apparatus a detail of which is seen in FIG. 2;

[0028] step b) applying a voltage of about 15-50 volt across said downstream thermistor to serve as an integral heat source, the temperature of said downstream thermistor being held constant at about 39-45 degrees C.;

[0029] step c) applying a low voltage of about 2-6 volts across said upstream thermistor to generate an electric measurement varying with the fluid flow with which said downstream thermistor is in direct thermal contact;

[0030] step d) preheating said apparatus;

[0031] step e) introducing the body fluid to be monitored into the upstream extremity of said conduit; and

[0032] step g) several times per second measuring the electric current flowing through both of said thermistors, and calculating the difference between said currents, and calculating the fluid flow rate as a function of thermistor resistance while using a memory component to effect corrections as required for any particular unit, and integrating the series of values over time to arrive at the increasing volume of fluid having passed through said conduit and displaying the value of said volume.

[0033] In a most preferred embodiment of the present invention there is provided a method for determining the flow rate and amount of secreted or excreted body fluid except that in step c) said voltage applied across said downstream thermistor is less than 15 volts and heating of

said downstream thermistor is effected by a resistance element in close thermal contact with said downstream thermistor and with said body fluid.

[0034] The use of thermistors ensures high sensitivity through large resistance change (negative change—for NTC thermistor, or positive change—for PTC thermistors) and corresponding large voltage signal for small changes in their temperature, induced by the fluid, at no-flow situation or during constant or varying flow rates. As such, the use of thermistors is preferable, but other electrical resistance elements, presenting resistance change over temperature, can also be used.

[0035] It will thus be realized that the novel device of the present invention serves to provide an apparatus and a method are provided for determining the flow rate and amount of secreted or excreted body fluids. The apparatus includes a measuring unit and a control and display unit. Depending on the required configuration of the apparatus, a connector cable, an electronic circuitry, a data communication cable, or electromagnetic transmitter/receiver, may be used for connecting the measuring unit to the control and display unit.

[0036] The measuring unit may comprise a set of two or three electrical components—two thermistors (NTC or PTC) or a resistor and two thermistors (NTC or PTC), mounted, in direct contact with the fluid, within the wall of a conduit that defines an outlet through which the fluid passes.

[0037] The display means may comprise a liquid crystal or similar display, and/or may be adapted to print a graphical representation of the data received from measuring unit.

[0038] The display means may also include a number of keys for entering data (e.g. the name of the subject, his age, etc.) or for selectively display of the flow rate or amount of fluid per measuring session, the accumulating amount of fluid in several measuring sessions, and previously measured fluid flow rates or accumulated amounts.

[0039] Thus, the apparatus according to the invention provides the subject, in real time, with an indication of the volume of fluid that is excreted or secreted from the body. It would accordingly no longer be necessary to follow the cumbersome weighing process mentioned hereinbefore.

[0040] 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] In the drawings:

[0042] FIG. 1 is a diagrammatic view of a preferred embodiment of the apparatus according to the invention;

[0043] FIG. 2 is an enlarged sectional view of a part of the apparatus having an auxiliary heating element;

[0044] FIG. 3 is a schematic view of an embodiment wherein the measuring unit is connected to the control and display unit by a radio or infrared link;

[0045] FIG. 4 is a sectional view of an apparatus arranged for monitoring lactation;

[0046] FIG. 5 is a diagram of a method which operates without any auxiliary heater; and

[0047] FIG. 6 is a diagram of a method which operates with an auxiliary heater at low voltage.

DETAILED DESCRIPTION OF THE INVENTION

[0048] There is seen in FIG. 1 an apparatus 10 for determining the flow rate and amount of a selected secreted or excreted body fluid passing through a conduit 12.

[0049] The apparatus 10 comprises a measuring unit 14, a control and display unit 16, a data and power link 18 interconnecting these units, and a power supply 26, which can be integral to the control and display unit 16.

[0050] The measuring unit 14 comprising a conduit 12 made of a material having a low thermal conductivity and supporting two thermistors 20, 22. The conduit 12 is made of a grade suitable for the transmission of the measured fluid, e.g., food grade material for lactation measurement. The low thermal conductivity of the conduit material allows for reducing the heat loss from the heated thermistor 22 to the environment and thus allows effective heat transfer from the electrical components 20, 22, directly to the measured fluid. The upstream thermistor 20 serves as a compensation thermistor. The electrically heated downstream thermistor 22 is wired in parallel to the upstream thermistor. The thermistors 20, 22 are located as far away as possible from each other. The downstream thermistor 22 is cooled by the body fluid flowing through the conduit 12, and is held at pre-defined temperature which is about 2-8 degrees warmer than the temperature of the body fluid being metered. Preferably, both thermistors 20, 22 are surface mounted devices mounted on a flexible printed circuit board 24 seen in FIG. 2. Both thermistors 20, 22 are mounted in direct contact with the fluid within the conduit 12 through which the body fluid passes.

[0051] With regard to applying electric voltages to the thermistors 20, 22 to enable the generation of an electric signal, in the present embodiment the needed power can be supplied by a multi-voltage transformer/rectifier 26 or a similar power supply which is arranged to provide over 15 volt to the downstream thermistor. The precise voltage is arranged to be sufficient to heat the thermistor between 2 and 8 degrees C. above the temperature of the body fluid being metered. Thus, there is no requirement for an auxiliary heater.

[0052] The control and display unit 16 is operatively connected to the measuring unit 14 in the present embodiment by means of a flexible cable 18.

[0053] The control and display unit 16 includes means for calculating the difference between the electrical signals from the upstream and the downstream thermistors 20, 22 and then calculating the fluid flow rate based on these values. The difference between the two values is a function of the body fluid flow rate. The control unit 16 then calculates the accumulated amount of fluid which has passed through the conduit by an integration function based on the internal cross section of the conduit 12 in which the fluid flows.

[0054] The electrical signal of the upstream compensation thermistor 20 will relate to the temperature of the fluid. This value is deducted from the electrical signal value registered by the downstream measuring thermistor 22. The compensated electrical signal value registered by the downstream measuring thermistor is an independent signal that is free of the influence of temperature changes of the fluid. Keys 34

are provided to enable users to enter data such as the name of the baby, date and time etc.

[0055] These calculations are easily performed by a microprocessor 30 located in the control and display unit 16. Readings are taken and processed many times per second. The microprocessor 30 uses these readings and the calibration data in the memory component of the measuring unit to convert the signal to flow data. The flow data is then integrated over time to give the accumulating amount of fluid which has passed through the conduit, based on the cross section area thereof. This value is then shown on the LCD display 32. Optionally the display 32 also shows the flow rate.

[0056] In the present higher voltage apparatus, the temperature rise is induced by applying a voltage directly to the thermistor 22. The thermistor 32 is encapsulated using a highly thermally conductive compound 38, seen in FIG. 2, for electrically isolating the thermistor from the fluid, while being in direct contact with it.

[0057] With reference to the rest of the figures, similar reference numerals have been used to identify similar parts.

[0058] Referring now to FIG. 2, there is seen an apparatus 38 further comprising a heating element 36, which is thermally coupled to the downstream thermistor 22 and distant from the upstream compensation thermistor 20 seen in FIG. 1. Using a separate resistor 36 for heating purposes, allows use of a high resistance thermistor 40 for flow measurement. The use of a separate heating resistor also eliminates the self heating effects of the thermistor 40, and allows a low current electrical circuit to be used to generate the electric signal from the thermistor 40.

[0059] The heating element 36 raises the temperature of the downstream thermistor 40, and maintains the downstream thermistor in a pre-defined temperature range. The precise voltage is arranged to be sufficient to heat the thermistor between 2 and 8 degrees C. above the temperature of the body fluid being metered.

[0060] Alternatively, the downstream thermistor 40 is provided with a controlled quantity of power, and fluid flow is calculated from the temperature loss of the thermistor 40.

[0061] As will be seen in FIG. 4, with regard to applying small electric voltages to the thermistors 20, seen in FIG. 1, and the thermistor 40 to enable the generation of an electric signal, in the present embodiment the needed power can be supplied by batteries 42 which are small enough to be housed in the control and display unit 44. It should be noted that the electrical signal generated by the thermistor 20 is required to be sufficiently low to prevent substantial heating thereof, while maintaining the downstream thermistor at the constant pre-defined temperature.

[0062] Preferably the heating element 36 is thermally coupled to the downstream thermistor 40 by means of a heat conducting material, for example copper.

[0063] When there is a flow of a body fluid the electric signal value received from the upstream compensation thermistor 20 will register the value that corresponds to the temperature of the body fluid, while the electric signal obtained from the downstream measuring thermistor 40 will change as a function of the flow rate—the higher the flow rate the larger the change. The heating element 36 provides heat to this thermistor 40, to return same to its original value after flow ceases.

[0064] The electrical signal values of the thermistors 20, 40 when in use, which in turn represent thermistor tempera-

ture, and the reduction of temperature on the downstream thermistor 40 indicates the flow rate of the body fluid which acts as a coolant.

[0065] FIG. 3 illustrates an apparatus 46 wherein the means for interconnecting the control and display unit 48 to the measuring unit 50 comprises an electromagnetic transmitter/receiver 52, 54.

[0066] Electric power is preferably supplied by batteries 42 in the measuring unit 50, while either batteries or a transformer/rectifier supply power 26 is contained in the control and display unit 48.

[0067] Seen in FIG. 4 is an apparatus 58 adapted for the specific purpose of determining the flow rate and amount of milk passing from the breast 60 of a woman to a baby (not shown).

[0068] A measuring unit 62 has a short conduit 64 containing two thermistors 20, 22 as described with reference to FIG. 1. This unit 62 is held in position by a vest, a bra or a special belt 66 which is arranged to support the measuring unit 62.

[0069] A flexible adaptor 68 is arranged to fit and retain contact with the nipple area of the breast 60, the adaptor 68 being attached to the upstream extremity 70 of the short conduit 64.

[0070] An elastomer baby nipple 72 is attached at a downstream extremity 74 of the conduit 64.

[0071] The adaptor 68 and nipple 72 can be molded as an integrated unit.

[0072] A control and display unit 16 as described with reference to FIG. 1 is operatively connected to the measuring unit 62 by a cable 18.

[0073] Referring now to FIG. 5, there is depicted diagrammatically a method for determining the flow rate and amount of secreted or excreted body fluid, comprising the following steps:

[0074] STEP a) providing an apparatus as seen in FIG. 1. 76

[0075] As minor variations occur during the production process of the measuring unit, and since each electronic component in the measuring unit is inherently different, a calibration of this unit is required. A memory component (e.g., EPROM) may be used to store calibration data. The calibration data should represent the true resistance-temperature data of the components in the measuring unit.

[0076] STEP b) applying a voltage 82 of about 15-50 volt across the downstream thermistor to serve as an integral heat source, 82 the temperature of the downstream thermistor being held constant at about 39-45 degrees C., or the thermistor being supplied with a precisely constant regulated power level;

[0077] Using the available calibration data, stored in the memory component of the measuring unit the electrical signal generated on the thermistors can then be corrected and used for calculating the flow rate. This is done by the microprocessor (or microcontroller) inside the control and display unit in which a pre-defined table (or equation) is stored, representing the specific electrical signal that corresponds to the specific flow rate.

[0078] STEP c) applying a voltage 82 of about 2-6 volts across the upstream thermistor to generate an electric signal varying with the fluid flow with which the downstream thermistor is in direct thermal contact;

[0079] STEP d) preheating 78 of the apparatus;

[0080] The pre-heating is essential for eliminating transient phenomena of resistance change of the thermistor when the flow starts and it allows for measurement to start immediately at the start of the flow. The apparatus can thus continuously measure the fluid flow (usually non stable, or oscillating flow), from start, based on small changes from a baseline resistance of the thermistor, corresponding to the pre-defined temperature. These small changes correspond to the fluid flow, and allow fast response of the measuring unit.

[0081] The correct pre-heating of the resistor, or the thermistor, should be determined based on the fluid to be measured (for e.g. retaining the original characteristics of the fluid, maintaining the overall original temperature of the fluid, etc.) and based on the thermal behavior of the thermistor e.g., the resistance-temperature behavior at the relevant temperature ranges, the maximum allowed power over the component, etc. For example, the initial temperature of the thermistor in a lactation measurement apparatus may be predefined to be between 39-45° C., based on the fact that the breast milk exits the body at 35-37° C. at the skin surface, and based on need to maintain the overall temperature of the fluid in human-relevant temperatures.

[0082] STEP e) introducing the body fluid 86 to be monitored into the upstream 88 extremity of the conduit; and

[0083] STEP g) 10-200 times per second measuring 90 the voltage over both of the thermistors, and calculating the difference between the voltages, and calculating 84 the fluid flow rate as a function of the downstream's thermistor's compensated voltage while using a memory component to effect corrections as required for any particular unit, and integrating the series of values over time to arrive at the increasing volume of fluid having passed through the conduit and displaying the value of the volume.

[0084] FIG. 6 represents a second method for determining the flow rate and amount of secreted or excreted body fluid. The second method 78-96 is similar to that described with reference to FIG. 5 except that the downstream thermistor is heated 94 by an electric resistance element. The advantage of this arrangement is in obviating the need to apply a higher voltage to the downstream thermistor.

[0085] Accordingly, in STEP c) the voltage applied 96 across the downstream thermistor is less than 15 volts and heating of the downstream thermistor is effected by said resistance element in close thermal contact with the downstream thermistor and with the body fluid.

[0086] The temperature of the thermistor should preferably be raised, by pre-heating of the heating element (resistor or thermistor itself) to several degrees higher than the expected temperature of the fluid, prior to the measurement starting point. Either the downstream thermistor is kept at this pre-defined constant temperature, by starting and stopping the power supply to the heating element based on the resistance value of the thermistor that corresponds to its temperature, or this thermistor is supplied with a precisely constant power level.

[0087] Using the available calibration data, stored in the memory component of the measuring unit the electrical signal generated on the thermistors is then corrected and used for calculating the flow rate. This is done by the microprocessor (or microcontroller) inside the control and display unit in which a pre-defined table (or equation) is stored, representing the specific voltage signal that corresponds to the specific flow rate.

[0088] 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 be aware that additional variants and modifications of the invention can readily be formulated without departing from the meaning of the following claims.

We claim:

1. An apparatus for determining a flow rate and amount of a body fluid, comprising:

a conduit made of a material having a low thermal conductivity;

an upstream thermistor located in the conduit;

a heating element; and

a downstream thermistor to be located downstream from said upstream thermistor along the conduit,

wherein said downstream thermistor is pre-heated by the heating element to a temperature which is warmer than the body fluid temperature and is positioned in a position along the conduit to allow the body fluid flowing through the conduit to cool down the downstream thermistor, and

wherein the heating element is at least one of: (i) thermally coupled to the downstream thermistor; and (ii) included as an internal heat source in the downstream thermistor.

2. The apparatus as claimed in claim 1, wherein said heating element is integral to said downstream thermistor.

3. The apparatus as claimed in claim 1, further comprising a power source for supplying said thermistors with a fixed constant regulated level of electric power.

4. The apparatus as claimed in claim 1, wherein said heating element is configured to maintain said downstream thermistor at a constant pre-defined temperature range.

5. The apparatus as claimed in claim 1, wherein said heating element is thermally coupled to said downstream thermistor by a heat conducting material.

6. The apparatus as claimed in claim 1 further comprising: a control and display unit; and

a connector for interconnecting said control and display unit to said upstream and downstream thermistors, wherein the connector comprises a connection selected from the group consisting of: electronic circuitry, a data and power communication cable, and an electromagnetic transmitter/receiver.

7. The apparatus as claimed in claim 1 further comprising: an adaptor arranged to fit and retain contact with a nipple area of the breast, said adaptor being attached to an upstream extremity of said conduit; and a baby nipple attached at a downstream extremity of said conduit.

8. A method for determining a flow rate and amount of secreted or excreted body fluid, comprising:

pre-heating, using a heating element, a downstream thermistor to a temperature warmer than the temperature of a body fluid flowing in a conduit, the downstream thermistor is located downstream in the conduit, wherein the heating element is at least one of: (i) thermally coupled to the downstream thermistor; and (ii) included as an internal heat source in the downstream thermistor;

applying a voltage of about 15-50 volt across said downstream thermistor to serve as an integral heat source, the temperature of said downstream thermistor being held constant at about 39-45 degrees C.;

applying a voltage of about 2-6 volts across an upstream thermistor, located upstream with respect to the downstream thermistor, to generate an electric signal varying with the body fluid flow with which said downstream thermistor is in direct thermal contact;

introducing the body fluid to be monitored into an upstream extremity of said conduit; and

measuring, 10-200 times per second, the voltage over both of said thermistors, and calculating a difference between these electric signals, and calculating the fluid flow rate as a function of a compensated electric signal, while integrating a series of values over time, to arrive at an increasing volume of fluid having passed through said conduit and displaying a value of said volume.

10. The method for determining the flow rate and amount of secreted or excreted body fluid as claimed in claim 8, wherein:

pre-heating the downstream thermistor comprises applying a voltage across said downstream thermistor of less than 15 volts and heating of said downstream thermistor is by a resistance element in thermal contact with said downstream thermistor and with said body fluid.

11. A method of determining a flow rate of a body fluid, comprising:

measuring a first electrical signal, using a first thermistor located upstream in a conduit, when the conduits filled with a flowing body fluid;

pre-heating, using a heating element, a second thermistor located downstream in the conduit, with respect to the first thermistor, to a temperature which is warmer than the body fluid temperature,

wherein the heating element is at least one of: (i) thermally coupled to the second thermistor; and (ii) included as an internal heat source in the second thermistor;

measuring a second electrical signal, using the second thermistor, while the second thermistor is cooled by the flowing body fluid; and

calculating the flow rate of the body fluid based on differences between the measured first and second electrical signals measured repeatedly several times a second.

* * * * *

专利名称(译)	用于确定排泄或分泌的体液的流速的方法和设备		
公开(公告)号	US20180303403A1	公开(公告)日	2018-10-25
申请号	US16/021064	申请日	2018-06-28
[标]申请(专利权)人(译)	VASA应用TECH		
申请(专利权)人(译)	VASA应用TECHNOLOGIES LTD		
当前申请(专利权)人(译)	VASA应用TECHNOLOGIES LTD		
[标]发明人	SELLA YOAV		
发明人	SELLA, YOAV		
IPC分类号	A61B5/00 G01F1/69 A61M1/06		
CPC分类号	A61M1/06 A61M2205/3334 G01F1/69 A61B5/742 A61B5/4288 A61B5/7278 A61B5/6823		
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摘要(译)

本发明涉及一种确定和监测由身体排泄或分泌的流体的流速和体积的装置和方法。该装置包括：测量单元，包括由具有低导热率的材料制成的导管，并支撑至少两个热敏电阻，所述热敏电阻包括用作补偿热敏电阻的上游热敏电阻和位于尽可能远离上游热敏电阻的下游的下游热敏电阻。预加热并保持在预定温度，该温度比待计量的流体温度更热。该装置还包括电源，用于向热敏电阻施加小电压以产生电信号；控制和显示单元可操作地连接到测量单元。

