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(54) SYSTEMS AND METHODS FOR COOLING OF INTRAVENOUS FLUID AND MONITORING OF IN VIVO CHARACTERISTICS

(75) Inventor: **Paul KUMHYR**, Wendell, NC (US)

Correspondence Address:
LATHROP & GAGE LC
4845 PEARL EAST CIRCLE, SUITE 300
BOULDER, CO 80301 (US)

(73) Assignee: **THINKVILLAGE, LLC**, Boulder, CO (US)

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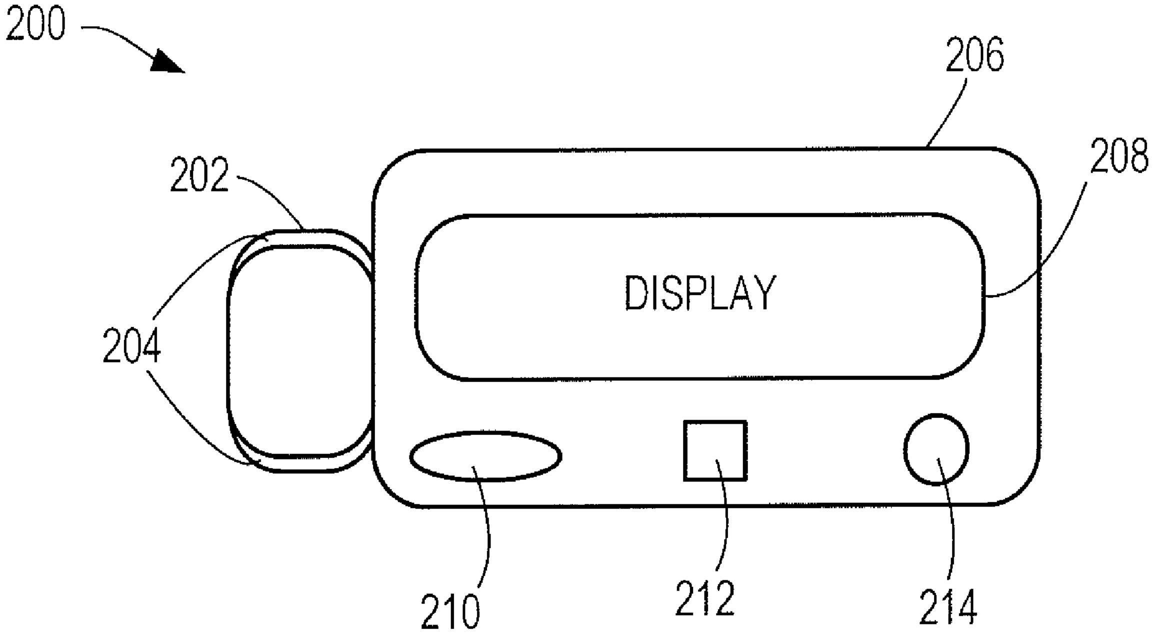
(57) ABSTRACT

Intravenous sensor systems and methods for determining in vivo characteristics are disclosed, as well as systems for cooling bags of intravenous fluid. The intravenous sensor systems include a probe configured for placement in a peripheral vein. The probe includes one or more sensors for obtaining sensed information, such as body temperature, blood oxygen saturation level and blood pressure. An interface unit determines the in vivo characteristics based upon sensed information received from the one or more sensors. The determined in vivo characteristics may be displayed on the interface unit and/or transmitted to a remote computer.



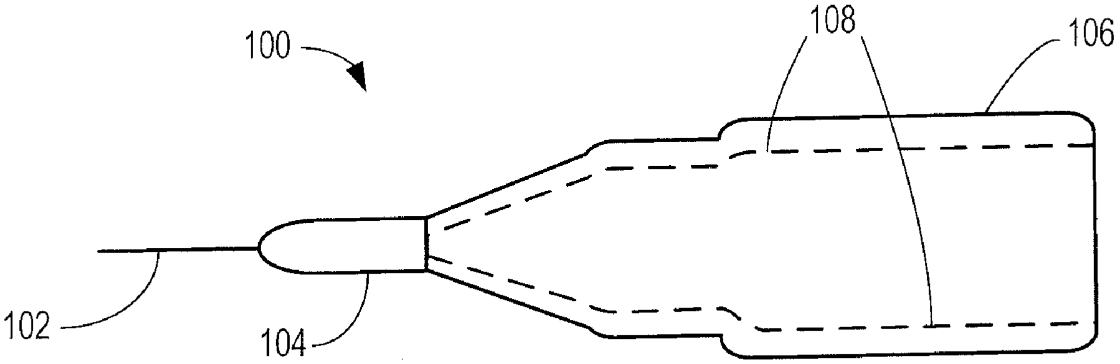


FIG. 1

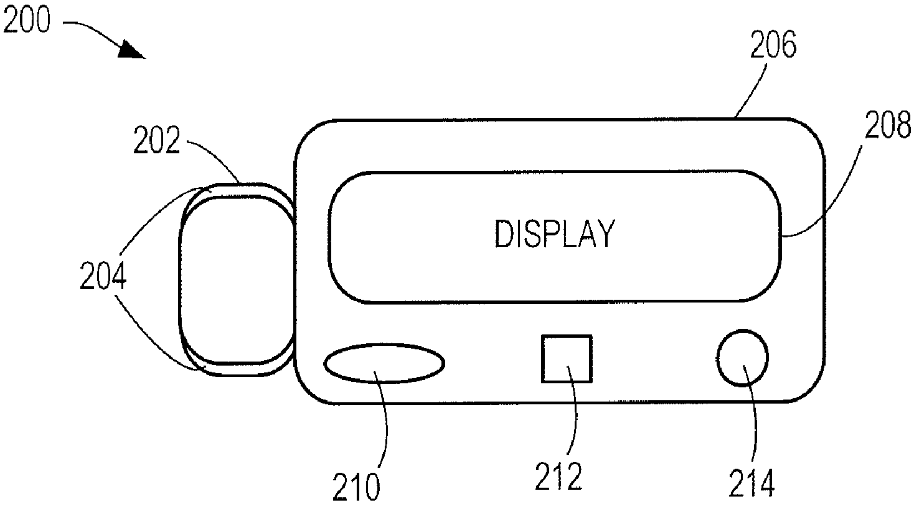


FIG. 2

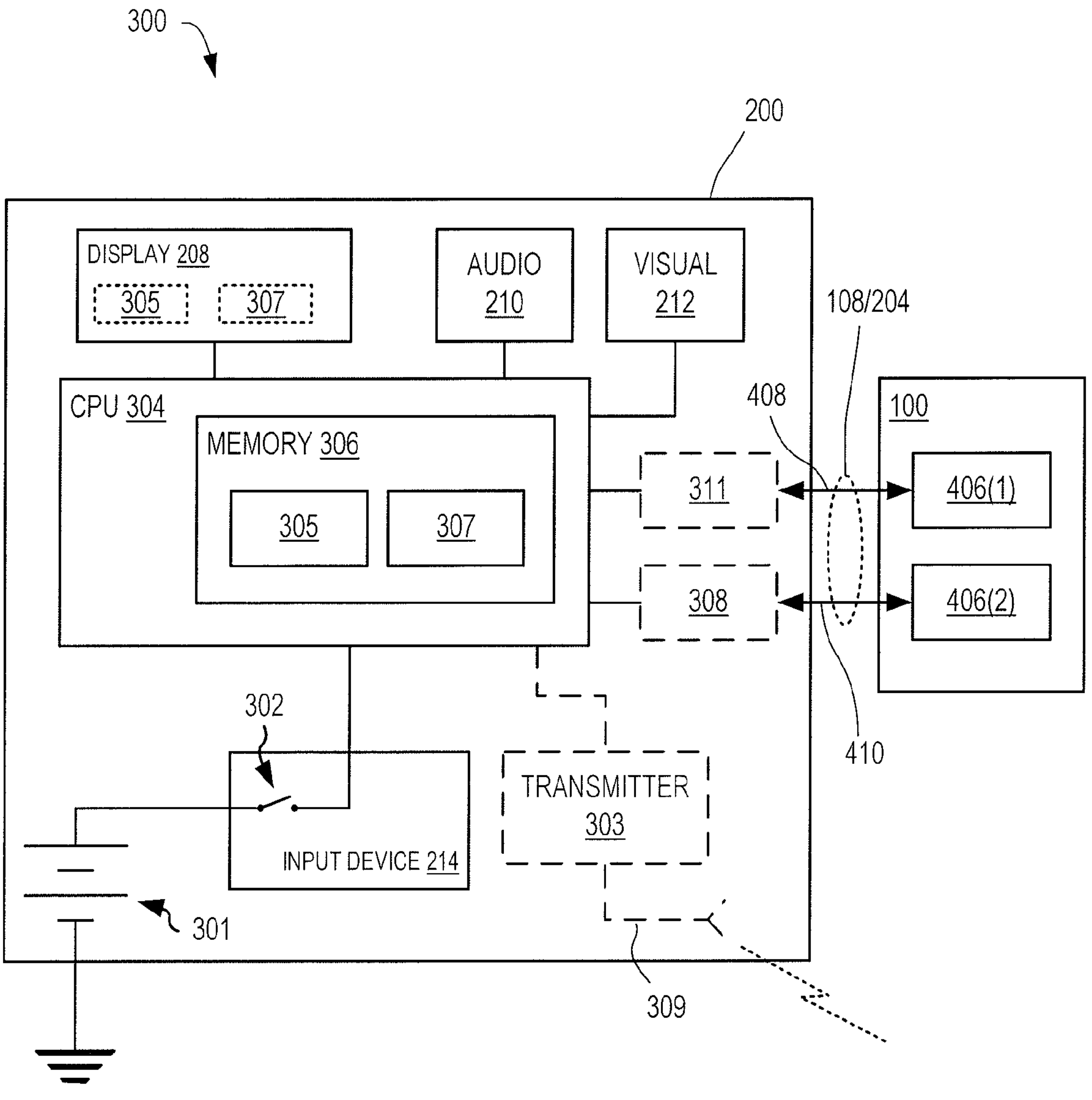

300
200
DISPLAY 208
305
307
AUDIO 210
VISUAL 212
108/204
CPU 304
MEMORY 306
305
307
408
100
311
406(1)
308
406(2)
410
302
INPUT DEVICE 214
TRANSMITTER 303
301
309

FIG. 3

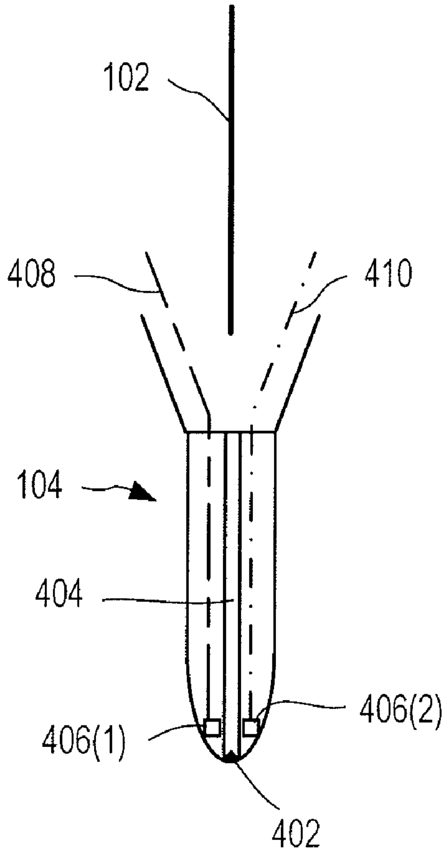

102
408
410
104
404
406(1)
406(2)
402

FIG. 4A

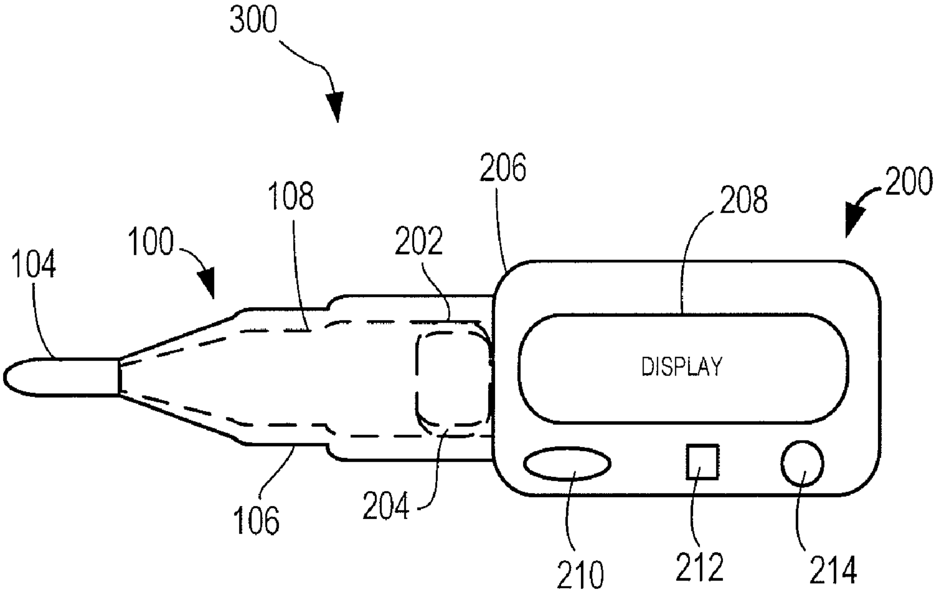

300
206
200
208
108
202
100
104
DISPLAY
106
204
210
212
214

FIG. 4B

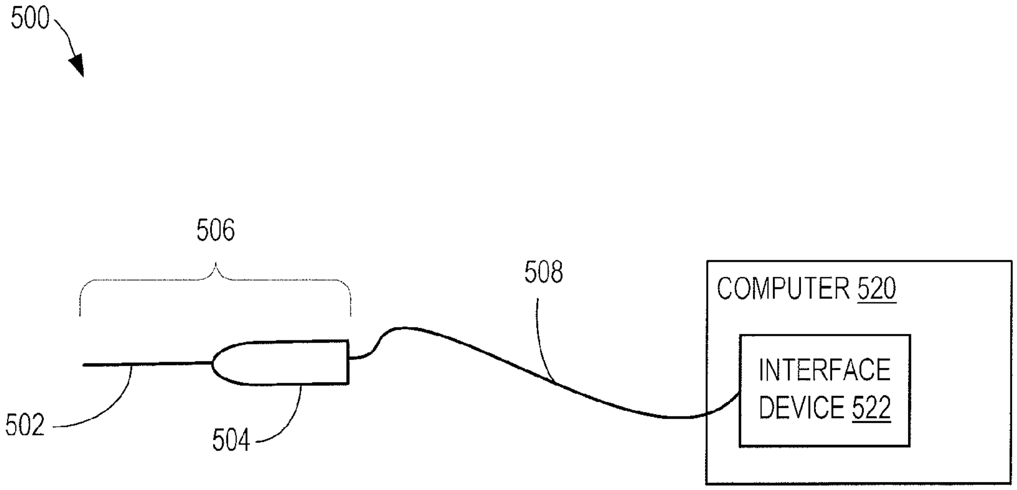

500
506
508
COMPUTER 520
INTERFACE DEVICE 522
502
504

FIG. 5

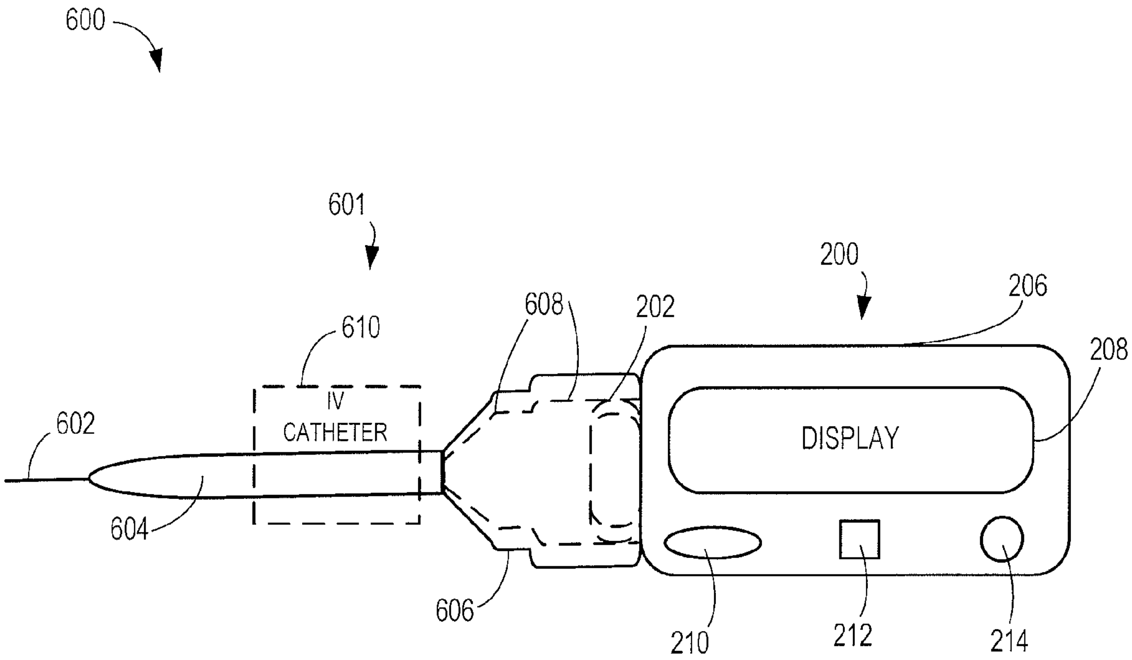

600
601
200
206
208
608
202
610
IV CATHETER
602
DISPLAY
604
606
210
212
214

FIG. 6

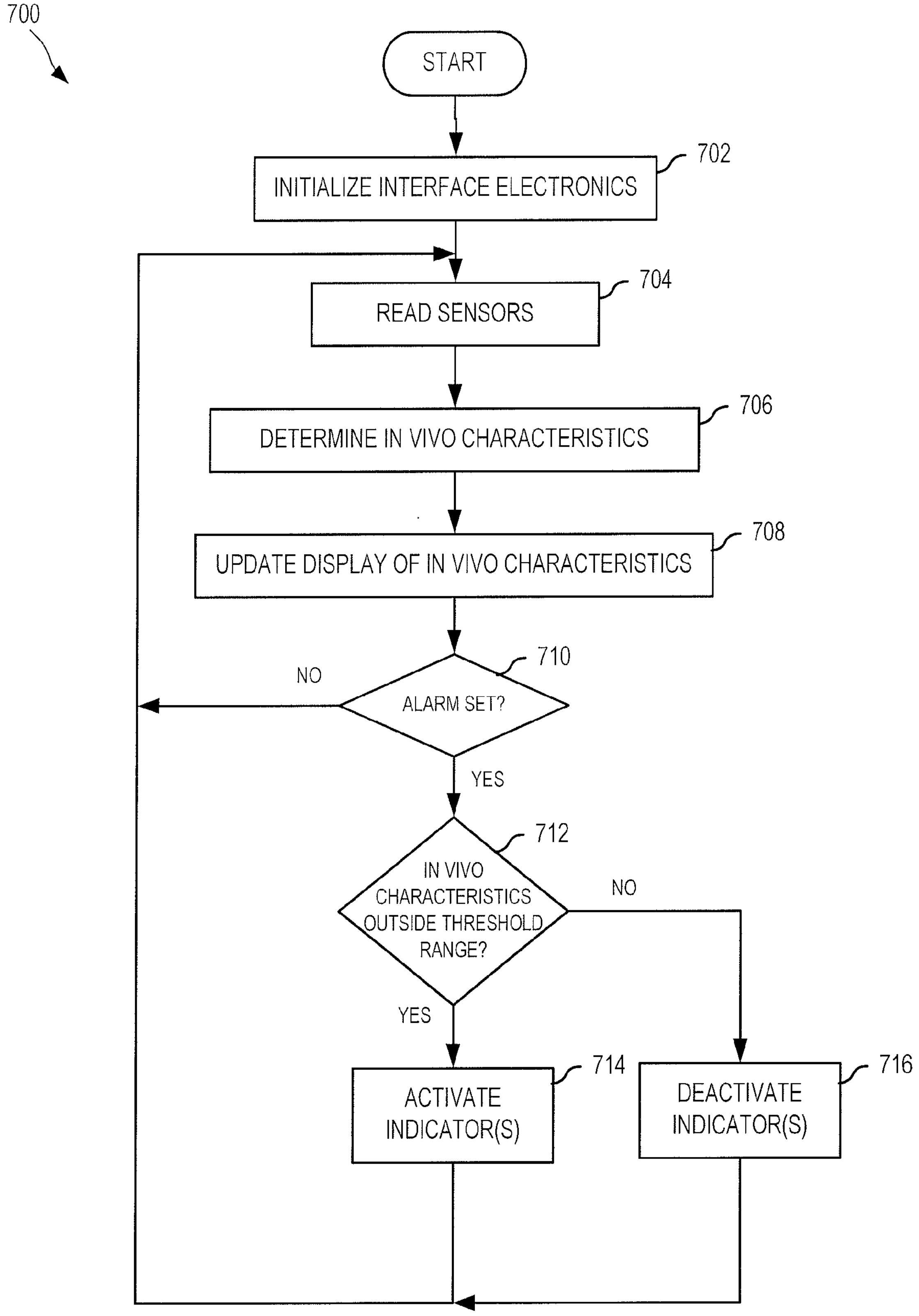

700
START
INITIALIZE INTERFACE ELECTRONICS
702
READ SENSORS
704
DETERMINE IN VIVO CHARACTERISTICS
706
UPDATE DISPLAY OF IN VIVO CHARACTERISTICS
708
ALARM SET?
710
NO
YES
IN VIVO CHARACTERISTICS OUTSIDE THRESHOLD RANGE?
712
NO
YES
ACTIVATE INDICATOR(S)
714
DEACTIVATE INDICATOR(S)
716

FIG. 7

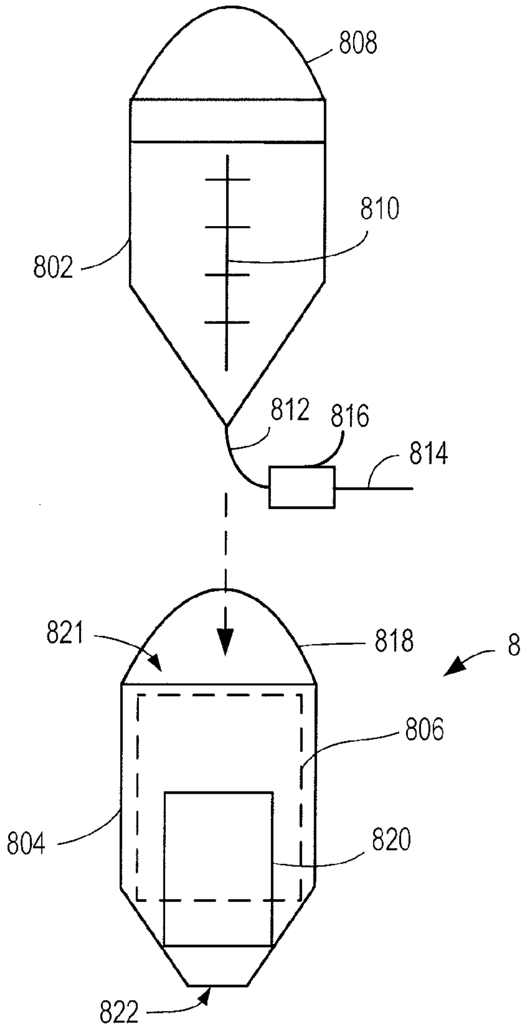


FIG. 8A

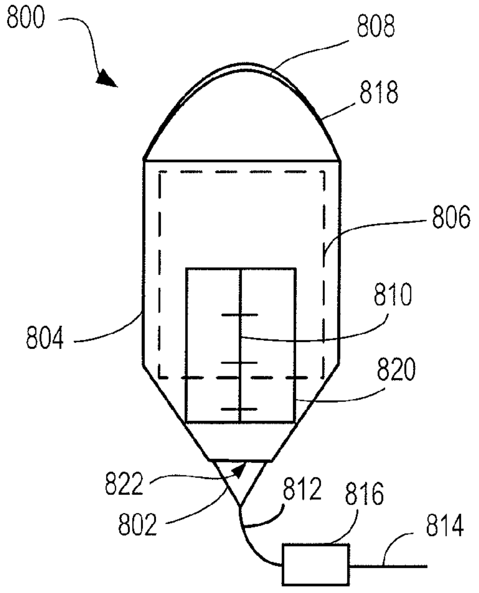


FIG. 8B

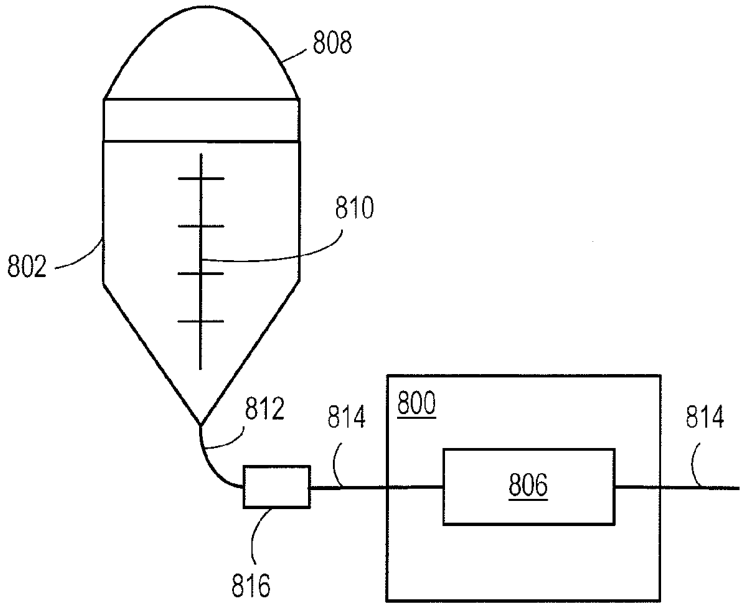


FIG. 8C

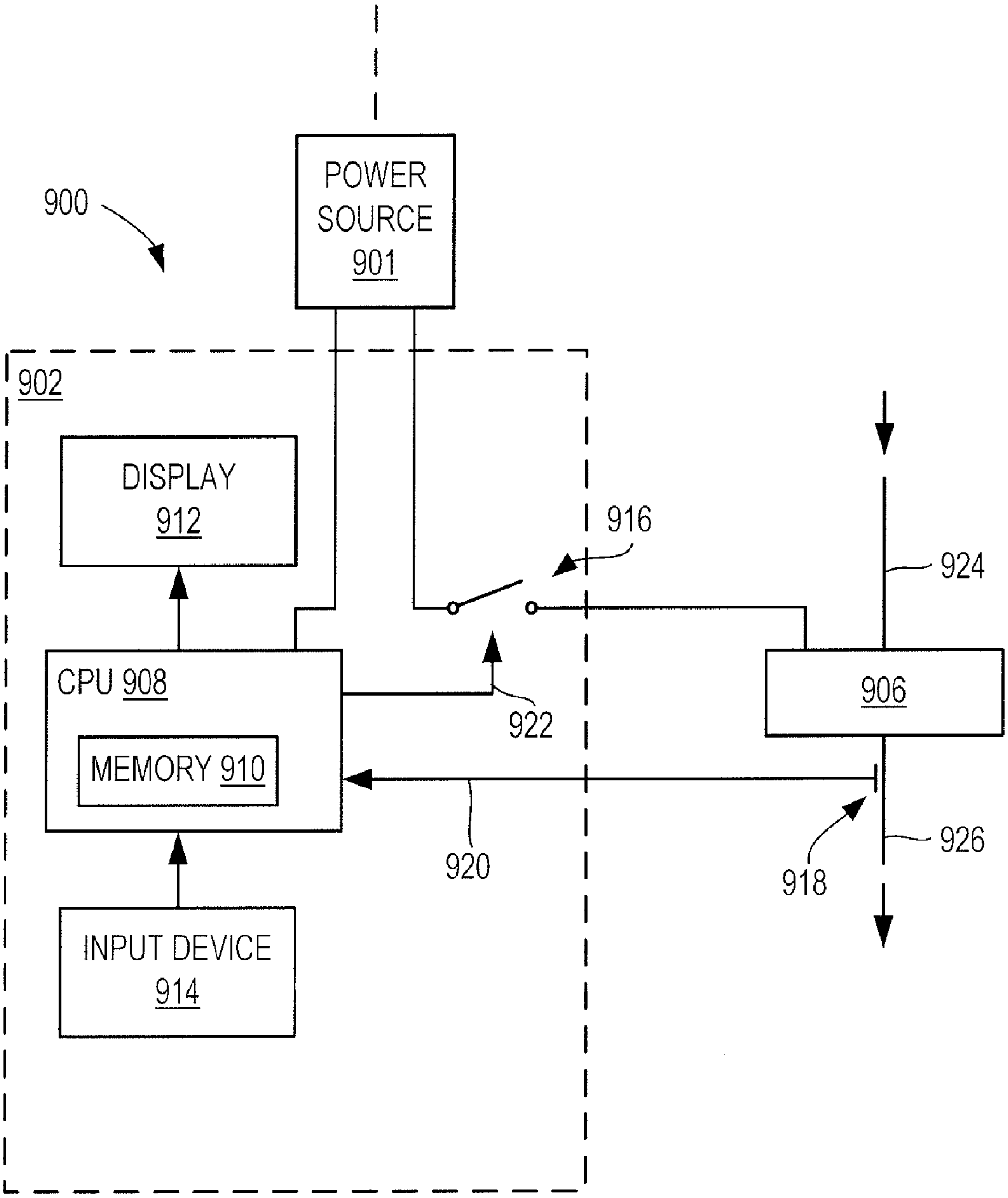

900
POWER
SOURCE
901
902
DISPLAY
912
916
924
CPU 908
MEMORY 910
922
906
920
918
926
INPUT DEVICE
914

FIG. 9

SYSTEMS AND METHODS FOR COOLING OF INTRAVENOUS FLUID AND MONITORING OF IN VIVO CHARACTERISTICS

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application Ser. No. 60/910,500, filed Apr. 6, 2007, and incorporated herein by reference.

BACKGROUND

[0002] Cardiac arrest disrupts blood supply to a patient's organs and causes widespread oxygen depletion. Such oxygen depletion impacts the brain, which utilizes nearly 20% of circulating blood, more severely than other organs. Even when normal cardiac rhythm resumes, there is competition among the organs for oxygenated blood, and cerebral ischemia and brain damage continue to accrue.

[0003] It has recently been discovered that hypothermia therapy may limit damage to the brain during recovery from a cardiac arrest episode. The beneficial effects of hypothermia therapy are believed to result from decreased oxygen demand by the brain, due to slowed metabolism of brain cells, and reduction of swelling.

[0004] Some methods for inducing hypothermia, such as immersing a patient in ice, using cooling blankets and perfusing organs with cooled intravenous fluids (e.g., saline, plasma, whole blood, etc.), may be performed by emergency response personnel or paramedics in the field. As induced hypothermia is most beneficial when provided within sixty to ninety minutes of a cardiac arrest episode, these methods are particularly useful. Other methods of inducing hypothermia, such as cooling blood as it flows past a heat exchanging catheter in the inferior vena cava, require surgical procedures that are less practical.

[0005] Body temperature must be closely monitored during an induced hypothermia procedure. Typically, monitoring is performed intermittently with a traditional thermometer, e.g., mercury, alcohol or infrared tympanic. However, traditional thermometers do not provide continuous, precise data and rapid changes in body temperature may go undetected.

SUMMARY

[0006] In an embodiment, an intravenous sensor system monitors in vivo characteristics. A probe includes a sensor housing with one or more sensors for sensing in vivo characteristics. An interface unit has a processor and a display. The interface unit determines the in vivo characteristics based upon sensed information received from the probe and displays the in vivo characteristics on the display.

[0007] In another embodiment, a method monitors in vivo characteristics. A probe of an intravenous sensor system is inserted into a patient's peripheral vein. An interface unit of the intravenous sensor system is coupled to the probe. The in vivo characteristics are determined from sensed information received from one or more sensors within the probe.

[0008] In another embodiment, an intravenous sensor system monitors in vivo characteristics. A probe containing one or more sensors for sensing in vivo characteristics is configured and placed in a peripheral vein of a patent. An interface device is connected to the probe to receive sensed information from the sensors and relay the sensed information to a computer.

[0009] In another embodiment, a system cools a bag of intravenous fluid. An insulated receptacle receives the bag of intravenous fluid and a cooling device reduces the temperature of the intravenous fluid within the insulated receptacle.

[0010] In another embodiment, a method cools a bag of intravenous fluid. The bag of intravenous fluid is inserted into an insulated receptacle and a cooling device is activated to reduce the temperature of the intravenous fluid within the insulated receptacle.

BRIEF DESCRIPTION OF THE FIGURES

[0011] FIG. **1** shows an exemplary probe of an intravenous sensor system, in an embodiment.

[0012] FIG. **2** shows an exemplary interface unit of an intravenous sensor system, in an embodiment.

[0013] FIG. **3** shows a schematic of an exemplary intravenous sensor system utilizing the probe of FIG. **1** and the interface unit of FIG. **2**.

[0014] FIG. **4**A shows the sensor housing of the probe of FIG. **1** in further detail.

[0015] FIG. **4**B shows the probe of FIG. **1** coupled to the interface unit of FIG. **2**.

[0016] FIG. **5** shows an exemplary probe with a remote interface device, in an embodiment.

[0017] FIG. **6** shows an intravenous sensor system inserted into an intravenous catheter, in an embodiment.

[0018] FIG. **7** is a flowchart illustrating one exemplary process for monitoring in vivo characteristics, in an embodiment.

[0019] FIGS. **8**A, **8**B and **8**C show an exemplary system for cooling intravenous fluid, in an embodiment.

[0020] FIG. **9** shows a schematic of one exemplary temperature controlled intravenous fluid cooling system, in an embodiment.

DETAILED DESCRIPTION OF THE FIGURES

[0021] FIG. **1** shows a probe **100** of an intravenous sensor system for in vivo monitoring. Probe **100** includes a needle **102**, a sensor housing **104** and a connector **106**. Sensor housing **104** may, for example, be a flexible cavity fabricated of biocompatible plastic or an inflexible cavity fabricated of metal, metal alloy or biocompatible plastic. Sensor housing **104** contains one or more sensors for sensing in vivo characteristics, which may for example include body temperature, blood oxygen saturation level ("oxygen level") and blood pressure. Two or more data paths **108** (e.g., electrodes and/or optical fibers) are disposed along an inside wall of connector **106**. Data paths **108** communicate sensed information from the one or more sensors of sensor housing **104** to an interface unit **200**, shown in FIG. **2**.

[0022] FIG. **2** shows an interface unit **200** of an intravenous sensor system for in vivo monitoring. Interface unit **200** includes a connector **202** and a body **206**. Connector **202** couples with connector **106** of probe **100** to connect interface unit **200** to probe **100**. Connector **202** includes two or more data paths **204** (e.g., electrodes and/or optical fibers) that couple with data paths **108** of probe **100** to receive the sensed information from the one or more sensors of sensor housing **104**. Body **206** includes a display **208**, a speaker **210**, a visual indicator **212** and an input device **214**. Display **208** is, for example, an LCD display. Visual indicator **212** may, for example, be a light-emitting diode (LED). Input device **214** may include a keypad or buttons.

[0023] It will be appreciated that, in an embodiment, connector **202** may be absent wherein data paths **204** alone may provide sufficient structural integrity to couple with connector **106** of probe **100**.

[0024] FIG. **3** is a schematic showing one exemplary intravenous sensor system **300** including probe **100** of FIG. **1** and interface unit **200** of FIG. **2**. In an embodiment, intravenous sensor system **300** is powered by a battery **301** when switch **302** is closed, e.g., by pressing a button of input device **214**. Power may alternatively be provided to system **300** from other suitable power sources, such as 50/60 Hz power, solar cells and the like, without departing from the scope hereof.

[0025] A central processing unit (CPU) **304** receives sensed information, via data paths **108** and **204**, from one or more sensors of sensor housing **104**. CPU **304** stores this sensed information within a memory **306** of CPU **304**. CPU **304** may represent one or more of a microprocessor, a microcontroller or an application specific integrated circuit ("ASIC"). CPU **304** controls operation of interface unit **200** and processes the sensed information received from the one or more sensors of sensor housing **104** to determine in vivo characteristics **305**, such as one or more of body temperature, oxygen level, and blood pressure. These in vivo characteristics **305** may be displayed on display **208**. Memory **306** may also store one or more threshold ranges **307** for each in vivo characteristic. Threshold ranges **307** may also represent a single value threshold without departing from the scope hereof. Threshold ranges **307** are set by the user operating input device **214** while viewing threshold ranges **307** on display **208**, for example. If a determined in vivo characteristic **305** falls outside of the set threshold range **307**, and an alarm feature has been enabled by the user, CPU **304** may control audio indicator **210** to generate a sound and/or control visual indicator **212** to generate a visible signal. Once activated, indicators **210** and **212** are deactivated by the user pressing a button on input device **214**, for example. In an embodiment, audio and/or visual indicators **210** and **212** are operated when power of battery **301** is low to indicate that battery **301** should be changed. Display **208** may also indicate battery status without departing from the scope hereof.

[0026] In an embodiment, interface unit **200** includes a transmitter **303** and an antenna **309** that transmits sensed in vivo characteristics **305** to a remote receiver (not shown), such as within a remote work station.

[0027] In an embodiment, an optical module **308**, shown within interface unit **200**, includes one or more wavelength-specific LEDs and one or more photodiodes for sensing oxygen level and/or blood pressure, as described below. In particular, optical module **308** provides an optical/electrical interface for providing an electrical signal, indicative of one or more of blood pressure and/or blood oxygen level, for input to CPU **304**. CPU **304** may include one or more analog to digital (A/D) converters for digitizing these received signals.

[0028] In an embodiment, an electronic conditioning module **311**, shown within interface unit **200**, includes one ore more electronic components for providing power to sensors **406** and for conditioning sensed information received from sensors **406**. For example, electronic signals from sensor **406** are conditioned to make them suitable for input to CPU **304**.

[0029] Body temperature, oxygen level and blood pressure threshold ranges **307** may be specified with upper and/or lower limits such that an audio and/or visual indicator operates when any one or more of sensed body temperature, oxygen level and blood pressure falls outside these specified ranges. For example, the user may specify upper and lower temperature limits such that an alarm occurs when the sensed temperature falls below the lower limit or rises above the upper limit. On one example, these limits may be between 33 and 35 degrees Celsius (mild hypothermia), or between 28 and 33 degrees Celsius (moderate hypothermia), or between 24 and 28 degrees Celsius (severe hypothermia).

[0030] When hypothermia is induced via perfusion, it is preferred that the patient's body temperature stays within the range of 32 to 34 degrees Celsius. In one example of operation, probe **100** is inserted into one of the patient's veins such that system **300** operates to measure the patient's in vivo characteristics (e.g., sensed in vivo characteristics **305**). If the sensed temperature rises above 34 degrees Celsius, audio indicator **210** and/or visual indicator **212** may be activated to alert a medical provider that additional cold fluids are needed. If the measured body temperature falls below 32 degrees Celsius, an indicator **210**, **212** may alert a medical provider that administration of cold intravenous fluids should be reduced (e.g., to a minimum flow rate of 30 mL/hr). In an embodiment, system **300** includes an automated intravenous fluid delivery system (not shown) such that CPU **304** controls delivery of cooled intravenous fluid based upon measured temperature. For example, CPU **304** may communicate wirelessly with the automated intravenous fluid delivery system using transmitter **303** and antenna **309**. Alternatively, a wired connection may be used to control the automated intravenous fluid delivery system.

[0031] FIG. **4**A shows needle **102** and sensor housing **104** of system **300** in further detail. In operation, needle **102** guides sensor housing **104** of probe **100** through a patient's skin and into a peripheral vein. A peripheral vein is for example any vein not in the chest or the abdomen. Ann and hand veins are typically used for monitoring, although leg and foot veins may also be used. Typically, the basilic vein or cubital vein of the arm, or the external jugular vein of the neck is used. Once probe **100** is inserted into the selected vein, needle **102** is removed or retracted through a channel **404** that has a one-way valve **402** at a distal end of sensor housing **104** to prevent blood from entering sensor housing **104**. Sensor housing **104** remains in the vein after removal or retraction of needle **102**, and connector **106** is coupled with connector **202** of interface unit **200**. Upon connection of interface unit **200** and probe **100**, visual indicator **212** and/or display **208** may illuminate indicating that system **300** is operational. A completed assembly of system **300** is shown in FIG. **4**B. Portions of system **300** located outside of the patient's body may be taped in place or secured with a self-adhesive dressing.

[0032] It will be appreciated that interface unit **200** does not have direct contact with body fluids, such as blood. Interface unit **200** may therefore be reused with other probes **100** without risk of cross-contamination.

[0033] Since the intravenous sensor system remains in the patient's vein, in vivo characteristics **305** may be continuously monitored or monitored periodically (e.g., once a minute, once a number of minutes, once an hour, once a number of hours, twice a day, once a day and once a number of days). Through use of system **300**, in vivo characteristics **305** may be obtained, without disturbing the patient, by viewing display **208** of interface unit **200** or by receiving periodically transmitted, via transmitter **303** and antenna **309**, sensed in vivo characteristics **305** at a remote location, such as a nurses' station.

[0034] Sensor housing **104** is shown with two sensors **406**(**1**) and **406**(**2**) for clarity of illustration. Sensor housing **104** may include more or fewer sensors **406** without departing from the scope hereof. Sensor **406** operates to monitor one or more of body temperature, oxygen level and blood pressure. Sensor **406**(**1**) may be a thermocouple or thermistor for measuring the temperature of blood passing outside sensor housing **104** (i.e., by sensing heat transfer through the wall of sensor housing **104**). Sensor **406**(**1**) may form at least a portion of sensor housing **104** wall thereby having direct contact with the patient's blood. System **300** may include conditioning electronics **311** that electrically connect, via electrodes **408**, with sensor **406**(**1**) to measure temperature.

[0035] Where sensor **406**(**2**) is an optical sensor, blood oxygen level may be sensed. In one example, an optical fiber **410** sequentially delivers two wavelengths of light, 660 nm from a red LED and one of 905 nm, 910 nm and 940 nm from an infrared LED, from within optical module **308**. Absorption at these wavelengths differs significantly between oxyhemoglobin and its deoxygenated form. Thus, a ratio of oxygenated to deoxygenated hemoglobin may be determined within CPU **304**. In an embodiment, a reflectance configuration of LEDs and a photodiode detector may be utilized. Optical fiber **410** delivers light generated by one or more LEDs within optical module **308** to sensor **406**(**2**) where the light is emitted from sensor housing **104** to the patient's blood. Optical fiber **410** also functions to return light reflected by the patient's blood to a photodiode within optical module **308**, where the reflected light is detected and transduced into an electrical signal that is received and processed by CPU **304**. Sensor housing **104** may be fabricated of a material that is transparent in the visible and near infrared wavelength range generated by optical module **308**. Suitable fabrication materials include, for example, quartz, polystyrene, polycarbonate and polypropylene.

[0036] In an embodiment, sensor **406**(**1**) represents a blood pressure sensor formed from a piezoelectric material that is either directly in contact with blood, or in contact with a flexible membrane that translates blood pressure changes to the piezoelectric material. In another embodiment, sensor **406**(**2**) represents a blood pressure sensor that is an optical sensor acting as an interferometer to detect changes in a silicon or flexible polymer (e.g., polyurethane, polystyrene) diaphragm. The diaphragm is in contact with the blood (i.e., the diaphragm forms part of the sensor housing wall) and variations in pressure cause the diaphragm to flex, thereby altering the cavity length of the interferometer. Thus, the unit may provide combined blood-pressure sensing and oxygen level measurements by using the same LEDs and photodiode detector within optical module **308**.

[0037] It is appreciated that sensors **406** are small enough to fit within sensor housing **104** which is to be inserted within a patient's vein while permitting continued blood flow within that vein. The size of sensor housing **104** is preferably between 14 and 22 gauge (i.e., the diameter of sensor housing **104** is between 25-65 thousandths of an inch).

[0038] FIG. **5** shows one exemplary intravenous sensor system **500** for in vivo monitoring. System **500** includes a probe **506** that connects, via a data path **508** (e.g., electrodes and/or optical fibers), to an interface device **522** within a computer **520**. Computer **520** is for example a nursing station and includes software appropriate for control and monitoring of probe **506** via interface device **522**. Interface device **522** includes electronic and optical components for controlling and utilizing one or more sensors within probe **506**. Interface device **522** may be external to computer **520** without departing from the scope hereof. For example, interface device **522** may connect to computer **520** via a standard computer communication port (e.g., USB, serial, parallel, firewire, etc.). Probe **506** is similar to probe **100**, FIG. **1**, and includes a needle **502**, a sensor housing **504** and one or more sensors (not shown). Data path **508** represents one or more electrodes and/or optical fibers that may be grouped into a single cable. Probe **506** senses in vivo characteristics such as one or more of body temperature, oxygen level and blood pressure. Data path **508** conveys sensed information from sensors within sensor housing **504** to computer **520** via interface device **522**. Computer **520** may include a display, a keyboard and a mouse for control of probe **506** and display of sensed in vivo characteristics. Software of computer **520** may provide alarm functionality based upon one or more user defined ranges for sensed in vivo characteristics. In an embodiment, computer **520** may be interface unit **200**.

[0039] FIG. **6** stows one exemplary intravenous sensor system **600** for use in conjunction with an intravenous catheter **61 0**. For example, where intravenous catheter **610** is used to deliver intravenous fluids and medications to a peripheral vein of a patient, intravenous catheter **610** is inserted into a patient s peripheral vein using a needle which is subsequently removed from the catheter. Sensor housing **604** of probe **601** is then inserted through catheter **610** and into the patient's vein to gain access to blood flowing through the vein. A needle **602** of probe **601** may be used to guide sensor housing **604** through intravenous catheter **610** and then subsequently removed or withdrawn, as previously described. Sensor housing **604** remains inside the vein, and connector **606** connects to interface unit **200** via connector **202**. Once connector **606** and connector **202** are connected, visual indicator **212** may illuminate to indicate that system **600** is operational.

[0040] Probes **100**, **506** and **601** may be utilized without a need for special surgical procedures and advanced imaging to guide the probes into place. The systems and methods described herein may thus be used in the field to provide continuous, precise monitoring of in vivo characteristics.

[0041] It will be appreciated that system **500** of FIG. **5** may be inserted into an intravenous catheter in a manner similar to that described for system **600** of FIG. **6**.

[0042] FIG. **7** is a flowchart illustrating one exemplary process **700** for monitoring in vivo characteristics. Process **700** is, for example, implemented within CPU **304** of interface unit **200**. In step **702**, process **700** initializes interface electronics. In one example of step **702**, CPU **304** clears memory **306** and initializes optical module **308** and electronic conditioning module **311** to activate sensors **406**. In step **704**, process **700** reads sensor values. In one example of step **704**, CPU **304** samples signal from optical module **308** and electronic conditioning module **311**. In step **706**, method **700** determines in vivo characteristics. In one example of step **706**, CPU **304** utilizes one or more algorithms to convert the sampled values of step **704** into in vivo characteristics **305**. In step **708**, process **700** updates the display of in vivo characteristics. In one example of step **708**, CPU **304** sends in vivo characteristics **305** to display **208**. Step **710** is a decision. If, in step **704**, process **700** determines that the alarm function is set, process **700** continues with step **712**; otherwise process **700** continues with step **704**.

[0043] Step **712** is a decision. If, in step **712**, process **700** determines that the in vivo characteristics determined in step **706** are outside of defined threshold ranges, process **700**

continues with step **714**; otherwise process **700** continues with step **716**. In step **714**, process **700** activates indicators. In one example of step **714**, CPU **304** activates audio indicator **210** and activates visual indicator **212**, thereby providing an indication to the user that sensed characteristics are not within the user specified ranges. Process **700** continues with step **704**.

[0044] In step **716**, process **700** deactivates indicators. In one example of step **716**, CPU **304** deactivates audio indicator **210** and deactivates visual indicator **212**. Process **700** continues with step **704**.

[0045] Steps **704** through **716** repeat to maintain operation of interface unit **200**. As appreciated, the order of steps **704** through **714** may vary without departing from the scope hereof.

[0046] Since induced hypothermia is most beneficial when provided within sixty to ninety minutes of a cardiac arrest episode, and there is limited space in an emergency vehicle to immerse a patient in ice or use a cooling blanket, perfusion with cold fluids is especially useful. However, bags of intravenous fluid are usually stored at room temperature, and use of a separate facility for cooling and storage of additional bags is not space or cost effective.

[0047] The present disclosure provides systems and methods for cooling individual bags of intravenous fluid so that cooling may be initiated during transit to or upon arrival at a cardiac arrest scene. Such systems eliminate the space and cost issues related to maintaining cold intravenous fluids.

[0048] FIGS. **8**A and **8**B show one exemplary intravenous fluid cooling system **800** for cooling an individual bag **802** of intravenous fluid. Bag **802** may for example contain one liter of saline, plasma, whole blood or the like. Bag **802** is shown with a handle **808**, a fluid level indicator **810**, medication lines **812**, **814**, and a medication port **816** (e.g., an intravenous drip). System **800** includes an insulated receptacle **804** for receiving bag **802** (e.g., inserted through a top opening **821** of insulated receptacle **804** as shown by an arrow in FIG. **8**A) and a cooling device **806**. Cooling device **806** may be a chemical coolant, a compressor based cooling device or a Peltier based cooling device. Insulated receptacle **804** includes a handle **818** and a transparent window **820** configured to allow monitoring of fluid level indicator **810**, as shown in FIG. **8**B. Insulated receptacle **804** may, for example, be fabricated from neoprene, polyurethane or nitrile rubber foam. An opening **822** at the bottom of insulated receptacle **804** allows medication lines **812**, **814** and medication port **816** to pass therethrough.

[0049] Chemical coolants, as may be used with cooling device **806** in an embodiment, are commercially available in the form of instant cold packs, which may include calcium chloride, ammonium nitrate and/or urea based products. A pouch containing the chemical coolant may be placed directly into insulated receptacle **804** in direct contact with bag **802**. Alternatively, insulated receptacle **804** may contain a pocket for receiving the chemical coolant pouch such that the pouch and the intravenous fluid bag are physically separated from, but in thermal contact with, one another. One disadvantage of chemical coolants is that their temperature is not easily regulated, e.g., using thermostatic control.

[0050] In another embodiment, cooling device **806** is Peltier based and is in thermal contact with bag **802** of intravenous fluid. Cooling device **806** may be a thermoelectric plate constructed within insulated receptical **804** such that heat is transferred from within insulated receptacle **804** to air external to insulated receptical **804**. Alternatively, a Peltier device in the form of a probe may be inserted directly into the flow of intravenous fluid at medication port **816** to provide cooling of the intravenous fluid during administration thereof.

[0051] In another embodiment, cooling device **806** is compressor based and is external to insulated receptacle **804** such that intravenous fluid passes through cooling device **806** during administration of the fluid. For example, intravenous fluid may be pumped through cooling device **806** or may flow as a result of gravity. In one example, one or more of medication lines **812** and **814** pass through or connect to cooling device **806** as shown in FIG. **8**C.

[0052] FIG. **9** shows a schematic of one exemplary temperature controlled intravenous fluid cooling system **900**. System **900** includes a thermostatic control device **902** and a cooling device **906**. Thermostatic control device **902** includes a display **912**, a CPU **908**, a switch **916** and an input device **914**. CPU **908** is, for example, a microprocessor, a microcontroller or an application specific integrated circuit ("ASIC ") suitable for controlling operation of cooling device **906**. CPU **908** may include a memory **910**. Thermostatic control device **902** and cooling device **906** are shown powered from a power source **901** external to device **902**. Power source **901** may be internal to device **902** without departing from the scope hereof. In one example, power source **901** is a battery. In another example, power source is a power converter (e.g., a transformer) connected to a suitable external power supply, such as external 50/60 Hz AC grid power, a vehicle battery, solar cells, or the like.

[0053] Cooling device **906** may represent cooling device **806** of FIGS. **8**A, **8**B and **8**C, such that cooling device **806** has temperature control through device **902**. Intravenous fluid flows into cooling device **906** through an inlet tube **924** and out of cooling device **906** through an outlet tube **926**. Tubes **924** and **926** may represent one or both of medication lines **812**, **814**. A temperature sensor **918** senses temperature of cooled intravenous fluid flowing out of cooling device **906**. Sensor **918** may be inserted into the flow of intravenous fluid or may attach to tube **926**. Where sensor **906** is enclosed within an insulated receptical together with a bag of intravenous fluid to be cooled, such as device **806** within insulated receptical **804**, sensor **918** may also be located within the insulated receptical.

[0054] CPU **908** operates to determine the temperature of the intravenous fluid based upon a sensed temperature signal received from sensor **918** via a connection **920**. CPU **908** may display the determined temperature upon display **912**. Memory **910** is used to store at least one temperature threshold value that defines the desired temperature of intravenous fluid output through tube **926**. This threshold value may be set by operation of input device **914** by a user, wherein the threshold value is displayed upon display **912** while being selected by the user.

[0055] In one example of operation, CPU **908** receives sensed temperature from sensor **918** and determines the temperature of intravenous fluid output from tube **926**. If the determined temperature is above the threshold value, CPU **908** controls switch **916** to close, thereby providing power to cooling device **906**; with power applied, cooling device **906** cools the intravenous fluid. If the determined temperature is lower than the threshold value, CPU **908** controls switch **916** to open, thereby removing power from cooling device **906**; without power cooling device **906** stops cooling the intravenous fluid.

[0056] It will be appreciated that changes to system **900** may be made without departing from the scope hereof. For example, thermostatic control device **902** may include a visual indicator (such as on display **912**) and an audio indicator to provide the user with additional information regarding the measured temperature of the intravenous fluid and operation of thermostatic control device **902**. In another embodiment, thermostatic control device **902** may be disposed with, or integrated within, insulated receptacle **804**.

[0057] Changes may be made in the above methods and systems without departing from the scope hereof. It should thus be noted that the matter contained in the above description or shown in the accompanying drawings should be interpreted as illustrative and not in a limiting sense. The following claims are intended to cover all generic and specific features described herein, as well as all statements of the scope of the present methods and systems, which, as a matter of language, might be said to fall there between.

What is claimed is:

1. An intravenous sensor system for monitoring in vivo characteristics, comprising:

a probe comprising a sensor housing with one or more sensors for sensing in vivo characteristics; and

an interface unit comprising a CPU and a display, the interface unit determining the in vivo characteristics based upon sensed information received from the probe and displaying the in vivo characteristics on the display.

2. The system of claim **1**, the probe further comprising a needle for guiding at least a portion of the probe into a patient's peripheral vein.

3. The system of claim **2**, the needle being retractable once the at least a portion of the probe is in the vein, the probe comprising a one-way valve at a distal end to prevent blood from entering the probe.

4. The system of claim **2**, the needle being removable once the at least a portion of the probe is in the vein, the probe comprising a one-way valve at a distal end to prevent blood from entering the probe.

5. The system of claim **2**, the probe being configured to penetrate an intravenous catheter inserted into the vein, the distal tip of the probe extending beyond the intravenous catheter and into the vein.

6. The system of claim **1**, the one or more sensors being selected from the group including a temperature sensor, an oxygen sensor, and a blood pressure sensor.

7. The system of claim **7**, wherein the in vivo characteristic comprises one or more of body temperature, oxygen level, and blood pressure.

8. The system of claim **1**, the interface unit comprising one or both of an audio indicator and a visual indicator, the CPU activating the one or both indicators if any one of the determined in vivo characteristics exceeds a set threshold.

9. The system of claim **8**, the interface unit comprising an input device for receiving input from a user to set the threshold.

10. The system of claim **1**, wherein the interface unit comprises a transmitter and an antenna for transmitting the in vivo characteristics to a remote receiver.

11. The system of claim **1**, wherein the interface unit comprises a memory for storing the in vivo characteristics.

12. A method for intravenous monitoring of in vivo characteristics, comprising:

inserting a probe of an intravenous sensor system into a patient's peripheral vein;

coupling an interface unit of the intravenous sensor system to the probe; and

determining the in vivo characteristic based upon sensed information received from one or more sensors within the probe.

13. The method of claim **12**, further comprising displaying the in vivo characteristic on a display of the interface unit.

14. The method of claim **12**, further comprising activating an indicator to alert a user when one or more of the in vivo characteristics fall outside of a threshold range.

15. The method of claim **14**, further comprising setting the threshold range via an input device.

16. The method of claim **12**, wherein the in vivo characteristic comprises one or more of body temperature, oxygen level, and blood pressure.

17. An intravenous sensor system for in vivo monitoring, comprising:

a probe configured for placement in a peripheral vein of a patent, the probe containing one or more sensors for sensing in vivo characteristics; and

an interface device connected to the probe to receive sensed information from the probe and for relaying the sensed information to a computer.

18. The system of claim **17**, the probe comprising a needle for guiding the probe into the peripheral vein.

19. The system of claim **18**, wherein the probe comprises a one-way valve that allows the needle to be retracted.

20. The system of claim **17**, wherein a portion of the probe is configured to penetrate an intravenous catheter.

21. The system of claim **17**, wherein the one or more sensors are selected from the group including a temperature sensor, an oxygen sensor, and a blood pressure sensor.

22. A system for cooling a bag of intravenous fluid, comprising:

an insulated receptacle configured to receive the bag of intravenous fluid; and

a cooling device for reducing the temperature of the intravenous fluid within the insulated receptacle.

23. The system of claim **22**, the insulated receptacle having a transparent window for monitoring a level of the intravenous fluid in the bag.

24. The system of claim **22**, wherein the cooling device is selected from the group including a chemical coolant, a compressor and a Peltier device.

25. The system of claim **22**, further comprising a thermostatic controller for controlling operation of the cooling device based upon sensed temperature of the intravenous fluid.

26. The system of claim **22**, further comprising a display for indicating a temperature of the intravenous fluid.

27. A method for cooling a bag of intravenous fluid, comprising:

inserting the bag of intravenous fluid into an insulated receptacle; and

activating a cooling device to reduce the temperature of the intravenous fluid within the insulated receptacle.

28. The method of claim **27**, further comprising setting a temperature threshold of a thermostatic controller to control operation of the cooling device to maintain the temperature of the intravenous fluid based upon the set temperature.

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摘要(译)

公开了静脉内传感器系统和用于确定体内特征的方法，以及用于冷却静脉内液体袋的系统。静脉内传感器系统包括配置用于放置在外周静脉中的探针。探针包括一个或多个传感器，用于获得感测的信息，例如体温，血氧饱和度和血压。接口单元基于从一个或多个传感器接收的感测信息确定体内特征。确定的体内特征可以显示在接口单元上和/或传输到远程计算机。