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(71) Applicant: **The GSI GROUP, LLC** [US/US]; c/o AGCO Corporation - Jeffrey Ellsworth, 420 West Lincoln Blvd, Hesston, Kansas 67062 (US).

(72) Inventors: **BOUCHARD, Marco**; GSI Electronics, 5200 Armand-Frappier, St-Hubert, Québec J3Z 1G5 (CA). **GAUDREAU, Yvon**; GSi Electronics, 5200 Armand-Frappier, St Hubert, Québec J3Z 1G5 (CA). **BRODEUR, Jonathan**; GSI Electronics, 5200 Armand-Frappier, St-Hubert, Québec J3Z 1G5 (CA). **LABERGE, Benoit R.**; GSI Electronics, 5200 Armand-Frappier, St-Hubert, Québec J3Z 1G5 (CA).

(74) Agent: **ELLSWORTH, Jeffrey**; c/o AGCO Legal, 420 W. Lincoln Blvd, Hesston, Kansas 67062 (US).

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(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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(54) Title: SENSING DEVICE FOR CLIMATE CONTROL SYSTEM

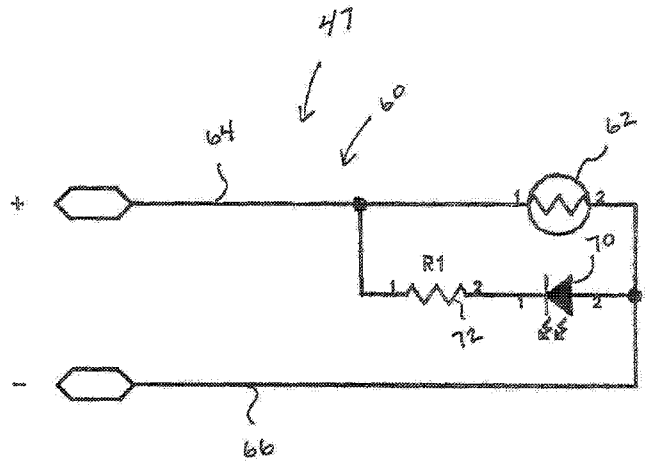

FIG. 3

(57) Abstract: A climate control system for an animal house having a plurality of climate control outputs such as heaters or ventilation fans has a control unit that regulates operation of climate control outputs. The control unit has a plurality of input terminals and a plurality of sensing devices, each of the plurality of sensing devices located in a different portion of the animal house and connected to one of the plurality of input terminals of the control unit with a connector to provide a signal to the control unit which is used to control the climate in the animal house. Each sensing device includes a thermal resistive sensor and an indicating LED configured to be selectively turned on by the control unit to indicate when the sensing unit is connected to the control unit.

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SENSING DEVICE FOR CLIMATE CONTROL SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application **No. 62/121,238** filed February 26, 2015, which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

Field of Invention

[0002] This invention relates to climate control systems for buildings used to house animals, and more particularly to a self-identifying sensing device used in such climate control systems.

Description of Related Art

[0003] In buildings that are used to house animals such as poultry, swine or livestock, it is important to maintain a desired building climate. A well-controlled environment involves monitoring and regulating the temperature, relative humidity and air quality in the building. For example, properly controlled temperatures enable animals to use feed for growth rather than for body heat. A properly heated animal house results in lower feed costs and increased animal productivity. Additionally, control over the level of humidity in the building is necessary because excess humidity contributes to animal discomfort and promotes the growth of harmful air born bacteria that can cause respiration diseases. Having an elevated humidity level in the animal house may also lead to more frequent changes of bedding and litter which increases production costs.

[0004] To maintain the proper climate in the animal building, various heaters and ventilation fans are used as necessary to maintain the desired

temperature, humidity. It is known to use a control unit to automatically control operation of the heaters and ventilation fans located within the building. Sensing devices, such as temperature sensing devices, are used to provide the necessary information to the control unit to enable such automatic control.

[0005] In some buildings, many sensing devices are installed into the growing space to collect the data required by the control unit to enable proper climate control. The control unit is typically installed in a remote location away from the growing space of the animals in the building, whereas the sensing devices are strategically placed within the growing space around the building. In order for the control unit to automatically operate the heaters and fans based on the received data, the location of each sensing device must be provided to the control unit. As the sensing devices are strategically placed throughout the building, it is key that each sensing device be connected to the proper input terminal of the control unit so the incoming climate data is attributed to the proper location with the building. Thus, the installer has to clearly identify the physical location of each sensing device within the building and connect the corresponding connector ends into the proper terminals at the control unit in order to match the incoming data with location in the building.

[0006] One problem encountered when a building has a number of sensing devices is that it is not always readily apparent which connector wire belongs to which sensing device. For example, if the ends of the connector wires next to the control unit are not properly identified, the operator must physically trace each connector wire to its sensor, or to cause a change in the reading of an individual sensor. Typically this is done by stimulating the sensing device, such as by immersing the sensing unit in a cup of cold water, to create a signal change. This requires the operator to enter the growing space, possibly disturbing or stressing the animals. The operator must then go back to the control unit and recognize which input value has changed. These steps must then be repeated for each of the sensing devices in the building. This can be a time consuming task and also can be stressful for the animals.

[0007] It is the aim of the present invention to provide a sensing device that enables simplified identification and programing of the climate control system.

OVERVIEW OF THE INVENTION

[0008] In one embodiment, the invention relates to a climate control system for an animal house having a plurality of climate control outputs such as heaters or ventilation fans. The climate control system includes a control unit that regulates operation of climate control outputs, the control unit having a plurality of input terminals. The climate control system also includes a plurality of sensing devices, each of the plurality of sensing devices located in a different portion of the animal house and connected to one of the plurality of input terminals of the control unit with a connector to provide a signal to the control unit which is used to control the climate in the animal house. Each sensing device includes a circuit having first and second electrical leads, the first and second leads carried by the connector to one of the plurality of input terminals of the control unit. The sensing device has a thermal resistive sensor, wherein when reading the thermal resistive sensor the control unit supplies an electric current through the thermal resistive sensor with the first lead being positive and the second lead being negative. The sensing device also has an LED wired in parallel with the thermal resistive sensor, wherein when turning on the LED, the polarity of the first and second electrical leads is reversed such that the second electrical lead is positive and the first electrical lead is negative to provide a forward voltage drop across the LED.

[0009] In another embodiment, the invention is directed to a climate control system for an animal house having a plurality of climate control outputs such as heaters or ventilation fans. The climate control system includes a control unit that regulates operation of climate control outputs, the control unit having a plurality of input terminals. The climate control system also includes a plurality of sensing devices, each of the plurality of sensing devices located in a different

portion of the animal house and connected to one of the plurality of input terminals of the control unit with a connector to provide a signal to the control unit which is used to control the climate in the animal house. Each sensing device includes a circuit having first and second electrical leads, the first and second leads carried by the connector to one of the plurality of input terminals of the control unit. The sensing device has a thermal resistive sensor, wherein when reading the thermal resistive sensor the control unit supplies an electric current through the thermal resistive sensor with the first lead being positive and the second lead being negative. The sensing device also has an LED wired in parallel. A pulse signal is applied to the electrical leads to provide a forward voltage drop across the LED to turn the LED on.

[0010] In another embodiment, the invention is directed to a climate control system for an animal house having a plurality of climate control outputs such as heaters or ventilation fans. The climate control system includes a control unit that regulates operation of climate control outputs, the control unit having a plurality of input terminals. The climate control system also includes a plurality of sensing devices, each of the plurality of sensing devices located in a different portion of the animal house and connected to one of the plurality of input terminals of the control unit with a connector to provide a signal to the control unit which is used to control the climate in the animal house. Each sensing device includes a thermal resistive sensor and an indicating LED configured to be selectively turned on by the control unit to indicate when the sensing unit is connected to the control unit.

[0011] These and other features and advantages of this invention are described in, or are apparent from, the following detailed description of various example embodiments of the systems and methods according to this invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The above mentioned and other features of this invention will become more apparent and the invention itself will be better understood by

reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0013] FIG. 1 is a diagrammatical block illustration of a climate control system of the present invention;

[0014] FIG. 2 is a perspective drawing of a self-identifying sensing unit of the present invention;

[0015] FIG. 3 is an electrical circuit schematic of the sensing unit of FIG 2; and

[0016] FIG. 4 is an electrical circuit schematic of an alternate embodiment of the sensing unit.

[0017] FIG. 5 is an electrical circuit schematic of an alternate embodiment of the sensing unit.

[0018] Corresponding reference characters indicate corresponding parts throughout the views of the drawings.

DESCRIPTION OF EXAMPLE EMBODIMENTS

[0019] The invention will now be described in the following detailed description with reference to the drawings, wherein preferred embodiments are described in detail to enable practice of the invention. Although the invention is described with reference to these specific preferred embodiments, it will be understood that the invention is not limited to these preferred embodiments. But to the contrary, the invention includes numerous alternatives, modifications and equivalents as will become apparent from consideration of the following detailed description.

[0020] Referring to FIG. 1, a schematic of an animal house 10 of conventional design is shown. The animal house has a climate control system 20 having a plurality of climate control outputs, such as ventilation fans, indicated at 30, 31 and 32, and heater units indicated at 33, 34 and 35, mounted in the building 10. Although three heaters and three ventilating fans are shown, it will be understood that this is for purposes of illustrations only, and that additional or fewer heaters and fans may be provided, as required. The climate control

system 20 has a control unit 40, which incorporates a suitable controller, such as a microprocessor main control unit 41, which regulates the operation of the ventilating fans 30, 31 and 32 and the heater units 33, 34 and 35 by way of control cables 30A-35A, respectively. The control unit receives its operating power from a suitable power supply 42.

[0021] The control unit 40 receives input from a plurality of sensing devices 47, 48 and 49 by way of connectors 47A, 48A and 49A, respectively. The sensing devices 47, 48 and 49 are located in different portions of the animal house 10 so that climate information, such as temperature, may be received for the different portions. Although only three sensing devices 47, 48 and 49 are shown, it will be understood that additional sensing devices, sometimes many more sensing devices, may be used as required to obtain the desired readings of the climate inside the animal house 10. Each sensing device 47, 48 and 49 is connected to a respective input 54, 55 and 56 to the control unit 40. As would be understood by one skilled in the art, the controller 41 in control unit 40 is adapted to regulate the operation of the fans 30, 31 and 32 and heaters 33, 34, 35 in response to specific data received from the sensing devices 47, 48 and 49, and in accordance with a program relating to the physical characteristics of the animal house 10 and needs of animals in the house. In one embodiment, the sensing devices 47, 48 and 49 are temperature sensing devices. However, one skilled in the art will understand that the sensing devices may be used to sense other climate parameters. It may be understood that sensing devices 48 and 49 can be structurally and functionally identical to sensing device 47. Therefore, while the following description is directed to sensing device 47, it should be understood that the description also applies to other sensing devices 48 and 49. As such, no further description will be given of sensing devices 48 and 49.

[0022] Turning also now to FIGS. 2 and 3, in the illustrated embodiment sensing device 47 is a temperature sensing device having a circuit 60 containing a thermal resistive sensor 62. The thermal resistive sensor 62 may be of any conventional design and will be understood by one skilled in the art. Therefore, a detailed description of the thermal resistive sensor 62 need not be provided

herein. The circuit 60 of the sensing device 47 has first and second electrical leads 64, 66 that supply electrical power to the thermal resistive sensor 62. The first and second leads 64, 66 are carried by the connector 47A to the input 54 of the control unit 40 to connect the sensing unit 47 to the control unit 40. When reading the thermal resistive sensor 62, the control unit 40 supplies a small electric current (e.g., about 1 mA) through the sensor 62 with the first lead 64 being positive and the second lead 66 being negative. As is known in the art, the control unit 40 translates the resulting power into a temperature reading.

[0023] According to the invention, the sensing device 47 also contains an indicating device 70 in the form of at least one light source. Preferably, the indicating device 70 is an integrated LED. Electrical power is supplied to the LED 70 when the installer wants to identify the sensing device 47 connected to a particular input to the control unit 40, such as input 54. Desirably, the circuit 60 has the thermal resistive sensor 62 and LED 70 wired in parallel such that the same first and second electrical leads 64, 66 used to read the thermal resistive sensor 62 are used to power the identification LED 70. Circuit 60 desirably has a suitable resistor 72 in series with the LED 70. When the installer wants to turn on the LED 70 to identify the sensing device 47, the polarity of the first and second electrical leads 64, 66 is reversed. This can be done by physically reversing the leads attached to the input terminal of the control unit, or the control unit 40 is used to switch the polarity. When the second electrical lead 66 is positive and the first electrical lead 64 is negative, the forward voltage drop across the LED 70 provides the LED current to light the LED 70.

[0024] Accordingly, on the installer's request, the control unit 40 will light the LED 70 on the sensing device 47, making it visible from a distance. Since it can be seen from distance, the installer can identify which sensing device 47 is being connected to which input 54 on the control unit 40 without having to access the sensing device 47 directly. Therefore, the sensing device 47 can be identified without having to move into the animal growing area to stimulate the sensing device 47 in order to track its signal into the control unit 40. The installer then can quickly identify which sensing device 47, 48, 49 is connected to each

input 54, 55, and 56 of the control unit 40 by individually reversing the polarity of the leads 64, 66 of each sensing device to turn on its indicating LED 70.

[0025] Turning now to FIG. 4, an alternate embodiment of circuit 73 for the sensing device 47 is shown with like components having the same reference numbers for clarity. Desirably, circuit 73 has the thermal resistive sensor 62 and LED 70 wired in parallel such that the same first and second electrical leads 64, 66 used to read the thermal resistive sensor 62 are used to power the identification LED 70. Circuit 73 desirably has resistor 72 in series with the LED 70. A capacitor 76 is used to AC couple the LED 70 with the thermal resistive sensor 62. When a reference DC voltage is applied (for example, 2.5 V_{DC}) to the electrical leads 64, 66, the thermal resistive sensor 62 may be read. A pulsed DC voltage is use to pass through the capacitor 76 to light the LED 70. In one embodiment, the control unit 40 generates a 0 to 5V_{DC} square wave pulse. However, one skilled in the art will understand that other pulsed voltages and even AC voltage may be used. A diode 74 is used to discharge the capacitor 76, otherwise the capacitor 76 becomes fully charged and the pulse cannot pass through and the LED 70 will not be powered. In this design, it is the change from the reference voltage to the pulsed voltage, rather than the shift in polarity as explained with reference to FIG. 3 above, that turns on the LED 70. The diode acts like a rectifier if the assembly is connected in reverse on the circuit 60. The magnitude of the voltage pulse is selected so as to not be large enough to damage the LED 70. It has been found that when the pulsed voltage is applied to turn on the LED 70, the thermal resistive sensor 62 cannot be accurately read because the pulsed voltage tends to heat up the thermal resistive sensor 62.

[0026] Turning now to FIG. 5, an alternate embodiment of the sensing device 47 is shown. In this embodiment, circuit 80 has three leads 82, 84, 86 connectable with the control unit 40. In this embodiment, the LED 70 has its own positive lead 82 and the thermal resistive sensor 62 has its dedicated positive lead 84 which share negative lead 86. The control unit 40 would select whether the thermal resistive sensor 62 is to be read or whether to turn on the LED 70 by selecting which positive lead is powered.

[0027] Accordingly, the climate control system 20 can be set up using the self-identifying sensing devices 47, 48 and 49. The installer can identify the sensing devices 47, 48 and 49 and critical outputs (input dependent) (e.g., heaters, fans, etc.) into the animal house 10. The installer can dress the list of input assignation relating critical outputs with the sensing devices 47, 48 and 49 they should be assigned to. The sensing devices 47, 48 and 49 are connected to input terminals 54, 55 and 56 of the control unit 40. From the control unit 40, the installer can activate the self-identifying indicator 70 for one sensing device 47, 48 or 49. The installer can then look into the animal house 10, with minimized effect on the animals therein, and identify which sensing device that is turned on. The installer can then identify the sensing device 47, 48 or 49 into the list and make any necessary corrections and program the control 41 to assign the input 54, 55 or 56 to proper output. The installer then repeats these steps for the other sensing devices 48 and 49.

[0028] The self-identifying sensing device 47 may also be used in the climate control system 20 to track and fix a bad connection on an input 54 when the control unit 40 recognizes and warns that a connection to a sensing device 47 is open or shorted even if there is no information on the specific sensing device location. The operator can tell the control unit 40 to activate the LEDs 70 on all the sensing devices 47, 48 and 49. The operator can walk into the animal house 10 and identify the sensing device without a lit LED 70.

[0029] While this invention has been described in conjunction with the specific embodiments described above, it is evident that many alternatives, combinations, modifications and variations are apparent to those skilled in the art. Accordingly, the preferred embodiments of this invention, as set forth above are intended to be illustrative only, and not in a limiting sense. Various changes can be made without departing from the spirit and scope of this invention.

What is claimed is:

1. A climate control system for an animal house having a plurality of climate control outputs, the climate control system comprising:

a control unit that regulates operation of climate control outputs, the control unit having a plurality of input terminals;

a plurality of sensing devices, each of said plurality of sensing devices located in a different portion of the animal house and connected to one of the plurality of input terminals of the control unit with a connector to provide a signal to the control unit which is used to control the climate in the animal house, each sensing device comprising:

a thermal resistive sensor, wherein when reading the thermal resistive sensor the control unit supplies an electric current through the thermal resistive sensor with the first lead being positive and the second lead being negative; and

an indicating LED configured to be selectively turned on by the control unit to indicate when the sensing unit is connected to the control unit.

2. The climate control system of claim 1 further comprising:

a circuit having first and second electrical leads, the first and second leads carried by the connector to one of the plurality of input terminals of the control unit;

a capacitor used to couple the thermal resistive sensor with the LED; and

a diode used to discharge the capacitor;

wherein the indicating LED is wired in parallel with the thermal resistive sensor, wherein when turning on the LED, when a reference DC voltage is applied to the electrical leads to read the thermal resistive sensor and wherein a pulsed DC voltage is use to light the LED.

3. The climate control system of claim 1 wherein the control unit provides a square wave pulse to light the LED.

4. The climate control system of claim 1 further comprising:

a circuit having first and second electrical leads, the first and second leads carried by the connector to one of the plurality of input terminals of the control unit;

a capacitor used to couple the thermal resistive sensor with the LED; and

a diode used to discharge the capacitor;

a resistor in series with the LED;

wherein a reference DC voltage is applied to the electrical leads to read the thermal resistive sensor and a pulsed DC voltage is use to pass through the capacitor to light the LED and the diode is used to discharge the capacitor, preventing the capacitor from becoming fully charged thereby preventing the pulsed voltage from passing through the capacitor and triggering the LED.

5. The climate control system of claim 1 further comprising:

a circuit having first, second and third electrical leads, the first, second and third leads carried by the connector to one of the plurality of input terminals of the control unit, wherein the LED has its own positive lead and the thermal resistive sensor has its dedicated positive lead and share a negative lead, wherein the control unit selects whether the thermal resistive sensor is to be read or whether to turn on the LED by selecting which positive lead is powered.

6. A method of installing a climate control system for an animal house having a plurality of climate control outputs, the climate control system

comprising a control unit that regulates operation of climate control outputs, the control unit having a plurality of input terminals, the method comprising:

installing a plurality of sensing devices, each of said plurality of sensing devices located in a different portion of the animal house, each sensing device comprising first and second electrical leads, a thermal resistive sensor and an indicating LED;

connecting each of the plurality of sensing devices to one of the plurality of input terminals of the control unit with a connector to provide a signal to the control unit which is used to control the climate in the animal house; and

identifying a specific sensing device of the plurality of sensing devices by triggering its indicating LED to light the LED.

7. The method of claim 6 wherein the step of identifying the specific sensing device comprises reversing the polarity of the first and second electrical leads.

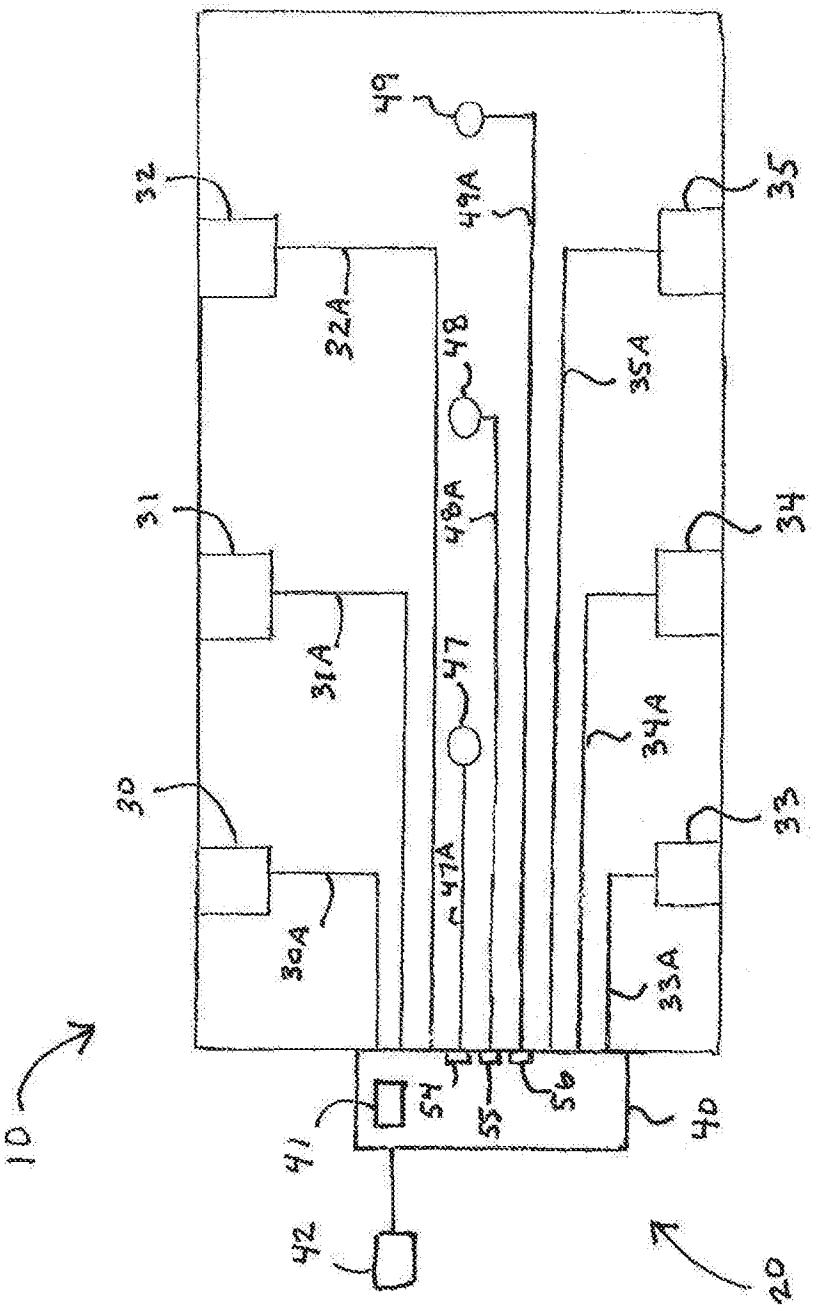
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FIG. 1

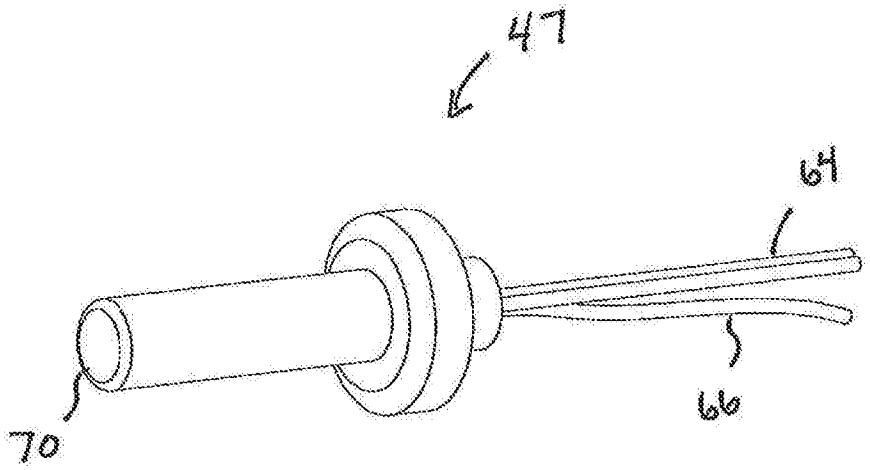

FIG. 2

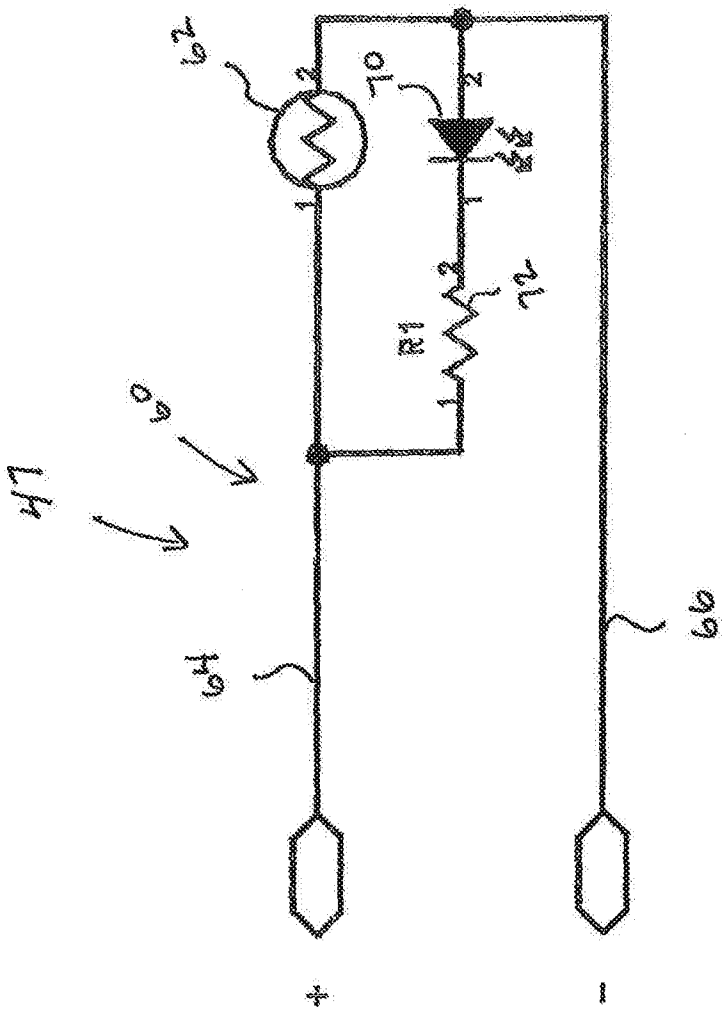

FIG. 3

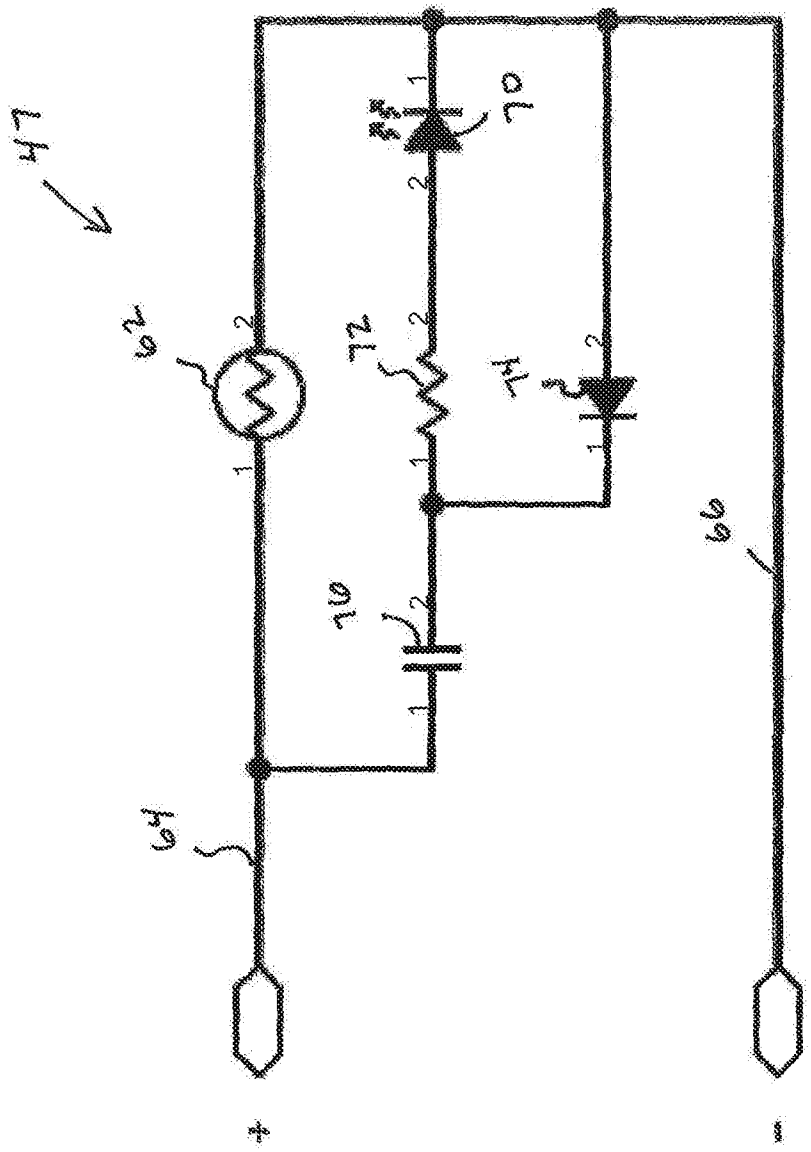

FIG. 4

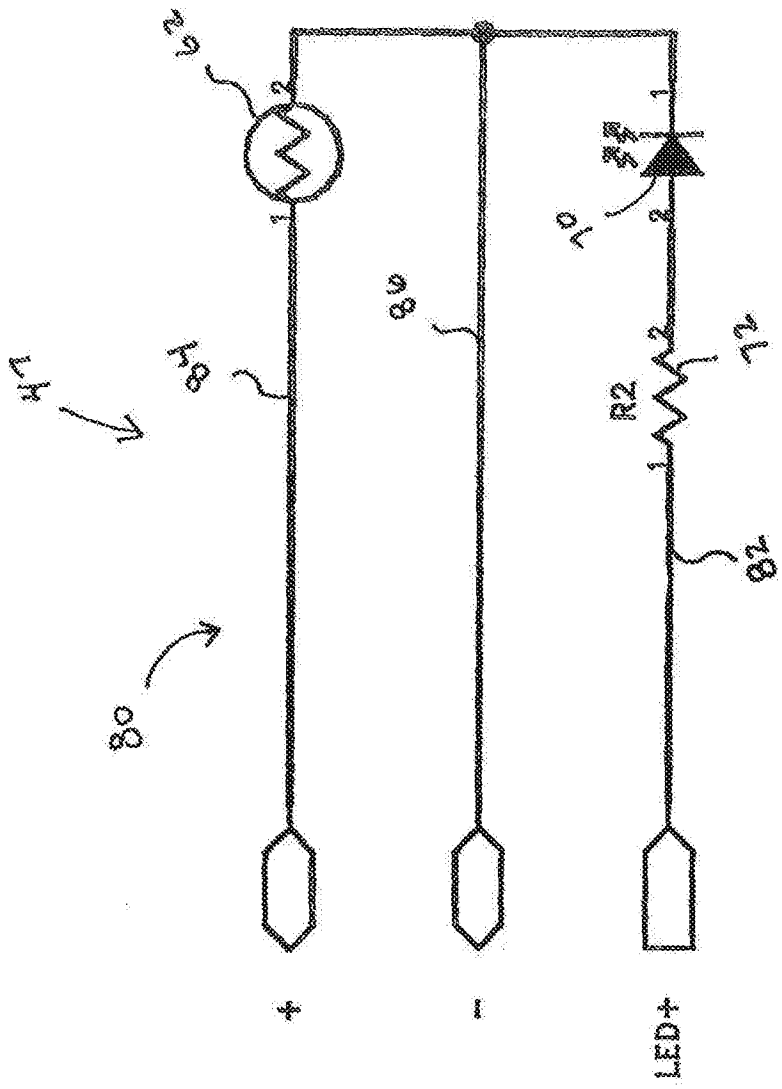

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/019091

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24F11/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A01K F24F G05D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	paragraph [0010] - paragraph [0010]; figures 6-8	4

Y	JP 3 379226 B2 (MITSUBISHI ELECTRIC CORP) 24 February 2003 (2003-02-24)	1-3,5-7
A	paragraph [0036] - paragraph [0036]; figures 1,4	4

A	US 2014/091153 A1 (STEFANSKI MARK D [US] ET AL) 3 April 2014 (2014-04-03) paragraph [0009] - paragraph [0011]; figures 6-8	1-7

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 May 2016	08/06/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Anconetani, Mirco

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/019091

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2007/130051 A1 (CARRIER CORP [US]; DOLAN ROBERT PAUL [US]; LYNN DOUGLAS CHARLES [US]) 15 November 2007 (2007-11-15) page 7, line 22 - page 8, line 15; figures 1,3,4 -----	1-7

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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