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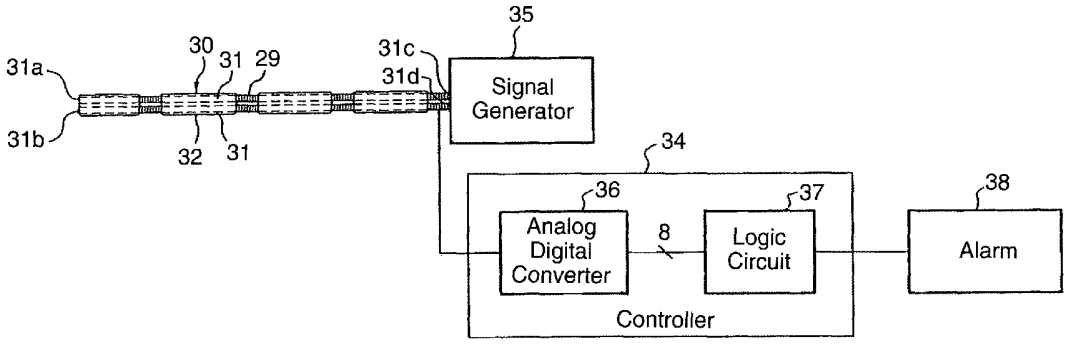
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** METHOD AND SYSTEM FOR DETECTING LIQUID LEAKAGE



(57) **Abstract:** A method and system for detecting liquid leakage. The system comprises a sensor having two separate conductive lines for detecting liquid leakage, the two separate conductive lines having two open terminals and two connection terminals; a single generator for supplying a detecting signal to detect liquid with impedance less than 100 mega ohm to the sensor; and a controller electrically connected to the negative terminal (or positive terminal) of the two connection terminals. If liquid leakage is detected between the two conductive lines, an analog signal is generated at the negative terminal (or positive terminal). The controller converts the analog signal into a digital signal to activate an alarm.

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METHOD AND SYSTEM FOR DETECTING LIQUID LEAKAGE

Field

The present invention relates to a method and system for detecting liquid leakage which is capable of detecting leaked liquid having an impedance less than 100 mega ohm, in which a detected analog signal is converted into a digital signal so as to increase the sensibility and accuracy of detecting liquid leakage, thereby enhancing the precision of liquid leakage detection and preventing operational errors caused by outside environmental interference.

Background

In manufacturing equipment, water and chemical liquid are commonly used for the purpose of cleaning or cooling. If water leakage or liquid leakage occurs, it would cause abnormal operation of the equipment and could possibly be harmful to the working staff. Prior attempts to solve this problem, include the leakage detector, for example, that was filed by the same applicant with the R.O.C. Patent Application No. 092116399. The structure thereof is shown in Fig. 1. The leakage detector shown therein is used to detect whether the equipment has the problem of water leakage. As shown in Fig. 1, the water leakage detector includes a sensor 10, a controller 14 and an alarm 18. The controller 14 consists of a transistor 15, a resistor 16 and a power source 17. The sensor 10 includes two conductive lines 11 and an integument 12, wherein the two separate conductive lines 11 have two open terminals and two connection terminals. The base and emitter of the transistor 15, the two connection terminals, the resistor 16 and the power source 17 are electrically connected in series. The collector and emitter of the transistor 15, the power source 17 and the alarm 18 are electrically connected in series. The integument 12 is used to cover the two separate conductive lines 11, wherein several parts of the two separate conductive lines 11 are exposed to form a plurality of electrodes 9.

When leakage water 20 is detected at any one of the electrodes 9, a current flowing through the sensor 10, the resistor 16 and the base and emitter of the

transistor 14 is generated so as to turn on the transistor 14. At this moment, the alarm 18 is activated to warn operators of the occurrence of water leakage.

The conventional water leakage detector can detect water leakage may not be optimized to detect chemical liquid leakage with high impedance. However, certain industrial chemicals may be harmful and therefore it is important to accurately detect liquid leakage.

SUMMARY OF THE INVENTION

The present invention provides a method and system for detecting liquid leakage, where the leaked liquid has an impedance less than 100 mega ohm can be detected. A detected analog signal is converted into a digital signal so as to increase the accuracy of detecting water leakage and the short circuit and the open circuit of a sensor, thereby enhancing the precision of liquid leakage detection and preventing operational errors caused by outside environmental interference. It may be desirable to be able to reliably detect such liquids, including the chemical liquids used in the manufacture process of the TFT-LCD, semiconductor and PDP, i.e. isopropyl alcohol, acetone, hydrochloric acid, ethanol, ammonia, photoresist, methylsulfinylmethane (DSMC), dimethyl sulfoxyde (DMSO), special soft copolymer (SPX), edge bead remover (EBR), LC–841: Cleaner for liquid crystal (Semi-aqueous type), stereolithography (SLA), oxalic, ultra pure water (UPW) or water, can be dangerous or hazardous.

In one exemplary embodiment, a method for detecting a liquid leak of the present invention comprises the steps of: using a sensor to detect the leak, the sensor comprises a first conductive line separate from a second conductive line, each conductive line having an open terminal and a connection terminal; generating a detecting signal from a signal generator, the detecting signal for detecting liquid with impedance less than 100 mega ohm, the detecting signal supplied to the sensor via the connection terminals of the first and second conductive lines by a controller; generating an analog signal at one of the two connection terminals when a leak is detected between the two conductive lines; converting the analog signal to a digital signal using the controller; and activating

an alarm with the digital signal.

In another exemplary embodiment, the invention comprises a computer readable recording medium for embodying a program, which program is executed for performing the steps as mentioned above.

In another exemplary embodiment of a system for detecting a liquid leak, the system comprises: a sensor comprising a first conductive line separate from a second conductive line, the first conductive line having a first open terminal and a first connection terminal, the second conductive line having a second open terminal and a second connection terminal, wherein an analog signal is generated at the first connection terminal of the first conductive line when the leak is detected between the two conductive lines; a signal generator providing a detecting signal for detecting liquid having an impedance less than or equal to 100 mega ohm, the signal generator connected to the first and second connection terminals of the first and second conductive lines; an alarm; and a controller controlling the signal generator and converting the analog signal to a digital signal that is used to activate the alarm, the controller connected to the first connection terminal of the first conductive line.

Another exemplary embodiment of the present invention, is a method for detecting a liquid leak comprising the steps of: using a sensor to detect the leak, the sensor comprises a first conductive line separate from a second conductive line, each conductive line having a terminal connected to a terminal resistor and a connection terminal; generating a detecting signal from a signal generator, the detecting signal for detecting liquid with impedance less than 100 mega ohm, the detecting signal supplied to the sensor via the connection terminals of the first and second conductive lines by a controller; generating an first analog signal at one of the two connection terminals when a leak is detected between the two conductive lines; converting the first analog signal to a first digital signal using the controller; and activating an first alarm with the first digital signal. The method further comprises: generating a second analog signal at one of the two connection terminals by the sensor, if the sensor is open circuited; converting the second analog signal into a second digital signal by the controller; and activating a second

alarm with the second digital signal.

Another exemplary embodiment of the invention further comprises a computer readable recording medium for embodying a program, which program is executed to perform the above steps.

According to another exemplary embodiment of the present invention, a system for detecting a liquid leak, the system comprising: a sensor comprising a first conductive line separate from a second conductive line, the first conductive line having a first terminal connected to a terminal resistor and a first connection terminal, the second conductive line having a second terminal connected to the terminal resistor and a second connection terminal, wherein a first analog signal is generated at the first connection terminal of the first conductive line when the leak is detected between the two conductive lines; a signal generator providing a detecting signal for detecting liquid having an impedance less than or equal to 100 mega ohm, the signal generator connected to the first and second connection terminals of the first and second conductive lines; a first alarm; and a controller controlling the signal generator and converting the first analog signal to a first digital signal that is used to activate the first alarm, the controller connected to the first connection terminal of the first conductive line. The system further comprises: a second alarm, wherein a second analog signal is generated at one of the first and second connection terminals if the sensor is open circuited, and the second analog signal is converted into a second digital signal by the controller, and the second alarm is activated by the second digital signal.

The advantages of the method and system for detecting liquid leakage reside in that: the impedance of the leaked liquid which can be detected by the present invention is less than 100 mega ohm, and a detected analog signal is converted into a digital signal so as to increase the accuracy of detecting liquid leakage, thereby enhancing the precision of liquid leakage detection and preventing operational errors caused by outside environmental interference.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a circuit block diagram showing a known water leakage detector;

Fig. 2 is a schematic diagram showing a possible non-symmetry pulse signal that can be used in the present invention;

Fig. 3 is a circuit block diagram showing an exemplary system for detecting liquid leakage according to the present invention;

Fig. 4 is a circuit block diagram showing another exemplary system for detecting liquid leakage according to the present invention;

Fig. 5 is a flow chart showing an exemplary method for detecting liquid leakage according to the present invention; and

Fig. 6 is a flow chart showing another exemplary method for detecting liquid leakage according to the present invention.

These figures are not drawn to scale and are intended only for illustrative purposes.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 3 shows a system for detecting liquid leakage according to an exemplary embodiment of the present invention. The system comprises a sensor 30, a signal generator 35, a controller 34, and an alarm 38. In one embodiment, the length of sensor 30 can be up to 450 meters, including the length of the sensor body (up to 100 meters) and the wires connected to the sensor 30. S ensor 30 has two separate conductive lines 31 and an integument or cover 32. The two separate conductive lines 31 have two open terminals (shown schematically as 31a and 31b) and two connection terminals (shown schematically as 31c and 31d). The integument 32 is used to cover the two separate conductive lines 31, wherein several parts of the two separate conductive lines 31 are exposed to form a plurality of electrodes 29.

In one exemplary embodiment, the signal generator 35 is electrically connected to the two connection terminals of the two separate conductive lines 31. The signal generator provides a detecting signal for detecting liquid with impedance less than 100 mega ohm (such as a non-symmetrical pulse signal with a voltage/period of +5V/1.7sec and –9V/0.8sec shown in Fig. 2) to the sensor 30. The controller 34 comprises an analog/digital converter 36 and a logic circuit 37. The input terminal of the analog/digital converter 36 is electrically connected to the negative terminal (or positive terminal) of the two connection terminals by using cables for shielding the signals from noise. The output terminal of the analog/digital converter 36 is electrically connected to the input terminal of the logic circuit 37. The analog/digital converter 36 outputs an 8-bit digital signal 8 to the logic circuit 37. In addition, the output terminal of the logic circuit 37 is electrically connected to the alarm 38.

As shown in Fig. 3, when liquid leakage is detected at an electrode 29 of the sensor 30 in equipment, an analog signal is generated at the negative terminal (or positive terminal) of the two separate conductive lines 31. The voltage of the analog signal is in the range of +5V to -9V. The voltage of the analog signal depends on the impedance of the leaked liquid. The analog/digital converter 36 converts the analog signal (+5V to -9V) into a digital signal (with the value ranging from 0 to 255). The logic circuit 37 processes the digital signal. Then, the alarm 38 is activated by the digital signal, thereby warning operators of the occurrence of the liquid leakage.

Fig. 4 shows a system for detecting liquid leakage according to another exemplary embodiment of the present invention. The embodiment shown in Fig. 4 is similar to the embodiment of Fig. 3 and further includes a terminal resistor 53. The terminal resistor has two terminals (not shown) and are connected to the open terminal of each conductive line. Like Fig. 3, the system in Fig. 4 comprises a sensor 50, a signal generator 55, a controller 54, a first alarm 58, a second alarm 60 and an integument 52. The integument is used to cover the conductive lines. Where the conductive lines are exposed a plurality of electrodes 49 are formed.

The signal generator 55 is electrically connected to two connection

terminals, schematically shown as 51c and 51d, of the conductive lines. The signal generator provides a detecting signal for detecting liquid with impedance less than 100 mega ohm (such as a non-symmetrical pulse signal with a voltage/period of +5V/1.7sec and –9V/0.8sec shown in Fig. 2) to the sensor 50. The controller 54 comprises an analog/digital converter 56 and a logic circuit 57. The input terminal of the analog/digital converter 56 is electrically connected to the negative terminal (or positive terminal) of the connection terminals by using cables for shielding the signals from noise. The output terminal of the analog/digital converter 56 is electrically connected to the input terminal of the logic circuit 57. The analog/digital converter 56 outputs an 8-bit digital signal 8 to the logic circuit 57. In addition, the output terminal of the logic circuit 57 is electrically connected to the first alarm 58 and the second alarm 60.

As shown in Fig. 4, when liquid leakage is detected at an electrode 49 of the sensor 50 in equipment, a first analog signal is generated at the negative terminal (or positive terminal) of the two separate conductive lines 51. The voltage of the first analog signal is in the range of +5V to -9V. The voltage of the first analog signal depends on the impedance of the leaked liquid. The analog/digital converter 56 converts the first analog signal (+5V to -9V) into a first digital signal (with the value ranging from 0 to 255). The logic circuit 57 processes the first digital signal, and then the first alarm 58 is activated by the first digital signal, thereby warning operators of the occurrence of the liquid leakage. If the sensor 50 is open circuited, a second analog signal is generated at the negative terminal (or positive terminal) of the two separate conductive lines 51. The analog/digital converter 56 converts the second analog signal (+5V to -9V) into a second digital signal (with the value ranging from 0 to 255). The logic circuit 57 processes the second digital signal, and then the second alarm 60 is activated by the second digital signal, thereby warning operators that the sensor 50 is open circuited.

Fig. 5 shows an exemplary method for detecting liquid leakage according to the present invention. First, in step S60, a sensor is prepared, wherein the sensor is in a length up to 450 meters, and has two separate conductive lines having two open terminals and two connection terminals, and a detecting signal for detecting

liquid with impedance less than 100 mega ohm (such as a non-symmetry pulse signal with a voltage/period of +5V/1.7sec and –9V/0.8sec shown in Fig. 2) is provided to the sensor through the two connection terminals by a signal generator. When performing step S61, if liquid leakage is detected between the two separate conductive lines, an analog signal is generated at the negative terminal (or positive terminal) of the two connection terminals, wherein the voltage of the analog signal is in the range of +5V to -9V. Next, when performing step S62, the analog signal is converted into a digital signal by a controller. Then, when performing step S63, the alarm is activated by the digital signal, thereby warning operators of the occurrence of the liquid leakage.

Fig. 6 shows an exemplary method for detecting liquid leakage according to the present invention. First, in step S70, a sensor and a signal generator are prepared, wherein the sensor has two separate conductive lines and a terminal resistor, two terminals of the two separate conductive lines being electrically connected to the two terminals of the terminal resistor, respectively, and the signal generator provides a detecting signal for detecting liquid with impedance less than 100 mega ohm (such as a non-symmetry pulse signal with a voltage/period of +5V/1.7sec and –9V/0.8sec shown in Fig. 2) to the sensor through the connection terminals of the two separate conductive lines. When performing step S71, if liquid leakage is detected between the two separate conductive lines, a first analog signal is generated at the negative terminal (or positive terminal) of the connection terminals of the two separate conductive lines, wherein the voltage of the first analog signal is in the range of +5V to -9V. Next, when performing step S72, the first analog signal is converted into a first digital signal by a controller. Then, when performing step S73, a first alarm is activated by the first digital signal, thereby warning operators of the occurrence of the liquid leakage.

In step S74, if the sensor is open circuited, a second analog signal is generated at the negative terminal (or positive terminal) of the sensor, wherein the voltage of the second analog signal is in the range of +5V to -9V. Next, in step 75, the second analog signal is converted into a second digital signal by the controller. Then, in step S76, a second alarm is activated by the second digital

signal, thereby warning operators that the sensor is open circuited.

The advantages of the method and system for detecting liquid leakage reside in that a detecting signal for detecting liquid with impedance less than 100 mega ohm is used to detect liquid leakage; when liquid leakage is detected, an analog signal is generated and converted into a digital signal (for example, +5V to –9V is divided into 256 intervals) so as to increase the sensibility and accuracy of detecting liquid leakage, thereby enhancing the precision of liquid leakage detection. The present invention also prevents operational errors caused by outside environmental interference.

While the invention has been described by way of example and in terms of the preferred embodiment, it is to be understood that the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements as would be apparent to those skilled in the art. Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A method for detecting a liquid leak comprising the steps of:

using a sensor to detect the leak, the sensor comprising a first conductive line separate from a second conductive line, each conductive line having an open terminal and a connection terminal;

generating a detecting signal from a signal generator, the detecting signal for detecting liquid with impedance less than 100 mega ohm, the detecting signal supplied to the sensor via the connection terminals of the first and second conductive lines by a controller;

generating an analog signal at one of the two connection terminals when a leak is detected between the two conductive lines;

converting the analog signal to a digital signal using the controller; and

activating an alarm with the digital signal.

2. The method as claimed in claim 1, wherein the controller further comprises an analog/digital converter and a logic circuit, and the controller controls a signal generator for supplying the detecting signal to the sensor.

3. The method as claimed in claim 1, wherein the detecting signal is a pulse signal.

4. A computer readable recording medium for embodying a program which is executed by a computer to perform the following steps:

detecting whether or not leakage occurs by a sensor, wherein the sensor comprises a first conductive line separate from a second conductive line, each conductive line having an open terminal and a connection terminal;

generating a detecting signal from a signal generator, the detecting signal

for detecting liquid with impedance less than 100 mega ohm, the detecting signal supplied to the sensor via the connection terminals of the first and second conductive lines by a controller;

generating an analog signal at one of the two connection terminals when a leak is detected between the two conductive lines;

converting the analog signal to a digital signal using the controller; and

activating an alarm with the digital signal.

5. The computer readable medium as claimed in claim 4, wherein the controller further comprises an analog/digital converter and a logic circuit, and the controller controls a signal generator for supplying the detecting signal to the sensor.

6. The computer readable medium as claimed in claim 4, wherein the detecting signal is a pulse signal.

7. A system for detecting a liquid leak, the system comprising:

a sensor comprising a first conductive line separate from a second conductive line, the first conductive line having a first open terminal and a first connection terminal, the second conductive line having a second open terminal and a second connection terminal, wherein an analog signal is generated at the first connection terminal of the first conductive line when the leak is detected between the two conductive lines;

a signal generator providing a detecting signal for detecting liquid having an impedance less than or equal to 100 mega ohm, the signal generator connected to the first and second connection terminals of the first and second conductive lines;

an alarm; and

a controller for controlling the signal generator and converting the analog signal to a digital signal that is used to activate the alarm, the controller connected

to the first connection terminal of the first conductive line.

8. The system as claimed in claim 7, wherein the controller further comprises an analog/digital converter and a logic circuit.

9. The system as claimed in claim 7, wherein the detecting signal is a pulse signal.

10. A method for detecting a liquid leak comprising the steps of:

using a sensor to detect whether or not a leak occurs, the sensor comprising a first conductive line separate from a second conductive line, each conductive line having a terminal connected to a terminal resistor and a connection terminal;

generating a detecting signal from a signal generator for detecting liquid with impedance less than 100 mega ohm, the detecting signal supplied to the sensor via the connection terminals of the first and second conductive lines by a controller;

generating a first analog signal at one of the two connection terminals when a leak is detected between the two conductive lines;

converting the first analog signal to a first digital signal using the controller; and

activating an first alarm with the first digital signal.

11. The method as claimed in claim 10, wherein the controller further comprises an analog/digital converter and a logic circuit, and the controller controls a signal generator for supplying the detecting signal to the sensor.

12. The method as claimed in claim 10, wherein the detecting signal is a pulse signal.

13. The method as claimed in claim 10, further comprising the steps of:

generating a second analog signal at one of the two connection terminals by

the sensor, if the sensor is open circuited;

converting the second analog signal into a second digital signal by the controller; and

activating a second alarm with the second digital signal.

14. A computer readable recording medium for embodying a program which is executed by a computer to perform the following steps:

detecting whether or not a leak occurs by a sensor, the sensor comprising a first conductive line separate from a second conductive line, each conductive line having a terminal connected to a terminal resistor and a connection terminal;

generating a detecting signal from a signal generator for detecting liquid with impedance less than 100 mega ohm, the detecting signal supplied to the sensor via the connection terminals of the first and second conductive lines by a controller;

generating an first analog signal at one of the two connection terminals when a leak is detected between the two conductive lines;

converting the first analog signal to a first digital signal using the controller; and

activating an first alarm with the first digital signal.

15. The computer readable medium as claimed in claim 14, wherein the controller further comprises an analog/digital converter and a logic circuit, and the controller controls a signal generator for supplying the detecting signal to the sensor.

16. The computer readable medium as claimed in claim 14, wherein the detecting signal is a pulse signal.

17. The computer readable medium as claimed in claim 14, further comprises the steps:

generating a second analog signal at one of the two connection terminals by the sensor, if the sensor is open circuited;

converting the second analog signal into a second digital signal by the controller; and

activating a second alarm with the second digital signal.

18. A system for detecting a liquid leak, the system comprising:

a sensor comprising a first conductive line separate from a second conductive line, the first conductive line having a first terminal connected to a terminal resistor and a first connection terminal, the second conductive line having a second terminal connected to the terminal resistor and a second connection terminal, wherein a first analog signal is generated at the first connection terminal of the first conductive line when a leak is detected between the two conductive lines;

a signal generator providing a detecting signal for detecting liquid having an impedance less than or equal to 100 mega ohm, the signal generator connected to the first and second connection terminals of the first and second conductive lines;

a first alarm; and

a controller for controlling the signal generator and converting the first analog signal to a first digital signal that is used to activate the first alarm, the controller connected to the first connection terminal of the first conductive line.

19. The system as claimed in claim 18, wherein the controller further comprises an analog/digital converter and a logic circuit.

20. The system as claimed in claim 18, wherein the detecting signal is a pulse signal.

21. The system as claimed in claim 18, further comprising a second alarm, wherein a second analog signal is generated at one of the first and second

connection terminals if the sensor is open circuited, and the second analog signal is converted into a second digital signal by the controller, and the second alarm is activated by the second digital signal.

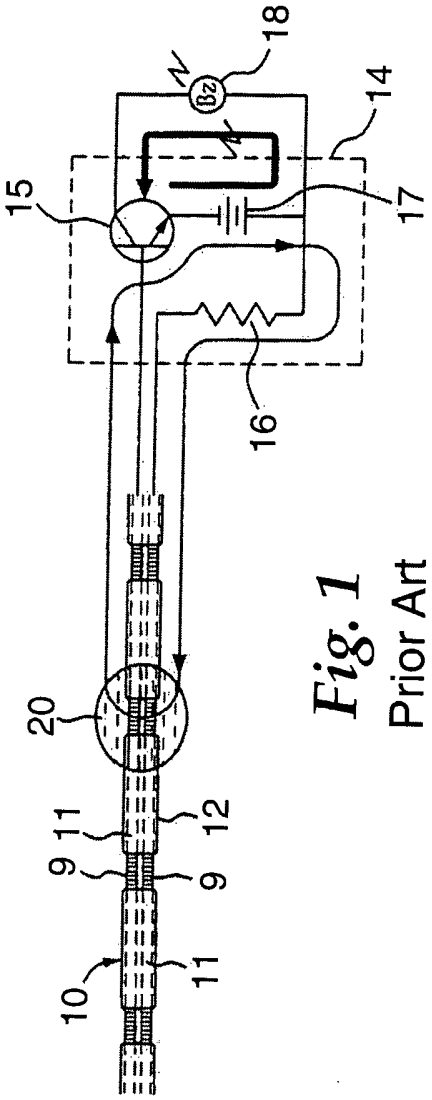


Fig. 1
Prior Art

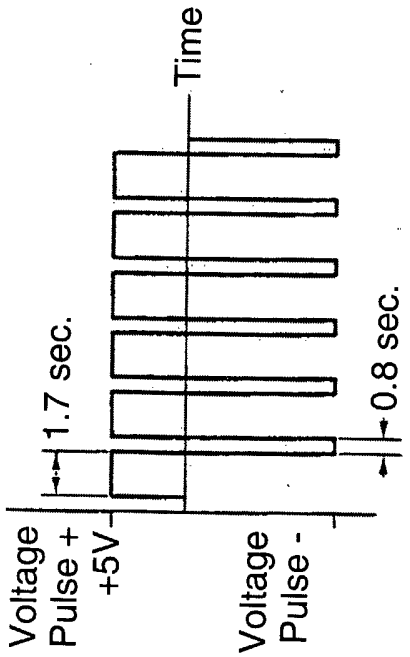


Fig. 2

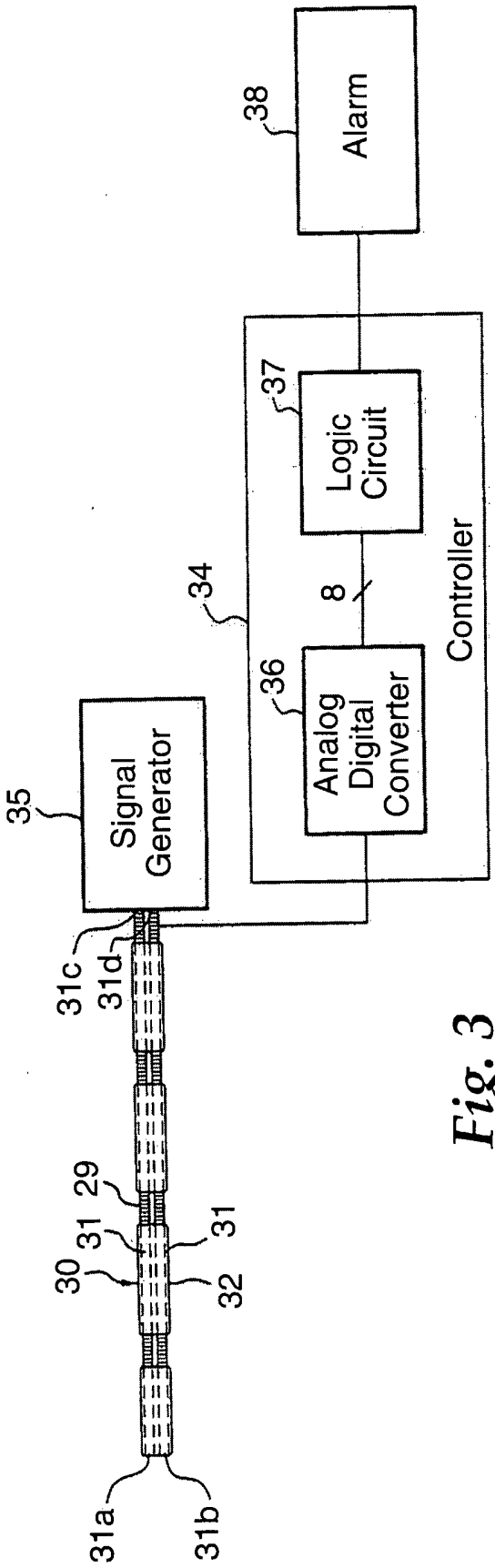
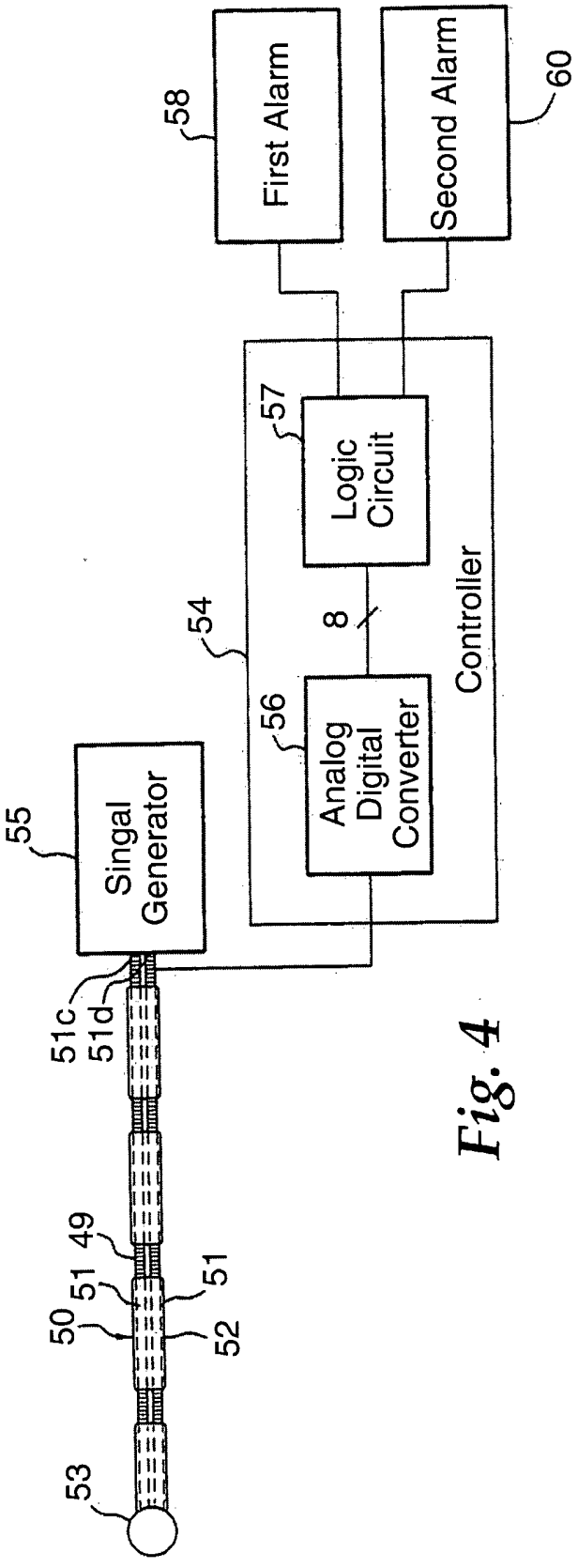

38
Alarm
37
Logic Circuit
34
8
Controller
36
Analog Digital Converter
35
Signal Generator
31c
31d
29
31
30
31
32
31a
31b

Fig. 3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Second Alarm
60
57
Logic Circuit
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54
Controller
56
Analog Digital Converter
55
Singal Generator
51c
51d
49
51
50
51
52
53

Fig. 4

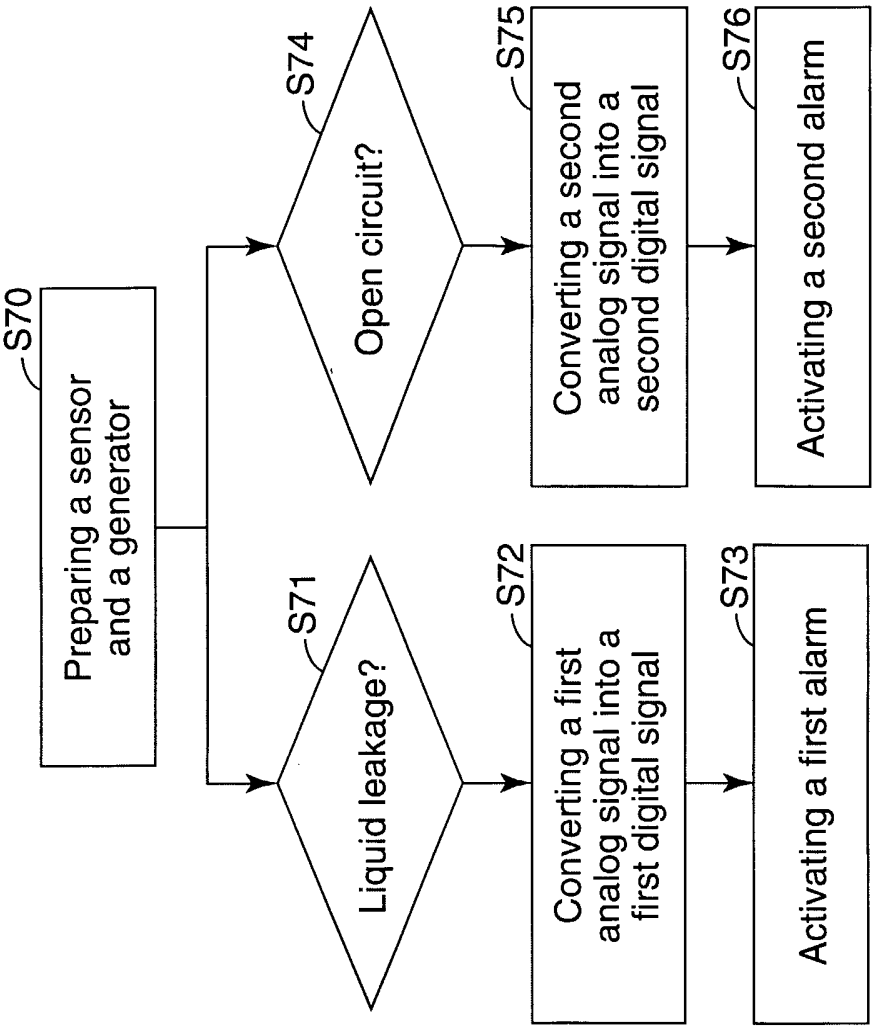
S70
Preparing a sensor and a generator
S71
Liquid leakage?
S72
Converting a first analog signal into a first digital signal
S73
Activating a first alarm
S74
Open circuit?
S75
Converting a second analog signal into a second digital signal
S76
Activating a second alarm

Fig. 6

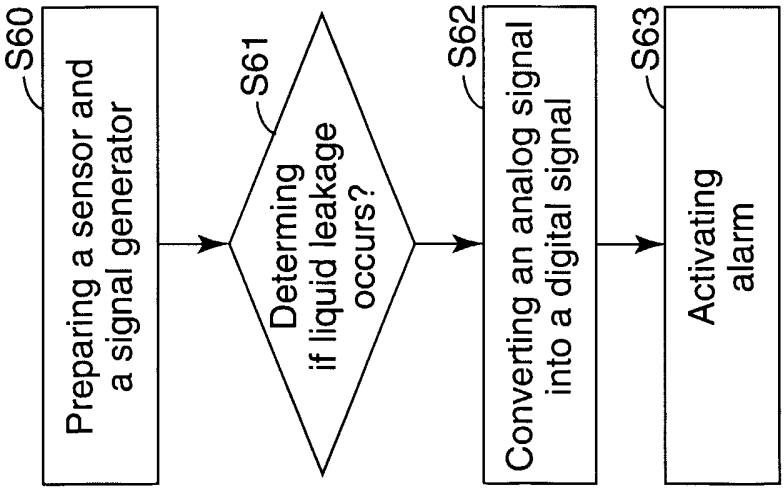
S60
Preparing a sensor and a signal generator
S61
Determing if liquid leakage occurs?
S62
Converting an analog signal into a digital signal
S63
Activating alarm

Fig. 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/024709

A. CLASSIFICATION OF SUBJECT MATTER
G01M3/16

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)
G01M

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 practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 298 479 B (MIDWESCO, INC; PERMA-PIPE, INC) 20 May 1992 (1992-05-20)	1-9
Y	column 4, line 28 - column 5, line 10; figure 3 column 14, line 31 - line 47; figure 7	10-12, 14-16, 18-20
X	FR 2 709 347 A (TTK) 3 March 1995 (1995-03-03)	1,2,4,5, 7,8
Y	page 2, line 16 - line 34 page 4, line 14 - line 20 page 3, line 35 - page 5, line 14; figures 1,2	13,17,21

-/--

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

[X] Patent family members are listed in annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
9 November 2005	24/11/2005

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/024709

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