(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 624 427 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
08.02.2006 Bulletin 2006/06

(51) Int Cl.:
G08B 21/08 *(2006.01)*

(21) Application number: **05254910.2**

(22) Date of filing: **05.08.2005**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **05.08.2004 GB 0417511**

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(54) Pool alarm

(57) A pool alarm responsive to the accidental immersion of a body in a pool. The alarm comprises an arrangement of at least two sensors, each sensor providing a sub-surface wave signal, a processor for processing the wave signals to provide sub-surface wave parameters, a detector for detecting wave parameters corresponding to the accidental immersion of a body, and an alarm signalling device. The alarm further comprises an activator for activating the alarm in response to the detected immersion wave parameters.

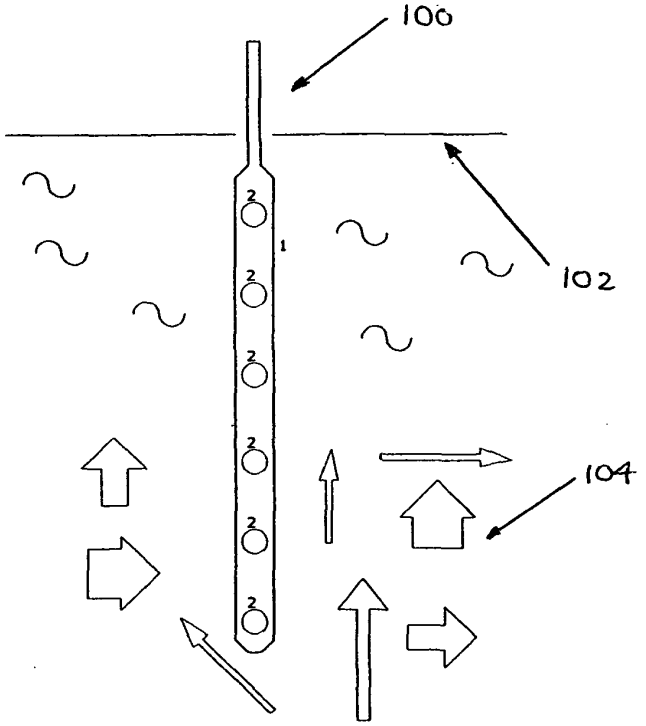

Fig 5

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Description

[0001] The present invention relates to a pool alarm.

[0002] Pool alarms, also known as "fall alarms" or "immersion alarms" are well known. Many of these alarms sense sub-surface waves to detect a person or animal accidentally falling into a pool. As these alarms detect waves below the surface of the water, they are less sensitive to disturbances caused by wind and rain on the pool surface than alarms which detect surface waves. However, sub-surface waves caused by sanitizing and cleaning equipment, reflections of surface waves on the pool walls, the effects of wind and rain, and the settling down of water after the intended use of the pool, all create sub-surface waves which can result in nuisance "false alarms" due to the erroneous detection of sub-surface waves not caused by an immersion.

[0003] To prevent this, the sensitivity of the alarm is reduced which renders these alarms less prone to false alarms due to disturbances on the water surface. Consequently, these alarms are less responsive to accidental immersions in the pool. This inevitably reduces the efficacy of the alarm and reduces its reliability. If the sensitivity is increased, the unit is more prone to false alarms, the user has therefore a reduced confidence in the alarm. This results in the alarm being ignored or deactivated so that the pool poses a danger to both humans and animals in the vicinity of the pool.

[0004] It is an object of the present invention to obviate or at least mitigate the above described problems and/or to provide improvements generally.

[0005] According to the invention there is provided a method and an apparatus of detecting an accidental immersion of a body as defined in any of the accompanying claims.

[0006] According to an aspect of the invention, there is provided a pool alarm for sensing sub-surface waves, comprising an arrangement of at least two sensors for providing sub-surface wave signals, a processor for processing the wave signals to calculate sub-surface wave parameters, a detector for detecting wave parameters corresponding to the accidental immersion of a body, and an alarm signalling device. The detector activates the alarm in response to the detected immersion wave parameters.

[0007] According to another aspect of the invention, there is provided a method of detecting an accidental immersion of a body comprising providing:

a) an arrangement of at least two sensors, the sensor arrangement sensing sub-surface waves, each sensor providing a sub-surface wave signal;
b) a processor for processing the signals to calculate sub-surface wave parameters;
c) a detector for detecting sub-surface wave parameters which correspond to immersion wave parameters of an accidental immersion of a body;
d) an alarm signalling device, and
e) an activator for activating the alarm signalling device in response to the detector. The method further comprises sensing sub-surface waves, the detector activating the alarm signalling device in response to the detected immersion wave parameters.

[0008] The alarm of the present invention differs from conventional alarms in that multiple wave sensors are used in an arrangement to enable sensing of the physical parameters of the waves. This greatly improves the reliability of the alarm over conventional sub-surface alarms as the alarm is less susceptible to sub-surface waves caused by non-immersion disturbances.

[0009] The wave characteristics of sub-surface waves in a pool following normal usage, or due to the effects of wind on the surface of the water, are distinguishable from the sub-surface wave characteristics due to a body immersing, or "falling" into the body of water. We have discovered that the wave characteristics for a body that passes gently into the body of water during normal use of a pool, or even the waves that occur as a result of normal use entry into the pool, differ from the wave characteristics due to the accidental immersion of a body such as a person or pet into the pool. The pool alarm of the invention can therefore remain activated even during normal use of the pool.

[0010] The sensors of the sensor arrangement detect sub surface wave characteristics, such as pressure or wave motion, and produce sub-surface wave signals. Preferably, each sensor in the sensor arrangement is the same type of sensor, and detects the same sub surface wave characteristic. Each sensor produces a sub-surface wave signal corresponding to the same sub-surface wave characteristic.

[0011] In a preferred embodiment, each sensor in the sensor arrangement is a pressure sensor for sensing the pressure of sub surface waves, and generating a sub-surface wave signal corresponding to the sub-surface wave pressure.

[0012] The sensor arrangement comprises sensors arranged in a specific fixed relationship relative to one another such as in an array. The sensors may be equidistant from each other, or arranged at varying distances relative to one another. This arrangement enables wave parameters, such as wave velocity, to be calculated by combining the wave signals from each sensor and/or from the individual wave signals. The wave parameters may comprise the wave velocity, frequency, wave length, direction relative to the sensors, depth or height relative to the water surface, amplitude and/or a combination of the aforesaid parameters. The processor preferably comprises one or more filters to filter the wave signals to facilitate processing of the wave signals and to provide the aforesaid wave parameters.

[0013] In a preferred embodiment, the sensor arrangement comprises six sensors arranged in a substantially vertical array, in which the sensors are spaced vertically apart relative to each other. The sensor arrangement

may also comprise multiple vertical arrays, wherein the sensors within each array are spaced vertically from each other, and each array is spaced relative to one another.

[0014] The processor provides wave parameters which correspond to the physical parameters of the sub-surface waves. Preferably, the processor comprises a model for extracting wave the characteristics, or wave parameter, from the sensed wave signals. The model may define algorithms for extracting the wave characteristics from the sensed wave signals. The parameters provided by the processor may be cross referenced with data relating to physical parameters generated by accidental immersion of a body in water. Consequently, the alarm is only triggered in response to the physical pool conditions which correspond to accidental immersion. This greatly improves the accuracy and reliability of the alarm and significantly reduces the occurrence of false alarms, without compromising the sensitivity of the alarm. Within the context of this application, the sensed wave parameters correspond to immersion wave parameters if the parameters or derivatives of the parameters are of the same order of magnitude to the immersion wave parameters. The sensed wave parameters and immersion wave parameters are thus substantially similar but not necessarily substantially identical.

[0015] The wave parameters are then fed from the processor to a detector, which is adapted to detect the particular wave parameters corresponding to an accidental immersion of a body into the water. Upon detection of immersion wave parameters corresponding to an accidental immersion, the activator activates the alarm to notify the user.

[0016] The wave parameters corresponding to an immersion wave may be stored in the detector. The immersion wave parameters may be pre-defined. Alternatively, the immersion wave parameters may be recorded when a body is immersed in the pool by the detector when the alarm is initially set up or activated. In the latter case, the alarm set-up is adaptive to the conditions in which the alarm is used. The detector may also be adapted to record wave parameters during conditions corresponding to non-use of the pool, and use of the pool. In this way, the detector can detect use and non-use conditions of the pool, which allows the alarm to be de-activated and activated accordingly. When the alarm is de-activated it operates in a "sleep" mode. When the alarm is in sleep mode, sensing of waves, processing and detection still continues, but the alarm signalling device is not activated in response to a detected immersion wave.

[0017] In another embodiment, the processor comprises a suitable electronic circuit that filters out the signals of interest from the wave signals provided by the sensor arrangement, and feeds the signals to the detector. The detector may comprise a microprocessor which has been programmed with codes specifically written to contain algorithms capable of extracting information from the sensed wave signals in order to detect the immersion wave parameters or wave characteristics.

[0018] As the alarm detects physical wave characteristics which are specific to an immersion wave, or a wave caused by a body falling into water, the pool alarm and method are thus capable of detecting the immersion of a body falling into a body of water, and distinguishing this from the effects of the pool settling after use and/or wind or rain interfering with the surface of the water in the pool. Also, the pool alarm and method may be capable of detecting the immersion of a body falling into the water during normal usage of the pool.

[0019] In another embodiment, the detector automatically activates the activator upon the sensed wave parameters being substantially similar to stored wave parameters corresponding to non-use of the pool. The detector automatically de-activates the activator upon the sensed wave parameters being substantially similar to stored wave parameters corresponding to normal use of the pool. Preferably, the detector comprises a comparator for comparing the wave parameters with stored immersion wave parameters, the comparator activating the activator upon the wave parameters corresponding to the stored immersion wave parameters, and de-activating the activator upon the sensed wave parameters being substantially similar to stored wave parameters corresponding to normal use of the pool. The detector may be programmable such that the user indicates normal use of the pool and non-use of the pool.

[0020] The processor may be adapted to cross-correlate the wave signals of the sensors. In this way, it is possible to calculate the wave velocity from the cross-correlation of the sensor signals.

[0021] In an advantageous embodiment of the invention, the pool alarm comprises a processor which is adaptive to the specific pool characteristics to thereby distinguish sub-surface waves due to accidental immersion of a body in water from conventional, non-accidental wave characteristics such as those caused by wind interaction on the surface of the pool.

[0022] In another embodiment of the invention, the sensor arrangement comprises an optical sensor, an acoustic sensor, a pressure sensor or another suitable sensor and/or a combination of the aforesaid sensors. The sensors may be active such as a Doppler sensor or passive such as a pressure sensor.

[0023] In a preferred embodiment, the sensor arrangement comprises at least three sensors. The sensors are preferably arranged in an array. The sensors may all be arranged in one plane. In use, the plane may be located approximately horizontally or vertically, i.e. parallel or perpendicular respectively relative to the water surface.

[0024] The sensors may be arranged in multiple planes which are each spaced relative to one another. Each plane may comprise the same number of sensors, or different numbers of sensors.

[0025] In another embodiment, the sensor arrangement comprises a pair of sensor arrays, each array comprising three or four sensors, with the pair of arrays being arranged in two spaced planes such that each plane com-

prises three or four sensors.

[0026] In another embodiment of the invention, the processor comprises a model for extracting wave characteristics or wave parameters from the sensed wave signals. The model may define algorithms for extracting or otherwise calculating the wave parameters from the sensed signals. The processor may further comprise suitable filters for filtering non-relevant wave parameters from the wave signal. The filters may be adjustable to control the sensitivity of the alarm. The detector and the processor may be integrated into a single unit.

[0027] The pool alarm may comprise means for controlling the detector to control the sensitivity of the alarm. We have discovered that the waves corresponding to the accidental immersion of a body in water are of a relatively low frequency of typically less than 20 Hz and particularly less than 10 Hz. Therefore, the filters are adapted to remove signals of frequencies higher than this frequency from the sensed signal.

[0028] In another advantageous embodiment of the invention, the pool alarm comprises a pool condition monitor for monitoring the condition of the pool, the condition monitor automatically activating the detector following non-use of the pool for a pre-determined time. The processor may comprise the condition monitor.

[0029] The condition monitor is adapted to detect whether the pool is being used or whether the pool is unused on the basis of the wave parameters or sensed wave signals. If the pool is unused for a period of time, the condition monitor activates the detector automatically to activate the pool alarm. This allows the pool alarm to operated continuously and automatically, whereby no user intervention is necessary.

[0030] In another embodiment of the invention, the detector is adapted to record the immersion wave parameters. Upon initial activation of the pool alarm, a body is immersed in water corresponding to an accidental immersion in water of a body. The wave signals corresponding to this immersion are processed and the corresponding immersion wave parameters are recorded by the detector. In subsequent use, if the sensed wave signals have wave parameters which are similar or correspond to the recorded immersion wave parameters, then the alarm is activated. This particular embodiment of the invention has the advantage that the pool alarm can be installed in any pool and can be operated effectively in any conditions.

[0031] The invention will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 presents a diagrammatic view of a pool alarm;

Figure 2 presents a diagrammatic view of another sensor arrangement;

Figure 3 presents a diagrammatic view of a further sensor arrangement;

Figure 4 presents a diagrammatic view of a pool alarm sensor; and

Figure 5 presents a diagrammatic view of a pool alarm senor according to the arrangement shown in Figure 3.

[0032] The pool alarm 10 of Figure 1 comprises a sensor arrangement A, comprising sensors 12. Each sensor 12 generates sub-surface wave signals in response to a physical wave characteristic, such as wave pressure. The sub-surface wave signals are fed to the processor 14. The processor 14 calculates sub-surface wave parameters, such as wave velocity, based on the sub-surface wave signals from the sensors.

[0033] The processor 14 comprises a comparator, which compares the sub-surface wave parameters calculated by the processor, with stored wave parameters corresponding to accidental immersion waves. If the detected wave parameters are within an order of magnitude of the stored accidental immersion wave parameters, an alarm is activated. The processor 14 is thereby adapted to detect an immersion wave from the sensed wave signals and to activate an alarm signalling device (not shown).

[0034] Two sensor arrangements A1 and A2 are shown in Figure 1. Sensor arrangement A1 comprises three sensors 12 arranged in a single plane. Sensor arrangement A2 comprises four sensors 12 arranged in a single plane.

[0035] The alternative arrangement B in Figure 2 comprises six sensors 12 arranged in two spaced planes (B1) or eight sensors 12 arranged in two spaced planes (B2).

[0036] The further alternative arrangement C in Figure 3 comprises six sensors 12 arranged in a vertical array. The sensors 12 are arranged in a single vertical plane, and are vertically spaced relative to each other at suitable distances. Whilst it is preferable that the vertical array comprises six sensors, it may comprise any number of sensors greater than or equal to two.

[0037] The processor 14 calculates the wave parameters of the sensed waves. The wave parameters comprise one of, or a combination of the wave frequency, amplitude, velocity and direction of the sub-surface waves in relation to the sensor arrangement A, B or C. The comparator compares the calculated wave parameters with the immersion wave parameters which correspond to the accidental immersion of a body in the pool.

[0038] In use, the sensor arrangement A, B or C is submerged in the pool, and activated to detect sub-surface waves corresponding to the accidental immersion of a body in the pool.

[0039] The signals from the sensor arrangement A, B or C are processed to calculate wave parameters. The calculated parameters are compared to the immersion wave parameters. If the calculated parameters correspond to or are similar to the immersion wave parameters, the processor 14 activates the alarm signalling device.

[0040] In an alternative embodiment, the alarm 10 is

self-activating if, for a predetermined period of time, wave parameters are detected which correspond to an unused state of the pool. This provides a fully automatic pool alarm which does not require user intervention to activate the alarm.

[0041] Figures 4 presents sensor arrangement 100, corresponding to sensor arrangement A or B, submerged in a pool below the surface 102 of the pool to detect sub-surface waves 104. The sensor arrangement is located at a suitable distance below the surface 102 of the water. Sensor arrangement C is shown submerged in figure 5, with the arrows 104 representing sub surface waves of varying velocities and amplitudes.

[0042] There is thus provided a pool alarm comprising a sensor arrangement which is adapted to sense wave characteristics relating to wave velocity, wave length, wave frequency, amplitude and/or other wave characteristics which correspond to the accidental immersion of a body in water. As the sensor arrangement measures the physical parameters of the sub-surface wave, it is possible to distinguish waves corresponding to the accidental immersion of a body in water from sub-surface waves due to normal disturbances of the pool caused by wind, rain or other interactions with the pool.

Claims

1. A pool alarm comprising :-

a) an arrangement of at least two sensors for providing a sub-surface wave signal,
b) a processor for processing the wave signals to provide sub-surface wave parameters,
c) a detector for detecting wave parameters corresponding to the accidental immersion of a body,
d) an alarm signalling device,
e) an activator for activating the alarm in response to the detected immersion wave parameters.

2. A pool alarm according to claim 1, **characterised in that** the sensor arrangement is an array.

3. A pool alarm according to claim 1 or 2, **characterised in that** the at least two sensors are sensors for sensing sub-surface wave characteristics.

4. A pool alarm according to any preceding claim, **characterised in that** the processor is adapted to cross-correlate the wave signals of the sensors.

5. A pool alarm according to any preceding claim, **characterised in that** the sensor arrangement comprises six sensors.

6. A pool alarm according to any preceding claim, **characterised in that** the sensors are arranged in a vertical array.

7. A pool alarm according to any preceding claim, **characterised in that** each sensor is adapted to provide a sub-surface wave signal corresponding to the same sub surface wave characteristic.

8. A pool alarm according to any preceding claim, wherein each sensor is a pressure sensor.

9. A pool alarm according to any of the preceding claims, further comprising means for storing wave parameters and a comparator for comparing the wave parameters with stored immersion wave parameters and activating the activator upon the wave parameters corresponding to the stored immersion wave parameters.

10. A pool alarm according to any of claims 1 to 4, and claims 6 to 9, **characterised in that** the sensor arrangement comprises at least two arrays of sensors, each array comprising at least two sensors, and each array being arranged in a single plane, the planes being spaced relative to one another.

11. A method of detecting an accidental immersion of a body in a pool comprising providing :-

a) an arrangement of at least two sensors, each sensor providing a sub-surface wave signal,
b) a processor for processing the wave signals to provide sub-surface wave parameters,
c) a detector for detecting sub-surface wave parameters corresponding to the accidental immersion of a body,
d) an alarm signalling device,
e) an activator for activating the alarm signalling device in response to the detector,

the method further comprising:

f) sensing sub-surface waves and activating the alarm signalling device in response to the detected accidental immersion.

12. A method according to claim 11, **characterised in that** the sensor arrangement is an array.

13. A method according to claim 11 or 12, **characterised in that** the sensor arrangement comprises six sensors.

14. A method according to any of claims 11 to 13, **characterised in that** the sensors are arranged in a vertical array.

15. A method according to any of claims 11 to 14, **char-**

acterised in that the processor is adapted to cross-correlate the wave signals of the sensors.

16. A method according to any of claims 11 to 15 **characterised in that** the processor comprises a model for extracting wave parameters from the sensed wave signals.

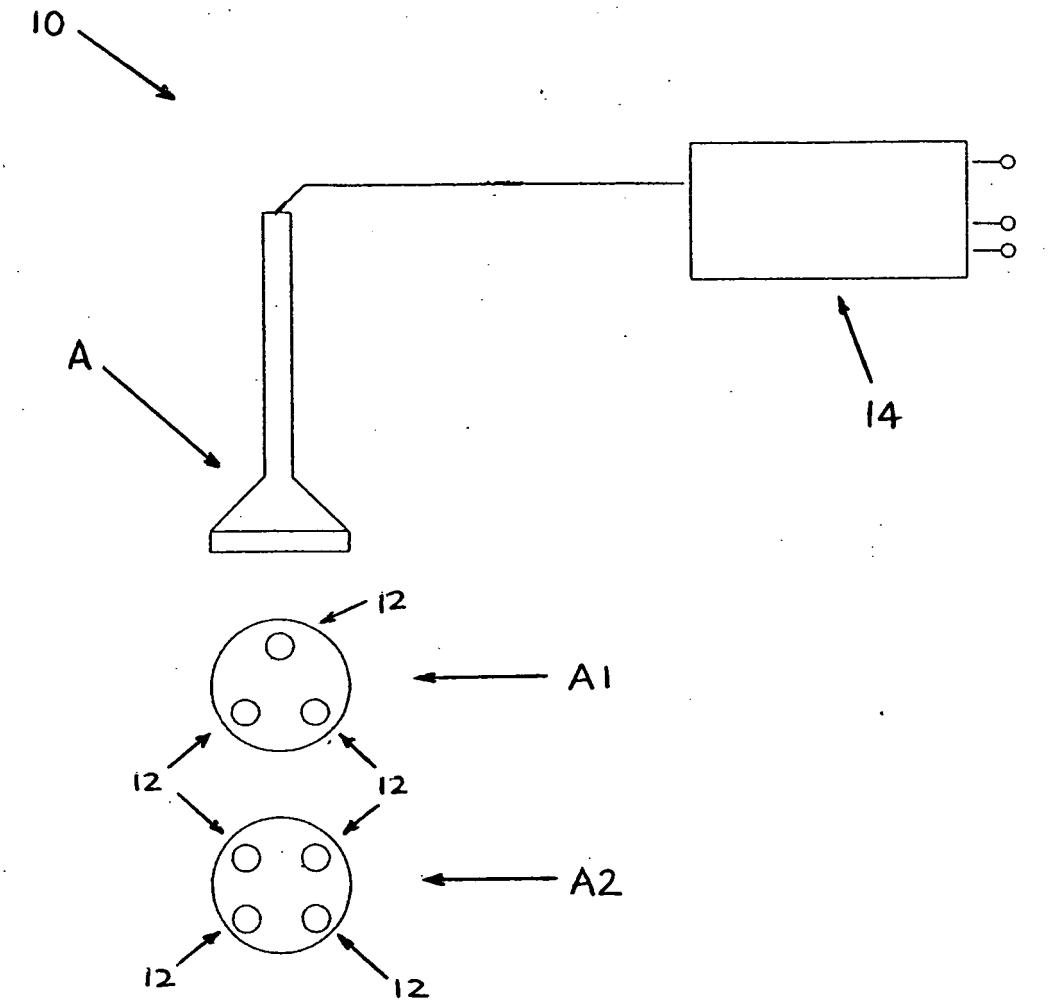

Fig 1

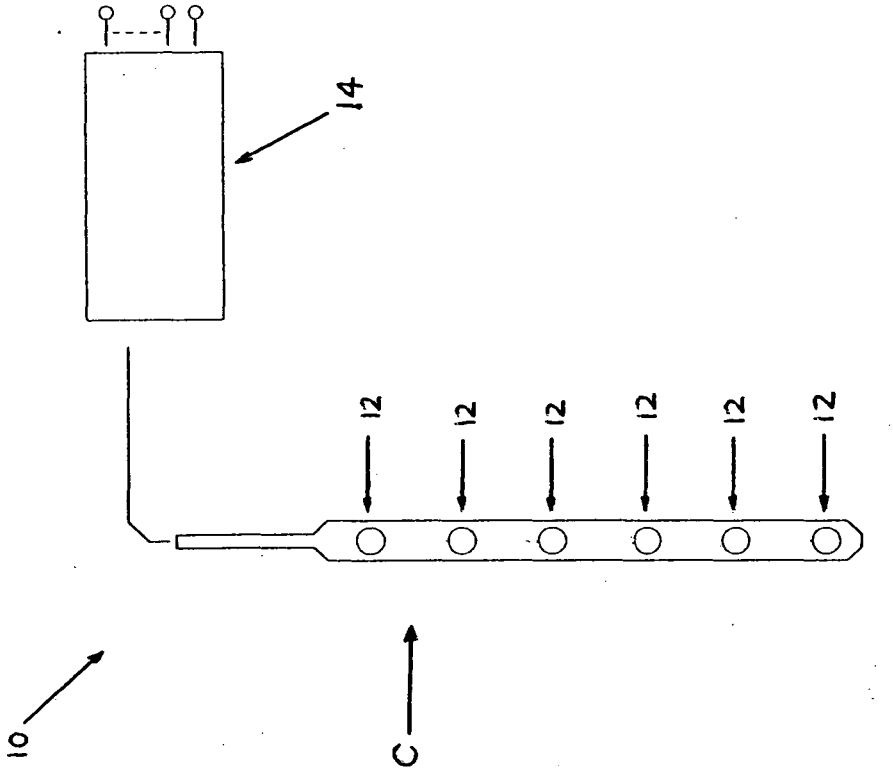

Fig 3

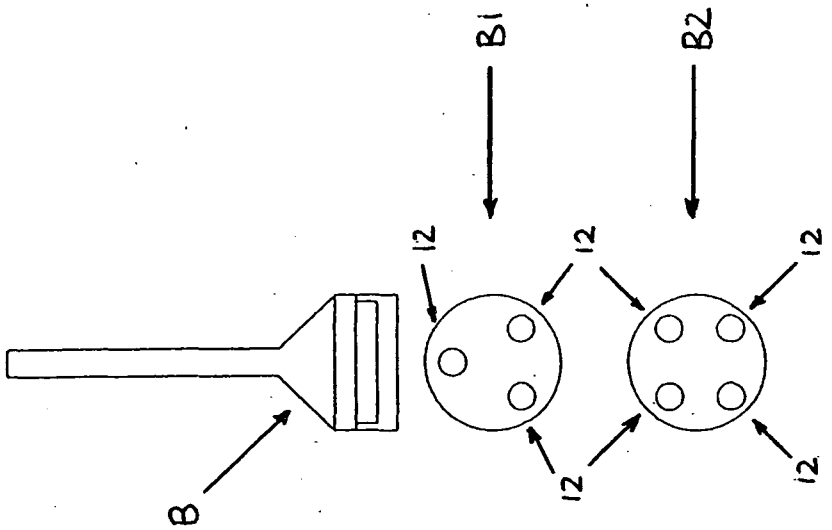

Fig 2

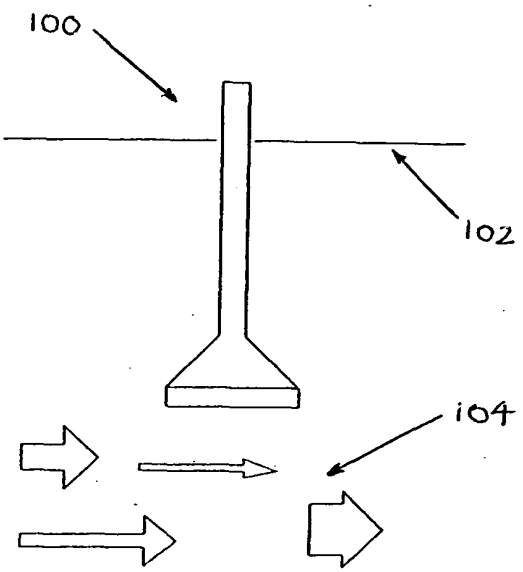

Fig 4

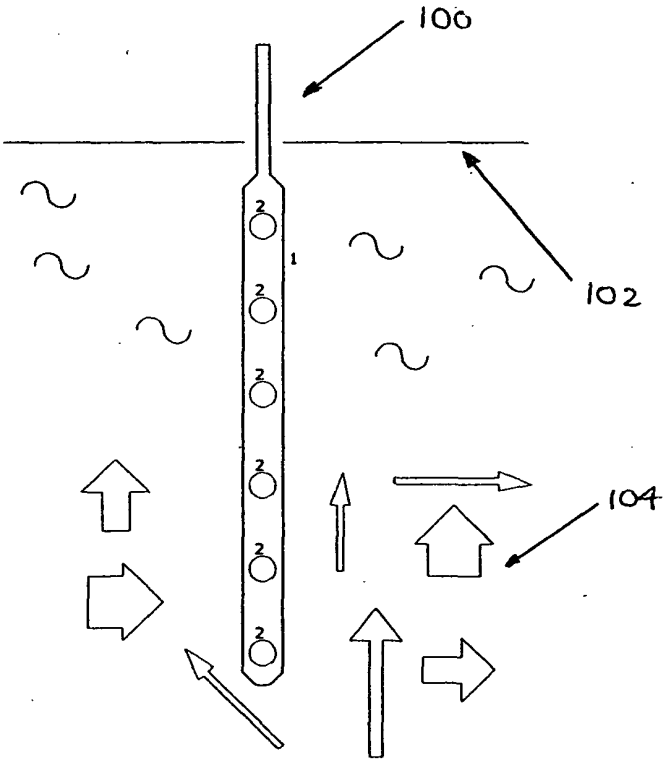

Fig 5

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EUROPEAN SEARCH REPORT

Application Number
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G08B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 November 2005	La Gioia, C

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number
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