(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 December 2009 (03.12.2009)

PCT

(10) International Publication Number
WO 2009/145643 A1

(51) International Patent Classification:
A01J 5/013 (2006.01) *G01N 15/00* (2006.01)
A01J 7/00 (2006.01) *G01N 21/00* (2006.01)

(21) International Application Number:
PCT/NZ2009/000086

(22) International Filing Date:
26 May 2009 (26.05.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
568744 29 May 2008 (29.05.2008) NZ

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (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, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

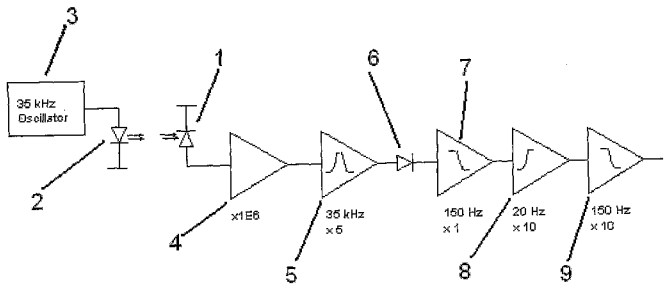
Published:

— *with international search report (Art. 21(3))*

WO 2009/145643 A1

(54) Title: FLUID SENSING APPARATUS

FIGURE 1



(57) Abstract: The present invention relates to a method of determining the presence of a discrete anomaly within the fluid, characterised by the steps of a) causing fluid to flow past a transducer, and b) receiving at least one transducer signal which varies with respect to a property of the fluid in the presence of the transducer, c) determining a quiescent state of the transducer signal, and d) indicating the presence of a particular discrete anomaly if the transducer signal varies significantly with respect to the quiescent state. This particular application to detecting the presence of mastitic milk but can be applied to detecting contaminants in other fluid systems as well.

FLUID SENSING APPARATUS

TECHNICAL FIELD

This invention relates to a method and apparatus for sensing fluids.

BACKGROUND ART

The present invention concerns the detection of particles within a fluid. While fluid flow in most embodiments of the present invention will be a liquid, it is possible that the present invention can also relate to particulate matter in which it is desirable to detect the presence of larger particles. It is envisaged that in most cases however, the present invention will relate to the detection of solids within a liquid.

Particular reference will now be made to the use of the present in the detection of mastitis of milk through determining the presence of clots within the milk. However, this should not be seen as limiting.

Mastitis is a significant problem to be managed by any dairy industry. The udder infections which cause mastitis result in significant loss of income to dairy farmers through the degradation of milk quality, in addition to adding costs for identifying, isolating and treating dairy animals with mastitis.

Clinical mastitis can be identified through the presence of solid clumps, clots or flocculant masses present in the milk produced by an animal. Such clots are readily apparent to the naked eye if mastitic milk is run over a dark smooth surface. However, it is not practical for dairy farmers to strip milk from every udder section of every dairy animal in their herd to detect mastitis problems.

Most milking equipment includes a filter element, generally known as "milk sock", mounted inside a common collection line prior to this line being connected to a milk collection vat or tank. The milk sock consists of a filter or straining element which

catches solid contaminants, such as grass, dirt or mastitic clots within milk delivered by all animals currently being milked.

The presence of mastitic milk clots within or on the milk sock will therefore indicate to a dairy farmer that at least one of their herd has a mastitis problem. However, the dairy farmer will need to in turn inspect each and every animal in their herd to identify which animal has mastitis.

Normal particle counting systems do not work in this situation. This is for at least the following reasons

- The first and most important is that milk is such a highly turbid medium. That is it is full of protein micelles and fat globules. These interfere with normal particle counting systems. That is the signal that would detect the clots is swamped due to the presence of the fat and protein
- Cost. The dairy shed is a low cost environment. Systems that may be able to detect clots would be far too expensive for dairy farming
- Reliability. The dairy shed has vibration, dust, dirt, high pressure water, cows kicking etc. Delicate systems that may be able to detect clots cannot work reliable in this environment.
- A two phase environment. This makes detection between air bubbles and clots difficult.

One attempt to address this issue is disclosed in US Patent No. 4376053. This patent describes the provision of a filter in the common milk line provided for a single milking station or cup cluster. Such physical filters can be used to detect the

presence of mastitis in a single identified animal as opposed to over the entire herd, as would be the case with inspection of the milk sock as described above.

However, such physical filters need to be manually inspected either during or immediately after the milking of a single animal. This again results in additional time consuming tasks which have to be performed for each animal by a dairy farmer during a milking session. Furthermore, such physical filters can impede milk flows through the long milk line of a single milking station, and can be installed at positions which are difficult for a dairy farmer to access easily and quickly.

It would therefore be of advantage to have a mastitis determination method and apparatus which addressed any or all of the above problems. In particular, a mastitis detection method and apparatus which could automatically indicate the presence of a mastitis problem in a single animal

It would also be an advantage if they provided a method by which contaminants could be detected in other fluids. This could include for example, particles within a crude oil flow such as sand, undissolved components within dyeing agents, particulate matter (grapes, seeds, skin and wines) in wine and dissolved additives within reconstituted drinks.

It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not

constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

It is acknowledged that the term 'comprise' may, under varying jurisdictions, be attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, the term 'comprise' shall have an inclusive meaning - i.e. that it will be taken to mean an inclusion of not only the listed components it directly references, but also other non-specified components or elements. This rationale will also be used when the term 'comprised' or 'comprising' is used in relation to one or more steps in a method or process.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

DISCLOSURE OF INVENTION

Accordingly to an aspect of the present invention there is provided a method of determining the presence of a discrete anomaly within a fluid,

characterised by the steps of

a) causing fluid to flow past a transducer, and

b) receiving at least one transducer signal which varies with respect to a property of the fluid in the presence of the transducer,

c) determining a quiescent state of the transducer signal, and

d) indicating the presence of a particular discrete anomaly if the transducer signal varies significantly with respect to the quiescent state.

According to yet another aspect of the present invention there is provided a fluid sensing apparatus configured to indicate the presence of a discrete anomaly in a

fluid flow, said apparatus including:

at least one transducer positioned relative to a fluid flow,

the transducer configured to receive a signal which varies with respect to a property of the fluid flowing in the presence of the transducer, and

a property detection element configured to receive at least one transducer signal, and

an indicator element configured to indicate the presence of a discrete anomaly if a change is detected in fluid flow property varies significantly with respect to the quiescent state of the transducer signal.

According to another aspect of the present invention there is provided a set of computer executable instructions which operates the steps of

a) receiving a transducer signal which varies with respect to a property of the fluid flowing in the presence of the transducer, and

b) determining a quiescent state of the transducer signal, and

c) indicating the presence of a particular discrete anomaly if the transducer signal varies significantly with respect to the quiescent state.

The discrete anomaly may be any body or contaminant which is desired to measure in the fluid flow. For example, the anomaly may be undissolved additives, grape seeds, grape skin, sand and so forth. The anomaly may alternatively be of lower density or colour than the fluid surrounding it, for example, entrained air bubbles. In a preferred embodiment of the present invention, the anomaly is a milk clot.

The fluid may be any flowing matter and could include gas, liquid, and particulate

masses such as sand or powder. In some embodiments, the fluid may be of the same general composition as the anomaly it is desired to detect. For example, in preferred embodiments the fluid is milk with the mass being milk clots. However, this should not be seen as limiting as the present invention could be used to determine unwanted contaminants within a fluid flow which have quite a different composition to that fluid.

Reference should now be made to the use of the present invention in relation to determining the presence in mastitic milk in a milk flow.

However it should be appreciated that the present invention does have broader implications as described above.

Further, when the present invention is applied to milk flow, it could be used to determine the presence of masses other than milk clots or indicator of mastitic milk.

Thus the transducer and/or property detection elements may vary according to the property being detected.

It should also be appreciated that in some embodiments the transducer and property detection element are the same component.

It is envisaged that in most embodiments of the present invention the property of the milk that is being measured is optical in nature.

For example, the property being measured may be the absorption or transmission of light in a particular frequency.

For example, a photo diode may be used as the transducer with the photo diode operating in the near infrared range (NIR).

In other embodiments, light at the other end of the spectrum (say blue visible light) may be used.

It should be appreciated that there is a significant advantage to using optical properties as this is a non-invasive way for determining fluid property in comparison to other methods.

However it should be appreciated that the transducer may be looking at another change of property or density, for example mass density or conductivity. With air bubbles, there will be a decrease in density.

The term quiescent state of the transducer signal refers to the normal background signal received by the transducer in the absence of any masses desired to be detected.

Using milk as an example, the milk composition varies considerably during the process of milking with different ratios of fat, water, and protein. However, these variations occur over a period of seconds (or even minutes) during the process of milking. These variations do not represent an event such as a mass (say a mastitic clot) passing a transducer. Such an event leads to a significant change in the signal received from the quiescent signal in terms of the frequency of the event detected and the size or amplitude of the signal.

Thus, it is an important aspect of the present invention to recognise that the signal must be differentiated to distinguish from normal variations in fluid composition passing the transducer (quiescent state) so as to recognise the presence of a mass flowing past the transducer.

Differentiation of the signal over the quiescent state is discussed in greater detail in this specification.

The present invention is adapted to provide a methodology and also preferably an apparatus used to determine the presence of mastitic milk in a milk flow. In particular the present invention may be adapted for installation or use within milking equipment to detect such mastitis problems in real time in relation to a single identified dairy animal.

Reference throughout this specification will be made to the present invention being used in conjunction with a milk flow travelling within the long milk line of a single milking station. The provision of the present invention in or association with such a location allows for a determination to be made as to the presence of mastitis in the single dairy animal currently being milked at the milking station. However, those skilled in the art should appreciate that the present invention may be used in conjunction with other locations associated with milking machinery or milk processing equipment in general, and reference to the present invention being used in conjunction with the long milk line of a single milking station should in no way be seen as limiting.

For example, one embodiment of the present invention may be used with respect to a holding tank which has been adapted to cause fluid flow past a transducer configured to operate in accordance with the present invention.

References to the determination of mastitis throughout this specification will also be made in relation to a determination as to the presence of clinical mastitis with respect to a particular dairy animal. Clinical mastitis results in symptoms which include clots or flakes of solid matter being expressed in the milk of an animal.

Reference throughout this specification will also be made to the present invention being used to detect the presence of mastitic milk clots in milk flows. However

those skilled in the art should appreciate that the present invention may also be used to detect the presence of other forms of solids or particulate materials within a milk flow or even entrained gas bubbles, any of which can immediately change the current density of the milk flow.

The present invention may be implemented through a mastitis determination apparatus which includes at least one transducer. Such a transducer or transducers may be located within or adjacent to a milk flow to allow the milk flow to influence the operation of the transducer's signal. Preferably the transducer selected may produce a signal which varies with respect to the optical properties of milk flowing past the transducer.

The present invention may be employed in conjunction with such flows to monitor the milk flow at the point at which a transducer or transducers are employed. The present invention is employed in conjunction with dynamic milk flows to ensure that the transducer signal will vary so that a rate of change can be determined or a high frequency transducer signal component may be isolated. In effect, the dynamic nature of the milk flow provides a characteristic required for the present invention to function effectively.

In a preferred embodiment a transducer as used in conjunction with the present invention may operate through receiving a reference signal transmitted through the milk flow which has been modified by the characteristics of the milk flow. In such embodiments the transducer or transducers provided need not necessarily extend out to any conduit which carries the milk flow, therefore preventing the present invention from impeding milk flows. The ability to measure non-invasively in food industry systems such as milking machines is of significant advantage – both in terms of efficiency and hygiene.

In a preferred embodiment the present invention may include at least one optical

transducer configured to receive a beam of light transmitted across a milk flow. Optical transducers can be used to measure the absorbance of light transmitted through a milk flow, where the absorbance measured is directly related to the composition of the milk flow. In such embodiments an optical transducer such as a photodiode can receive an incident light beam and subsequently provide an electrical signal which varies in relation to the composition of the milk flow.

In such embodiments the transducer or transducers employed may provide a signal which varies with respect to the composition of the milk currently in the presence of the transducer. Those skilled in the art should appreciate that the clots or masses to be detected in conjunction with the present invention are more optically dense than a normal flow of milk – leading to greater absorption of the signal.

Reference throughout this specification will also be made to a transducer used in conjunction with the present invention being provided by a photodiode or any other similar form of optical transducer. However, those skilled in the art should appreciate that other forms of transducer assemblies or systems may also be employed in conjunction with the present invention, and reference to the above only throughout this specification should in no way be seen as limiting.

For example, in one alternative embodiment a transducer may be provided through a voltage divider circuit with the centre tap between the divider resistances providing an output transducer signal voltage. The resistances of the divider can be located within a milk flow so that mastitic milk clots which collide with the upstream resistance modify the overall balance of resistances within the divider. Any incident milk clot will therefore cause a change in voltage at the centre tap of the divider, in turn giving a transducer signal which varies in accordance with the overall density of the milk flow.

Reference in general throughout this specification will also be made to the transducer or transducers used having signals which vary with respect to the composition of milk in the presence of the transducer.

In yet another alternative embodiment a transducer may be provided through a capacitive plate arrangement with the plates of the capacitor formed being located on either side of a conduit used to carry the milk flow. The capacitance of such an arrangement may be measured, with variations present in same being attributed to the varying density of the milk flow.

Reference throughout this specification will also be made to the present invention including a single transducer only which provides a single transducer signal. However, those skilled in the art should appreciate that multiple transducers may be provided and used in required and reference to the above only throughout this specification should in no way be seen as limiting.

Preferably the mastitis determination apparatus provided also includes an optical detection element which receives the transducer signal. Such a density detection element may be employed to detect changes in the optical characteristics of the milk flow.

In a further preferred embodiment an optical detection element may be configured to assess the rate of change of a transducer signal. As transducer signals are selected so as to vary with the optical characteristics of the milk flow, a sudden change in such signals can indicate that at least one or potentially more mastitic milk clots have flowed passed the transducer.

Reference throughout this specification will also be made to the optical detection element differentiating over the quiescent state of a transducer signal. However those skilled in the art should appreciate that instantaneous rates of change will be

affected by the speed at which transducer signals can be received and sampled or assessed. Such rate change values can be used to indicate the presence of a mastitic clot irrespective of any average or overall biasing characteristics associated with the milk flow. For example, the composition of a milk flow may vary over time with seasonal variations being present due to environmental factors.

Thus, a signal indicating the presence of a mass may be differentiated from the quiescent signal through the use of a high pass filter. Such a high pass filter can remove signals which vary over a long period of time (for example as a result of generic change in milk composition) while detecting signals that represent a significant change in composition over a short period of time (say a mass).

The frequency of the high pass filter will naturally vary according to the flow rate of fluid past the transducer, the nature of the quiescent signal and the composition of the mass (whether optical, size or shape) desired to be detected. However, in a typical milking system the flow rate of milk past the transducer is expected to be in the order of 1 to 1.5 meters per second. Given the nature of mastitic clot flows, a high pass filter frequency of 20 Hz is sufficient to allow for a signal corresponding to mastitic masses to pass as opposed to the background (quiescent) signal.

In a further preferred embodiment an optical detection element may use the transducer signals to provide an integer count of the number of mastitic masses which have flowed past the transducer over a measurement period.

In a preferred embodiment a density detection element may be implemented through a comparator circuit which drives or triggers a counter component. A comparator may be readily assembled using well known electrical components to compare received transducer signals with a quiescent signal in real time. An associated digital counter may be provided in a further preferred embodiment which is triggered by a comparator. Such a counter can maintain and increment a

count of mastitic masses detected over a fixed or known measurement period. The count provided can give an indication as to the severity of any mastitis problem through to determining the rate at which mastitic clots are detected.

In a preferred embodiment the density detection element may be configured to assess or isolate at least one high frequency signal component from a transducer signal. Such high frequency signal components are indicative of elevated rates of change in the transducer signal. By isolating such high frequency components the density detection element may readily determine whether the rate of change of a transducer signal exceeds the quiescent signal.

For example, in a further preferred embodiment where a photodiode transducer is employed the electrical transducer signal it supplies may be filtered to investigate the amplitude of any high frequency signal components. If such signal components exceeds a quiescent signal value (say amplitude), then a determination can be made that a mastitic clot is in the vicinity of the transducer.

Preferably the mastitis determination apparatus provided may also include an indicator element configured to indicate the presence of mastitic milk. Preferably such an indicator element may be activated once changes in the composition of the milk flow have been detected at a level high enough to assume that at least one mastitic milk clot has flowed passed the transducer.

In a further preferred embodiment an indicator element may be triggered when a set number of mastitic milk clots have been detected within a fixed period of time. Those skilled in the art should appreciate that this clot count rate may be varied depending on the applications in which the present invention is used to detect either severe or early stage clinical mastitis.

In a preferred embodiment the present invention may be associated with a

sampling chamber well located within the conduit in which the milk flow travels. Preferably such a well may be provided through the technology disclosed in New Zealand Patent No. 519133 which can allow for the settling or dispersal of entrained air from milk. Entrained air bubbles can cause false positive readings through periodically and rapidly changing the current density of a milk flow. By employing a well based sampling chamber in conjunction with the present invention the error producing effects of entrain air may be mitigated.

Further differentiation may be employed in the present invention to remove the effect of air bubbles. This may be in addition to or instead of using a sampling system as described above. For example, in a substantially streamed flow, the air bubbles tend to appear at a substantially constant rate according to a normalised curve. The inventor has found that the count rate of bubbles above a certain threshold is less per minute than that found for mastitic milk. Therefore, if a count is found in a certain range, then that can be attributed to air bubbles. Counts significantly above that range can therefore be attributed to mastitic milk instead.

Alternatively, as mentioned earlier the air bubbles may be specifically detected in some applications of the present invention.

The present invention may provide many potential advantages over the prior art clinical mastitis detection systems.

The present invention may be used to indicate that the presence of clinical mastitis has been determined in conjunction with a single dairy animal. Such an indication may be used in a range of applications ranging from diverting the milk produced by the animal away from a common collection vat, through to directing the animal involved to a holding area or pen for subsequent veterinarian treatment.

The invention may be used to activate an audible or visual alarm system which

alerts a dairy farmer to the detection of mastitis in relation to a particular animal. Those skilled in the art should appreciate that the indications of mastitis provided by the invention may be used in a range of applications.

The invention may readily detect the presence of mastitic milk clots through considering the current density of a milk flow. By detecting that the density of such flows has sharply increased at a point in time, this can indicate the presence of a clot. Furthermore, by tracking the rate or number of clots which are detected over a fixed measurement time, an assessment can be made as to the severity of the clinical mastitis problem of a single dairy animal.

It should be appreciated that the present invention also offers many advantages in relation to the generic sensing of anomalies within a fluid flow. In particular the present invention has advantages with regard to single and two phase fluid flow which often has air entrained in liquid. Contaminants can be readily sensed without interrupting the flow of fluid, not only that there is contamination but also the amount of contamination can be readily detected as well. Various control systems can be implemented as a consequence whether an alarm or diversion of the contaminated fluid.

BRIEF DESCRIPTION OF DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1 illustrates a schematic diagram of portions of an optically based mastitis determination apparatus provided in accordance with a preferred embodiment, and

Figures 2a, 2b illustrate an electrical transducer based mastitis

determination apparatus provided in accordance with an alternative embodiment.

Figure 3 illustrates graphical results for clots in water

Figure 4 illustrates graphical results for non clotty milk (Blue and green) and clotty milk (black) run through sensor.

BEST MODES FOR CARRYING OUT THE INVENTION

Figure 1 illustrates a schematic diagram of portions of an optically based mastitis determination apparatus provided in accordance with a preferred embodiment.

The apparatus shown includes a transducer, which is provided in this embodiment by a photodiode (1). The photodiode (1) is configured to receive a modulated light signal transmitted from LED (2). Light from the LED (2) is transmitted across a conduit carrying a milk flow to the photodiode (1). The LED (2) is driven or powered by a 35 kHz oscillator signal which applies a modulation to the light transmitted.

The output of the photodiode (1) is fed through to a current to voltage conversion amplifier (4) which converts the current pulses of the diode into a proportional voltage signal. This voltage signal is supplied to a 35 kHz band pass filter used to remove the effect of ambient light in the signal received by the photodiode (1).

A diode (6) and low pass filter (7) are then provided to demodulate the signal, providing a DC voltage proportional to the amount of light transmitted through the milk flow.

Finally, a high pass filter removes the DC offset component from the signal

resulting in a high frequency signal component only which is directly indicative of the detection of rapid changes in density of the milk flow. This high frequency signal component can in turn be further filtered by a low pass filter (5) to remove any additional noise components prior to supply to a further comparator and counter element (not shown).

As can be seen from figure 1 neither of the photodiode (1) or LED (2) need to be located within a milk flow. Furthermore, the arrangement of filters which receive the output of the photodiode (1) can remove ambient light noise effects and provide an output signal which clearly indicates when a rapid change in density has been detected.

Figures 2a, 2b illustrate an electrical transducer based mastitis determination apparatus provided in accordance with an alternative embodiment.

In particular figure 2a illustrates conditions where a voltage divider transducer does not have a clot present and when a clot is present. As can be seen from the left hand case the transducer output signal provided by the centre tap is expected to sit at half the input voltage as the two resistors are balanced.

Conversely, when a clot hits the upstream resistance, the resistances become unbalanced, resulting in a variation in the output voltage provided at the centre tap.

Figure 2b illustrates elements of a optical detection element provided when the electrical impedance transducer discussed with respect to figure 2a is used.

In this embodiment the voltage divider circuit is driven by a 30 kHz oscillator. The centre tap of the divider provides the output transducer signal which is in turn demodulated. Lastly a high pass filter is provided to amplify the changes made, and then a low pass filter is provided to smooth out any noise effects. The final output signal provided consists of an indication of the high frequency components

of the signal showing when rapid changes in density of the milk flow have been detected.

The results for above system are illustrated below in Figure 3 with the clot count being the y axis. When plastic in water is flushed through it clearly detects these, as the clot count rises from 0 to about 300.

When flushing real milk through the sensor the output is very low, and clotty milk the output is much higher. Figure 4 illustrates results from running real milk through the sensor in the laboratory. The x axis is again time, and the y axis clot count. The lines at the bottom of the graph are clean and clot free milk. The upper line is clotty milk run through the sensor. Clearly there is a significant difference between the two types of milk.

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof as defined in the appended claims.

WHAT WE CLAIM IS:

1. A method of determining the presence of a discrete anomaly within the fluid,

characterised by the steps of

a) causing fluid to flow past a transducer, and

b) receiving at least one transducer signal which varies with respect to a property of the fluid in the presence of the transducer,

c) determining a quiescent state of the transducer signal, and

d) indicating the presence of a particular discrete anomaly if the transducer signal varies significantly with respect to the quiescent state.

2. A method as claimed in claim 1 wherein the discrete anomaly is in the form of a milk clot.

3. A method as claimed in either claim 1 or claim 2 wherein the fluid is milk.

4. A method as claimed in any one of claims 1 to 3 wherein the property being detected is an optical characteristic.

5. A method of determining the presence of mastitic milk in the milk flow,

characterised by the step of

applying the method as claimed in any one of claims 2 and 4.

6. A fluid sensing apparatus configured to indicate the presence of a discrete anomaly in a fluid flow, said apparatus including:

at least one transducer positioned relative to a fluid flow,

the transducer configured to receive a signal which varies with respect to a property of the fluid flowing in the presence of the transducer, and

a property detection element configured to receive at least one transducer signal, and

an indicator element configured to indicate the presence of a discrete anomaly if a change is detected in fluid flow property varies significantly with respect to the quiescent state of the transducer signal.

7. Apparatus as claimed in claim 6 wherein the property detection element is a optical detection element.

8. Apparatus as claimed in claim 7 wherein the optical detection element is an optical transducer.

9. Apparatus as claimed in either claim 7 or claim 8 previously which is configured to provide an integer count of the number of anomalies which have flowed past the optical detection element over a measurement period.

10. A milking system wherein the apparatus as claimed in any one of claims 7 to 9 is positioned within the long milk line.

11. A set of computer executable instructions which operates the steps of

    a) receiving a transducer signal which varies with respect to a property of the fluid flowing in the presence of the transducer, and

    b) determining a quiescent state of the transducer signal, and

    c) indicating the presence of a discrete anomaly if the transducer signal varies significantly with respect to the quiescent state.

12. A method substantially as herein described with reference to and as illustrated by the accompanying examples and drawings in the Best Modes Section.

13. An apparatus substantially as herein described with reference to the accompanying examples and drawings in the Best Modes Section.

FIGURE 1

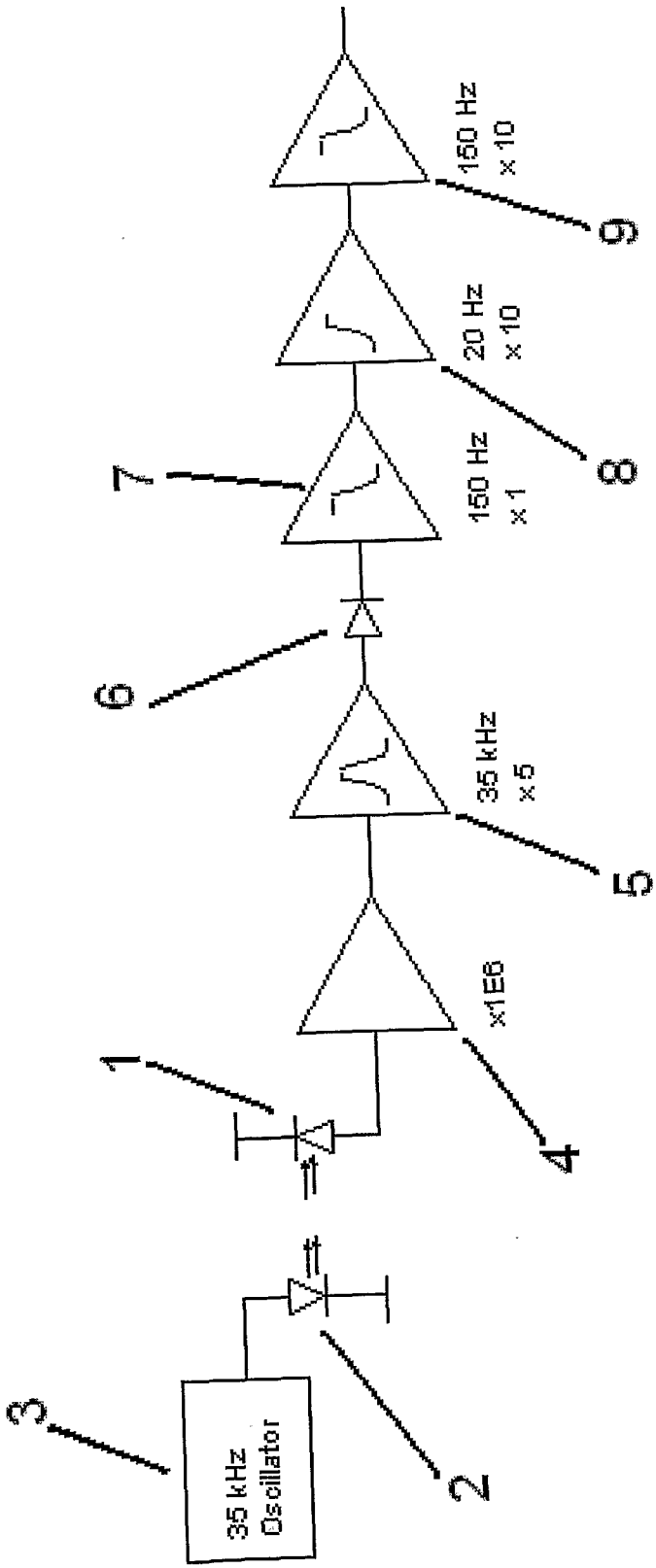

35 kHz
Oscillator
3
2
1
x1E6
4
35 kHz
x 5
5
6
150 Hz
x 1
7
20 Hz
x 10
8
150 Hz
x 10
9

FIGURE 2A

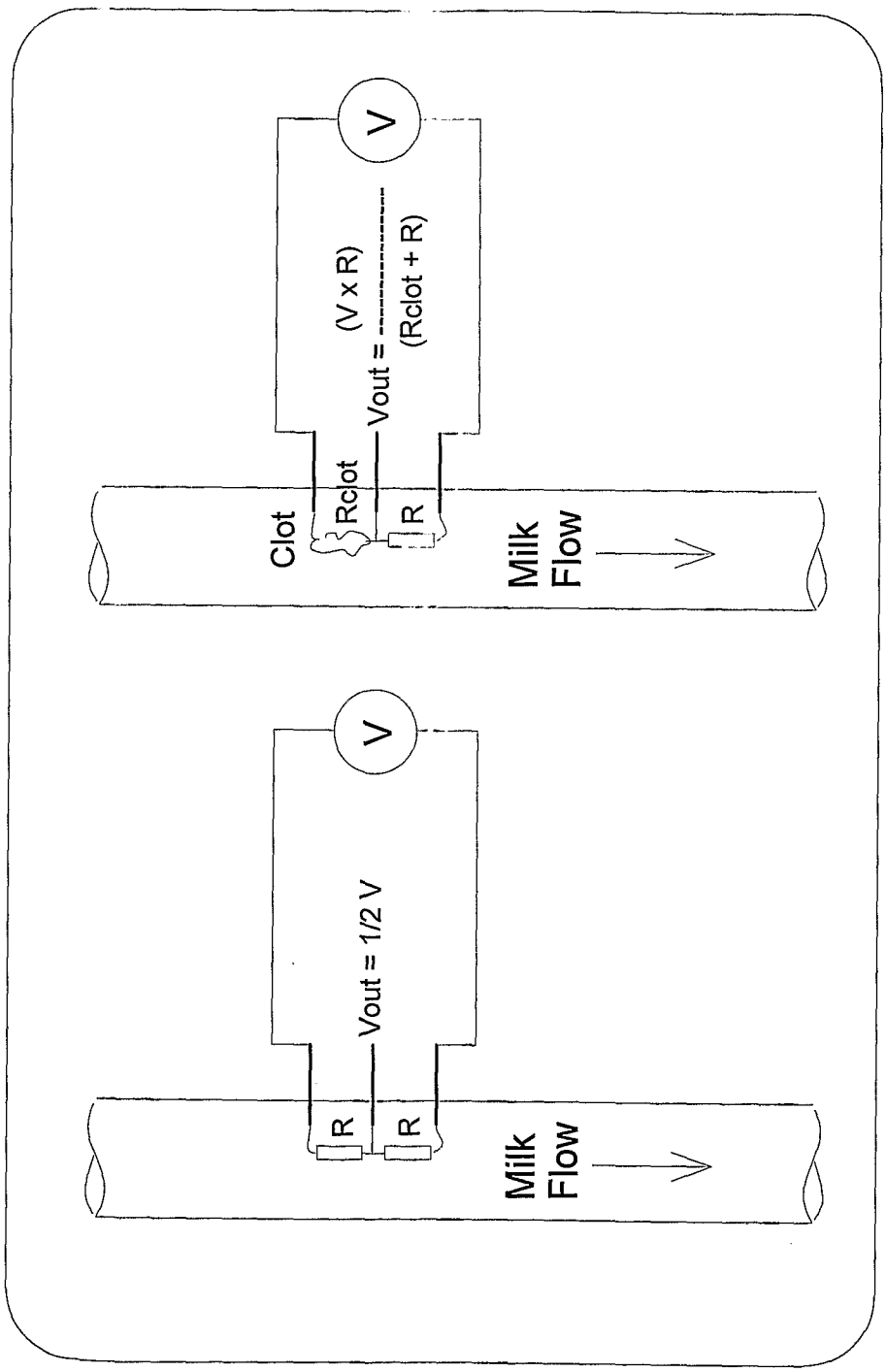

V
(V x R)
Vout = ----------
(Rclot + R)
Clot
Rclot
R
Milk
Flow
V
Vout = 1/2 V
R
R
Milk
Flow

FIGURE 2B

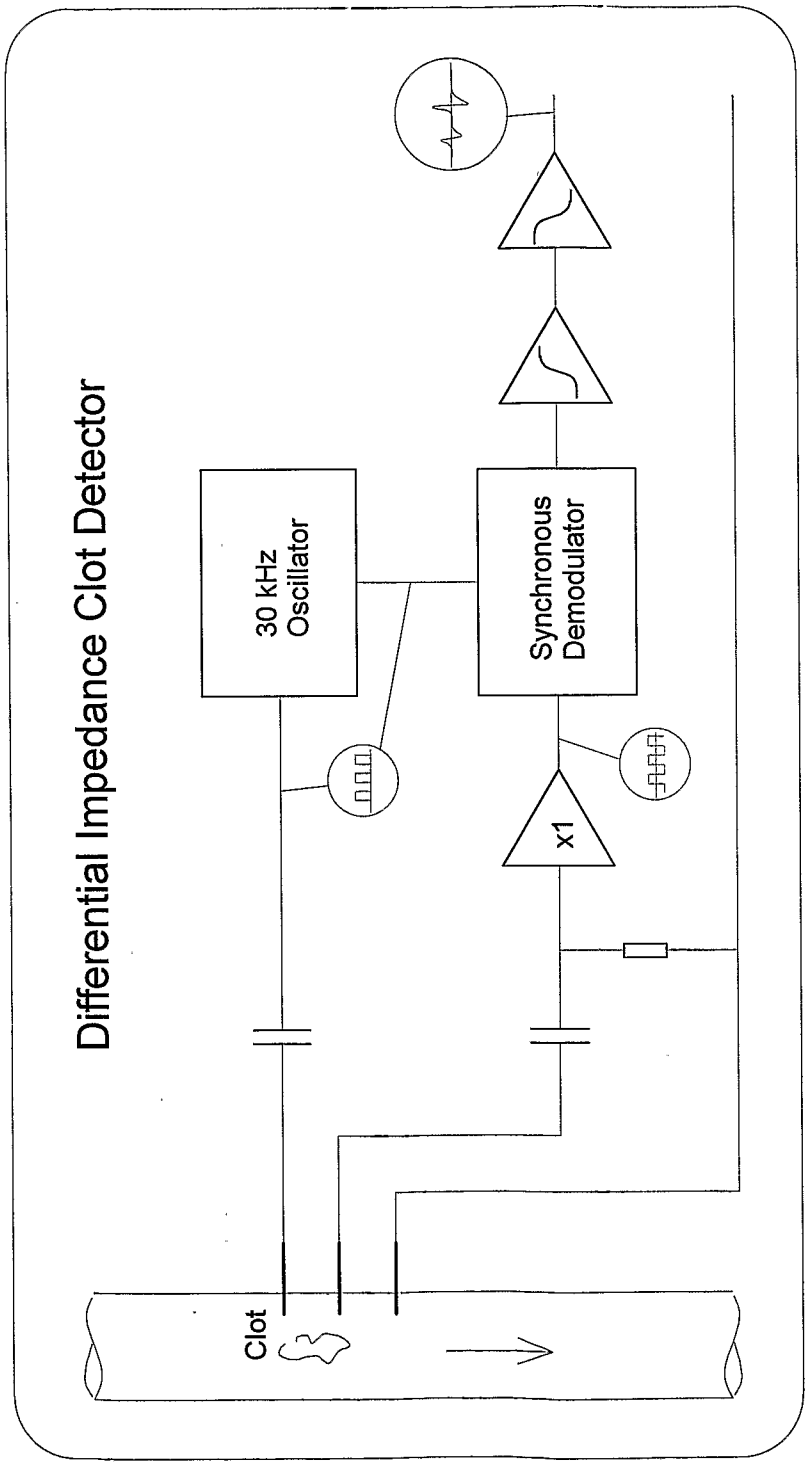

Differential Impedance Clot Detector
30 kHz Oscillator
Synchronous Demodulator
x1
Clot

FIGURE 3

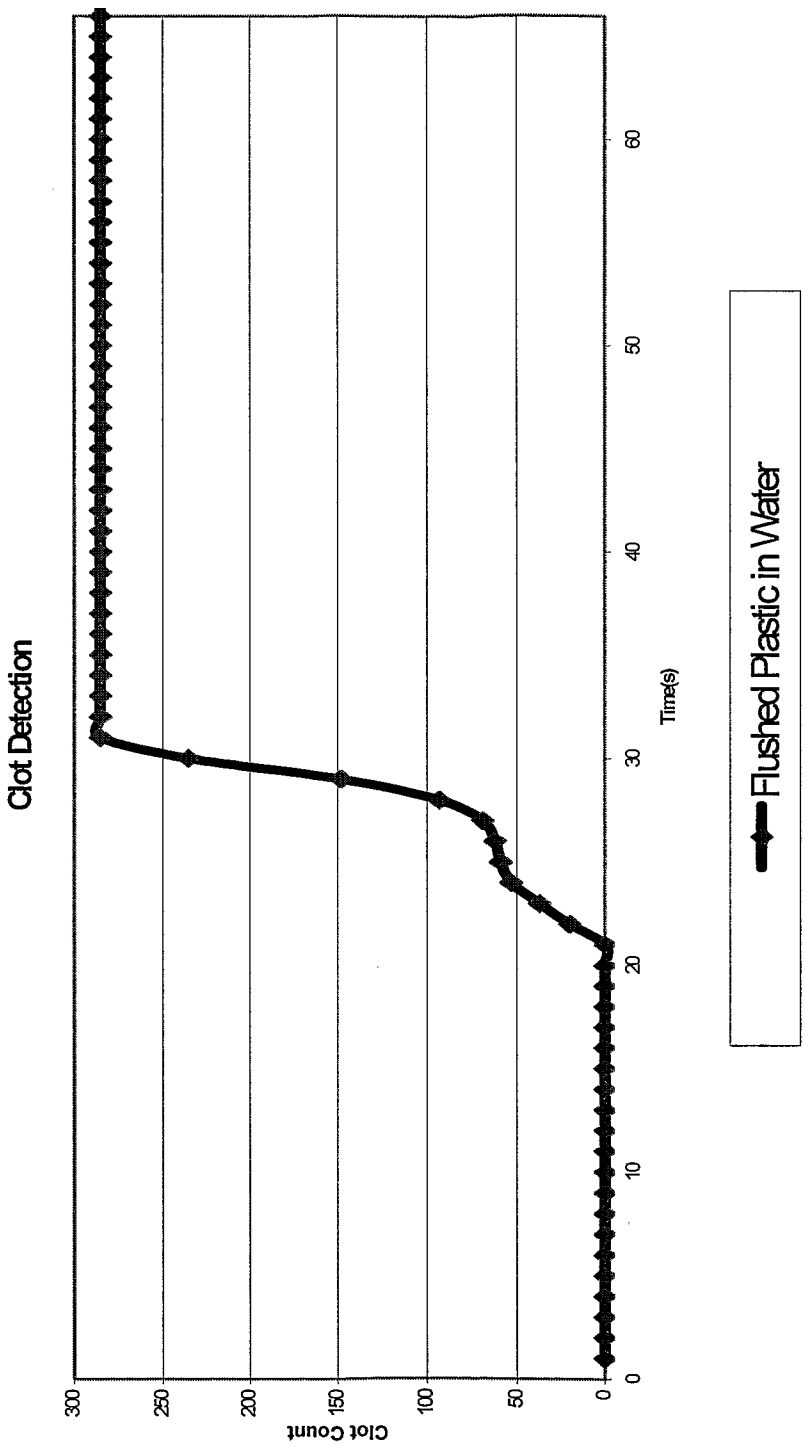
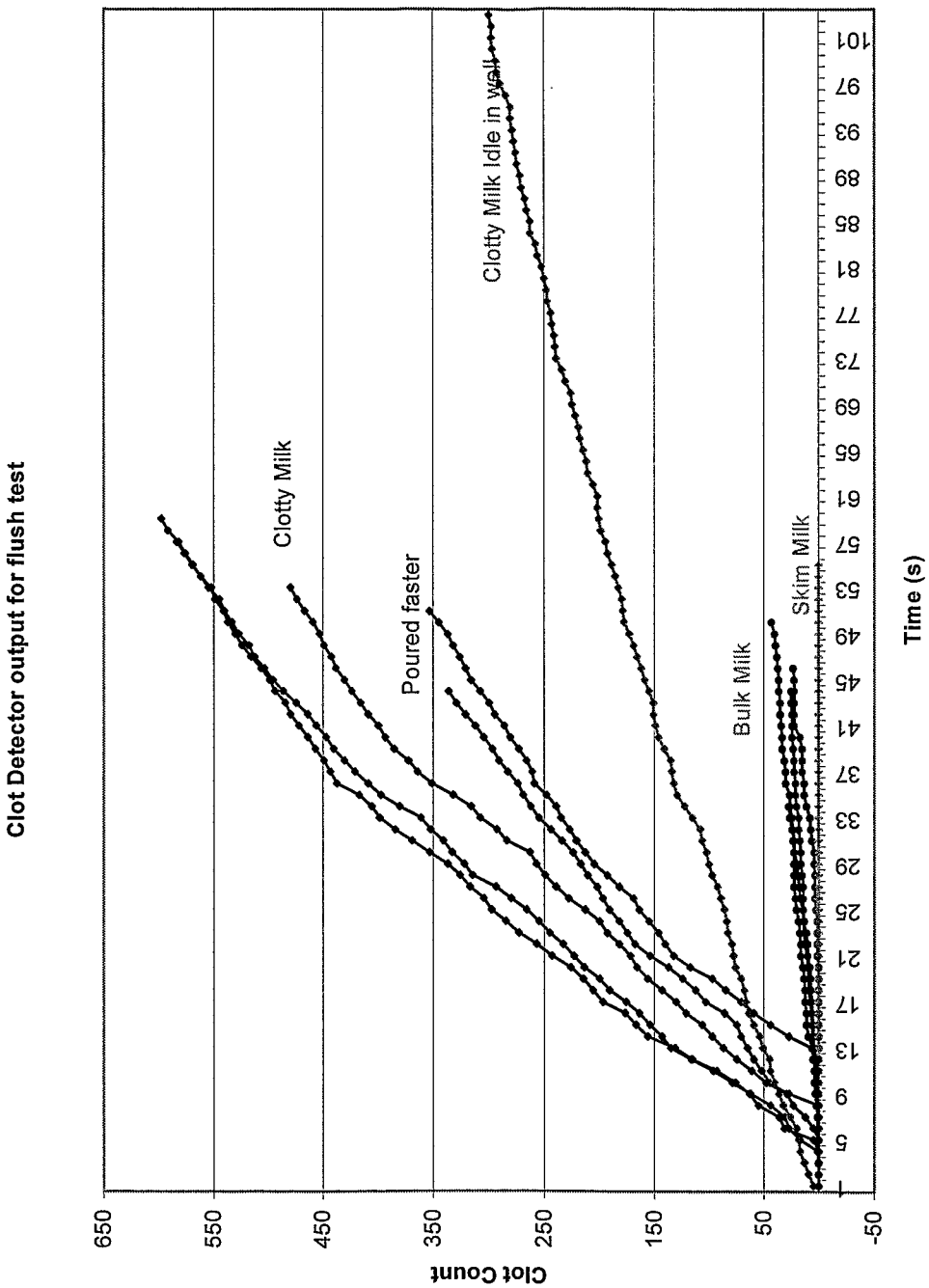

Clot Detection
Clot Count
300
250
200
150
100
50
0
0
10
20
30
40
50
60
Time(s)
Flushed Plastic in Water

FIGURE 4


Clot Detector output for flush test
Clotty Milk
Poured faster
Clotty Milk Idle in well
Bulk Milk
Skim Milk
Clot Count
650
550
450
350
250
150
50
-50
Time (s)
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2009/000086

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

A01J 5/013 (2006.01) ***G01N 15/00*** (2006.01)
A01J 7/00 (2006.01) ***G01N 21/00*** (2006.01)

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)

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)
Google patents, esp@ce, WPI, EPODOC (keywords): fluid, milk, mastitis, lump, clot, anomoly, flow, path, detect, sense, optic, light, count, and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/0195324 A1 (ADAMS et al.) 23 August 2007 See abstract, figure 1, paragraphs 67-73 and 136	1, 4, 6-9, 11
X	US 6731100 B1 (HANSEN et al.) 4 May 2004 See abstract, figure 1, column 3 lines 1-22, column 4 lines 26-45, column 6 lines 6-67	1, 3-11
X	US 6315955 B1 (KLEIN) 13 November 2001 See abstract, figure 1a-c, column 14 lines 22-58	1, 3, 4, 6-8, 10, 11
X	WO 2001/019170 A1 (DELAVAL HOLDING AB) 22 March 2001 See abstract, figure 1, page 7 lines 6-30, page 9 lines 1-22	1-8, 10, 11

[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
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 July 2009	14 JUL 2009

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2009/000086

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: **12 and 13**
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
The claims do not comply with Rule 6.2(a) because they rely on references to the description and/or drawings.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ2009/000086

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6197538 B1 (VAN DEN BERG et al.) 6 March 2001 See abstract, figures 1-4 item 12, claim 1, column 5 lines 42-59, column 6 lines 11-28	1, 3, 4, 6-8, 10, 11
X	JP 2001004523 A (AGENCY OF IND SCI & TECHNOLOGY) 12 January 2001 English abstract retrieved from EPODOC database See abstract, figure 1 items 1-8	1, 4, 6-9, 11
X	US 6064480 A (MOUNTAIN et al.) 16 May 2000 See abstract, figure 1, column 2 lines 42-65, column 3 lines 6-17	1, 4, 6-9, 11
X	WO 1999/022219 A1 (PARTICLE MEASURING SYSTEMS, INC.) 6 May 1999 See abstract, figure 3 items 224 and 238, page 2 lines 20-22, page 8 lines 1-8	1, 4, 6-9, 11
X	US 5365559 A (HSUEH et al.) 15 November 1994 See abstract, figure 2 items 2 and 3, column 2 lines 41-68	1, 4, 6-9, 11
X	US 3676647 A (STAFFIN et al.) 11 July 1972 See abstract, figures 1, 2, items 21 and 23, column 2 lines 32-42, column 5 lines 29-60	1, 4, 6-9, 11
A	WO 2006/045759 A1 (AGNET) 4 may 2006 See all of document	1-11
A	US 4385590 A (MORTENSEN) 31 May 1983 See all of document	1-11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/NZ2009/000086

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	2007195324	EP	1904807	EP	1907820	US	7518723
		US	7532327	US	7551279	US	7554661
		US	2006227324	US	2006256333	US	2007046938
		US	2007146703	US	2007194244	WO	2006034129
		WO	2006130296	WO	2006135902	WO	2008043079
		WO	2008067492	WO	2008140593		
US	6731100	AU	72057/98	AU	73722/98	CA	2288801
		CA	2288996	EP	0980516	EP	0983378
		EP	1180675	EP	1180676	EP	1180677
		EP	1933127	EP	1933128	EP	1935983
		EP	1936351	EP	1947442	EP	1947443
		IL	132688	JP	2007304104	NZ	500686
		NZ	500687	US	6710879	US	6919960
		US	7068365	US	2004246483	US	2005225766
		US	2006256340	US	2008186493	US	2008246946
		WO	9850577	WO	9850777		
US	6315955	AU	52935/96	CA	2217476	EP	0871858
		EP	1710556	NO	974597	NZ	270877
		WO	9631764				
WO	0119170	AU	74197/00	SE	9903284		
US	6197538	AU	58351/99	CA	2288452	EP	1000535
		JP	2000146832	NZ	500916		
JP	2001004523	NONE					
US	6064480	NONE					
WO	9922219	NONE					
US	5365559	JP	5209822				
US	3676647	BE	759821	CH	543086	DE	2058124
		FR	2072874	GB	1332316		
WO	2006045759	EP	1816909	FR	2876867		
US	4385590	NONE					

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX