

(19)



(11)

EP 2 206 457 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

14.07.2010 Bulletin 2010/28

(51) Int Cl.:

A47L 15/42^(2006.01)

A47L 15/44^(2006.01)

(21) Application number: **09000087.8**

(22) Date of filing: **07.01.2009**

(84) Designated Contracting States:

**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL
PT RO SE SI SK TR**

Designated Extension States:

AL BA RS

(72) Inventors:

- **Pimputkar, Girish
11221 Stockholm (SE)**
- **Pers, Per-Erik
792 33 Mora (SE)**

(71) Applicant: **Electrolux Home Products Corporation
N.V.**

1930 Zaventem (BE)

(74) Representative: **Bodin, Henrik**

**AKTIEBOLAGET ELECTROLUX
Group Intellectual Property
S:t Göransgatan 143
105 45 Stockholm (SE)**

(54) **Detection of detergent**

(57) A dish-washing machine (400) comprising a detergent detector (100) is disclosed. The detergent detector (100) comprises a turbidity sensor and a processor communicatively coupled to the turbidity sensor. The turbidity sensor may include a light source for emitting light, and a light-sensitive element for receiving light emitted from the light source. The light source and the light-sensitive element are advantageously positioned relative to each other so that, when the light source is in operation, light emitted from the light source propagates through a

fluid contained in the dish-washing machine on its way to the light sensitive element. The light-sensitive element is configured to measure the radiant intensity of light received at the light-sensitive element. The processor is configured to compare the radiant intensity of the light emitted from the light source with the radiant intensity of the light received at the light-sensitive element and, based on this information, to determine a turbidity value. Furthermore, the processor is configured to interpret the turbidity value as an indication of the presence of detergent in the fluid.

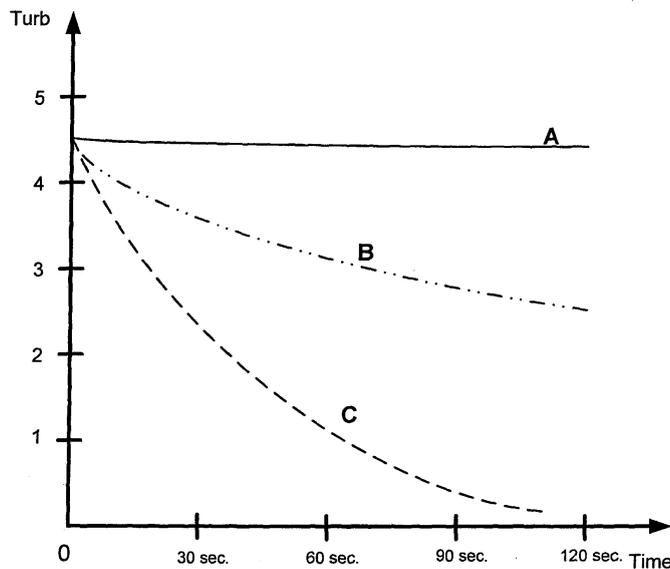


Fig. 3

EP 2 206 457 A1

Description

TECHNICAL FIELD

[0001] The present invention generally relates to a dish-washing machine for washing dishware and, more particularly, to a detergent detector for detection of the presence of detergent in a fluid, or liquid medium, contained in the dish-washing machine.

BACKGROUND

[0002] A dish-washing machine is an apparatus for automatically washing dishware such as plates, glasses, cutlery and other utensils used in, e.g., cooking or serving. In order to perform washing of the dishware, a detergent can be introduced into a detergent container (a.k.a detergent receptacle) or the like and water can be supplied. The detergent may be of different types, such as powder, gel or tablets. Sometimes users forget to add the detergent before starting the washing cycle for washing the dishware. Generally, this leads to the dishware still being soiled or unclean after the washing cycle has finished. This may lead to wasteful water and energy consumption, as the washing will have to be repeated in order to clean the dishware. In turn, this may lead to frustrated users. As users may have forgotten whether they added detergent or not before starting the washing cycle, this user frustration is sometimes even worse. Furthermore, if users have forgotten whether they added detergent or not they may draw the erroneous conclusion that the dish-washing machine is malfunctioning even if the unclean dishware is the result of the lack of detergent.

SUMMARY

[0003] It is with respect to the above considerations and others that the present invention has been made. The present invention seeks to mitigate, alleviate or eliminate one or more of the above-mentioned deficiencies and disadvantages singly or in combination. In particular, it would be desirable to achieve an improved device and/or method for avoiding or at least reducing user frustration. It would also be desirable to achieve an improved device and/or method for avoiding possible service calls to operators in situations where the bad cleaning result is the result of the lack of detergent, in contrast to a situation where the dish-washing machine really malfunctions.

[0004] To better address one or more of these concerns, a detergent detector, a method and a computer-program product having the features defined in the independent claims are provided. Embodiments of the present invention are defined in the dependent claims.

[0005] In accordance with a first aspect of the invention, there is provided a detergent detector for detection of the presence of detergent in a fluid contained in a dish-washing machine, wherein the detergent detector com-

prises: a turbidity sensor configured to measure the turbidity of a fluid during a predetermined time period subsequent to an expected release of detergent into the fluid, the turbidity being indicative of the presence of detergent in the fluid; and a processor communicatively connected to the turbidity sensor, the processor being configured to determine a turbidity value based on the measured turbidity and to interpret the turbidity value as an indication of the presence of detergent.

[0006] It should be appreciated that the above-mentioned expected release of detergent may include multiple expected releases of detergent.

[0007] The present invention is based on the inventors' realization that the point of detergent release is known for any given washing cycle in dish-washing machines and, furthermore, that the turbidity of the fluid contained in the dish-washing machine is a reliable indication of the presence of detergent, at least for a relatively short time period (e.g. 120-300 seconds) subsequent to the detergent release. Within this relatively short time period, very little or no soil is dissolved in the dish-washing water. Consequently, the initial increase in turbidity of the dish-washing water is only, or at least for the major part, due to the presence of undissolved solid detergent particles. On the other hand, if detergent is missing, there will be no or very little turbidity during this relatively short time period. Hence, by monitoring the measured turbidity of the fluid during this period, it is possible to establish or detect whether detergent has been added or not.

[0008] In one embodiment, the predetermined time period is less than or equal to 300 seconds, such as less than or equal to 120 seconds. It is within this time period that the turbidity gives the best, or most reliable, indication of the presence of detergent. After this period, the turbidity of the fluid is increasingly influenced by other particles in the fluid, such as soil from dishware, and hence the indication of the presence of detergent becomes less reliable the longer the time period is.

[0009] In one embodiment, the turbidity sensor is configured to measure the turbidity of the fluid continuously. This way, turbidity variations can be monitored over the predetermined time period. After the detergent release, the turbidity will vary over the predetermined time. In addition, the inventors have found that variations in the turbidity over this predetermined time period are distinctively different for different detergent types. Thus, by continuously monitoring the turbidity (which is indicative of the presence of detergent) over the predetermined time period and comparing it with known characteristics of different detergent types in advance, it may be possible to interpret which detergent type is used.

[0010] In one embodiment, the processor is configured to communicate a signal indicative of the presence of detergent to a controller forming part of a dish-washing machine, the controller being communicatively connected to the processor and configured to control a washing program of the dish-washing machine in dependence of the indication of the presence of detergent.

[0011] In one embodiment, the turbidity sensor comprises a light source for emitting light, the light having a radiant intensity; and a light-sensitive element for receiving light emitted from the light source, the light source and the light-sensitive element being positioned relative to each other so that, when the light source is in operation, light emitted from the light source propagates through the fluid on its way to the light sensitive element, wherein the light-sensitive element is configured to measure the radiant intensity of light received at the light-sensitive element. Furthermore, in this embodiment the processor may be configured to compare the radiant intensity of the light emitted from the light source with the radiant intensity of the light received at the light-sensitive element and to determine, based on this comparison, the turbidity value.

[0012] In one embodiment, the processor is configured to communicate a signal indicative of the presence of detergent to a user interface, the user interface being communicatively connected to the processor and configured to indicate the presence of detergent to a user. The user interface may include a display screen. Thus, the user can be informed whether detergent is present in the dish-washing fluid or not.

[0013] In one embodiment, the processor is configured to communicate a signal indicative of the presence of detergent to a transmitter, the transmitter being communicatively connected to the processor and configured to transmit the signal indicative of the presence of detergent to a receiver. The receiver may be external to the dish-washing machine, in which the detergent detector is employed.

[0014] In accordance with a second aspect of the invention, there is provided a dish-washing machine comprising a detergent detector according to the above-mentioned first aspect of the invention.

[0015] In accordance with a third aspect, there is provided a method for detecting the presence of detergent in a fluid contained in a dish-washing machine, wherein the method comprises: measuring the turbidity of a fluid during a predetermined time period subsequent to an expected release of detergent into the fluid, the turbidity being indicative of the presence of detergent in the fluid; determining a turbidity value based on the measured turbidity of the fluid; and interpreting the turbidity value as an indication of the presence of detergent.

[0016] It should be appreciated that the above-mentioned expected release of detergent may include multiple expected releases of detergent.

[0017] In one embodiment, the predetermined time period is less than or equal to 300 seconds, such as less than or equal to 120 seconds.

[0018] In one embodiment, the step of measuring comprises continuously measuring the turbidity of the fluid, so that turbidity variations can thereby be monitored over the predetermined time period.

[0019] In one embodiment, the method comprises controlling a washing program of the dish-washing machine

in dependence of the indication of the presence of detergent.

[0020] In one embodiment, the method comprises: emitting light, having a radiant intensity, at a light source; receiving light from the light source, at a location to which the light propagates through the fluid, and measuring the radiant intensity of the received light; and comparing the radiant intensity of the light emitted from the light source with the radiant intensity of the light received at the light-sensitive element for determining the turbidity value.

[0021] In one embodiment, the method comprises communicating a signal indicative of the presence of detergent to a user interface for indicating the presence of detergent to a user.

[0022] In one embodiment, the method comprises communicating a signal indicative of the presence of detergent to a transmitter for transmitting the signal to a receiver.

[0023] In accordance with a fourth aspect of the invention, there is provided a computer-program product comprising software instructions which, when executed in an apparatus having computer capabilities, perform the method according to the third aspect of the invention.

[0024] In one embodiment, the computer-program product comprises computer program code means, comprising:

- code means for causing a turbidity sensor to measure the turbidity of a fluid during a predetermined time period subsequent to an expected release of detergent into the fluid, the turbidity being indicative of the presence of detergent in the fluid,
- code means for causing a processor to determine a turbidity value based on the measured turbidity of the fluid, and
- code means for causing the processor to interpret the turbidity value as an indication of the presence of detergent.

[0025] In one embodiment, the predetermined time period is less or equal to 300 seconds, preferably less or equal to 120 seconds.

[0026] The computer-program product may further comprise:

- code means for causing the turbidity sensor to continuously measure the turbidity of the fluid.

[0027] The computer-program product may further comprise:

- code means for causing a light source to emit light, the light having a radiant intensity;
- code means for causing a light-sensitive element to receive light from the light source, at a location to which the light propagates through the fluid, and for causing the light-sensitive element to measure the radiant intensity of the received light, and

- code means for causing the processor to compare the radiant intensity of the light emitted from the light source with the radiant intensity of the light received at the light-sensitive element for determining the turbidity value.

[0028] Generally, the second, third and fourth aspects may exhibit the same advantages and features as the first aspect.

[0029] These and other aspects of the invention will be apparent from and elucidated with reference to the illustrative embodiments described hereinafter.

[0030] Generally, all terms used herein are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the [element, device, component, means, step, etc.]" are to be interpreted openly as referring to at least one instance of the element, device, component, means, step, etc., unless explicitly stated otherwise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] Embodiments of the present invention will now be described in more detail, reference being made to the enclosed drawings, in which:

FIG. 1 is a block diagram of a detergent detector in accordance with an embodiment of the invention;
FIG. 2 is a graphical representation of the dependence of transmittance on turbidity for an exemplary case;

FIG. 3 is a graphical representation of the relationship between detergency presence and turbidity during a certain time period.

FIG. 4 shows a dish-washing machine comprising the detergent detector of FIG 1; and

FIG. 5 is a flow chart of a method of measuring the turbidity of a fluid according to an embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0032] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Furthermore, like numbers refer to like elements throughout.

[0033] FIG. 1 illustratively shows a detergent detector 100 in accordance with an exemplary embodiment of the invention. The detergent detector 100 according to this exemplary embodiment, which is here represented in

block-diagram form, comprises a turbidity sensor 120 for measuring the turbidity of a fluid 110. Furthermore, in the disclosed embodiment the detergent detector 100 comprises a data processing unit or processor 130 communicatively coupled to the turbidity sensor 120. It should be appreciated that the detergent detector 100 may further include or be coupled to a power supply section, a clock and similar auxiliary components. However, these components have been intentionally omitted from the drawings, since they are not considered necessary for explaining the principles of the present invention. Furthermore, the addition of such components is considered to belong to the common general knowledge of persons skilled in the art.

[0034] In the disclosed embodiment, the turbidity sensor 120 comprises a light-emitting portion 210 and a light-receiving portion 220. The light-emitting 210 and light-receiving 220 portions are so positioned that light emitted by the former, at least for the most part, can propagate through the fluid 110 to reach the latter. In the disclosed embodiment, the light-emitting portion 210 comprises a light source 211 and a focusing lens 212. The light source 211 may be subject to certain requirements regarding dimensions, reliability and power consumption, and can advantageously be realised as a solid-state light source such as a light-emitting diode (LED). The focusing lens 212 may serve as a relatively simple means for collecting the light beams emitted by the light source 211 into a parallel or substantially parallel beam. Different focusing means could be envisaged, such as a collimator or an assembly of several lenses. The light emitted by the light source 211, at a radiant intensity I_0 , may propagate along an optical path 111, a portion of which intersects the fluid 110, and is eventually received by the light-receiving portion 220. Along the optical path 241, optical attenuation (which, as will be described hereinafter may, e.g., be the result of detergent which is dissolved therein) may take place along with scattering in various directions. Due to attenuation and scattering, the light beam exits the fluid 110 with intensity I , which may be comparatively lower than the radiant intensity I_0 of the emitted light.

[0035] Still with reference to the exemplary embodiment disclosed in FIG. 1, the light-receiving portion 220 comprises a light-sensitive element 221, which may suitably be a phototransistor for receiving light in a wavelength range that is compatible with the light source 211. The light-sensitive element 221 may be one from a group comprising a phototransistor, a photodiode and a photoresistor. Phototransistors and photodiodes are both capable of emitting a voltage responsive to the radiant intensity of light impinging on a light-sensitive surface. The resistance of a photoresistor may vary in dependence of the intensity of light hitting a light-sensitive surface of the photoresistor. Hence, these components are suitable for measuring the radiant intensity of received light. To prevent re-scattered light from exciting the light-sensitive element 221, this latter may advantageously be preceded by a collimator 222 or a similar de-

vice, which is capable of cutting out light not impinging substantially on the optical axis 111. A signal that encodes the radiant intensity of the received light I can then be provided to the processor 230.

[0036] Still with reference to Fig. 1, the detergent detector comprises the processor 130. The processor 130 is configured to receive the two signals indicative of the radiant intensities of the emitted and received light. That is I_0 and I , respectively. In this embodiment, the processor 130 comprises a computing means 231. The computing means 231 is configured to receive the two signals indicative of the radiant intensities of the emitted and received light and provide, on the basis of these, a signal indicative of the turbidity of the fluid 110 to an output gateway 232. The computing means 231 is configured to compute, or calculate, the transmittance T of the fluid 110 by comparing the radiant intensity (radiated power per unit solid angle) I_0 of the emitted light and the radiant intensity I of the received light using the following equation: $T = I/I_0$. The computing means 231 is configured to output a turbidity value on the basis of the calculated transmittance. Generally, as used herein the term *turbidity* refers to the concentration of light-scattering or light-absorbing particles suspended in the fluid 110. If turbidity increases in the fluid 110 then, for a given wavelength, the transmittance generally decreases in dependence of, e.g.: the wavelength, the diameter distribution of the suspended particles, the refractive index of the suspended particles, and the surface properties of the suspended particles. Thus, the transmittance is indicative of the turbidity of the fluid 110 via an empirical transmittance-turbidity curve, such as the illustrative curve shown in FIG 2. FIG. 2 shows an exemplary curve of transmittance T (in per cent) as a function of turbidity $Turb$ (in arbitrary units) in a range of interest.

[0037] Dissolved matter such as detergent in the form of e.g. gels, powder or tablets generally attenuate light travelling in the fluid 110. As described previously, the point of expected detergent release (or rather, the opening of the detergent receptacle) is known for any given washing cycle in dish-washing machines. Likewise as described previously, the inventors have realized that during a relatively short time period after the expected detergent release (such as 120-300 seconds), very little or no soil is suspended into the dish-washing water. Consequently, the initial increase in turbidity of the dish-washing water is only, or at least for the major part, due to the detergent being incompletely dissolved in the fluid. On the other hand, if detergent were missing, the turbidity would be zero or very low during this relatively short time period. Hence, by determining the turbidity of the fluid 110 during this period, it is possible to establish or detect whether detergent has been added or not.

[0038] To this end, the processor 130 may comprise a comparator or interpreting means 233 for interpreting the turbidity value as an indication of the presence of detergent. A signal indicative of the turbidity is provided to the interpreting means 233 from the gateway 232. If

the turbidity is determined to be less than a certain threshold value, the interpreting means 233 will indicate that no detergent is in the process of being dissolved in the fluid 110. On the other hand, if there is a significant increase in turbidity, then the turbidity value is determined to be above the certain threshold value and the interpreting means 233 will, accordingly, indicate that detergent is being dissolved in the fluid 110.

[0039] The interpreting means 233 may be communicatively connected to a user interface 301, e.g. a display screen, forming part of the dish-washing machine (see FIG. 4). Thus, the user can be informed whether detergent is present in the dish-washing fluid or not through the user interface. Additionally, or alternatively, the interpreting means 233 may be communicatively connected to a regulating means 302 forming part of the dish-washing machine. Additionally, or alternatively, interpreting means 233 may be communicatively connected to a transmitter 303 for transmitting a signal indicative of the detergent presence to a receiver, which may be external to the dish-washing machine.

[0040] FIG 3 is a graphical representation of the turbidity (i.e. indicative of detergent presence) in the dish-washing water during a predetermined time period of 120 seconds after detergent release into the fluid 110. In the graph illustrated in FIG. 3, the turbidity (in arbitrary units) is represented by the vertical axis. In the disclosed graph, the turbidity is represented by a measured voltage, which is indicative of the radiant intensity of light impinging on a light-sensitive surface of the light-sensitive element 221. However, it should be appreciated that the turbidity could be in any arbitrary units. The time (in seconds) after detergent release is represented by the horizontal axis. The point "0" indicates the release of detergent. The point of detergent release is the point of time when the detergent receptacle is activated, i.e. opened, for introducing the detergent into the dish-washing machine. As described previously, the point of detergent release is known in advance, i.e. known a priori, for any given washing cycle in dish-washing machines.

[0041] The inventors have realized that different detergents exhibit distinctively different behavior as regards the measured turbidity in the dish-washing water, at least for a relatively short time period such as 120 seconds after the detergent release. The various curves represent the turbidity increase (i.e., voltage drop in the illustrated example) in fluid 110 due to detergent dissolution during the relatively short time period after the detergent release for three different detergent types. Curve A represents the case where detergent is missing. In this case, the voltage will not change significantly, since there will be no apparent turbidity increase. Curve B illustrates a case where a detergent without polymers is used. Such detergent may, e.g., be powder or a tablet without polymers. As can be seen, the turbidity increases (voltage drops) gradually after the detergent has been released. Recent development has shown the possibility of producing detergent tablets, where different compositions such as pol-

ymers are added to the tablets in order to dissolve the tablets at a faster rate. Curve C illustrates such a case where the detergent includes polymers, e.g. a tablet with polymers. When additional substances such as polymers are present in the tablet, the polymers will break down the tablet into a foam base solution when it gets into contact with the water. The inventors' have found that the foam causes a relatively rapid increase in turbidity (thus, a rapid voltage drop) as shown by Curve C.

[0042] In one embodiment, the turbidity sensor 120 is therefore advantageously configured to measure the turbidity value of the fluid 110 continuously, so that variations in the turbidity can thereby be monitored over the predetermined time period of, e.g., the 120 seconds illustrated in FIG. 3. By monitoring the variations over the predetermined time period, it is possible to compare the variations of a present turbidity increase with known characteristics of different detergent types (i.e., Curve A, Curve B or Curve C) to determine, or establish, which detergent type that is used based on whether the present turbidity increase follows Curve A, Curve B or Curve C.

[0043] To further illustrate use of a detergent detector 100 according to various embodiments of the invention, FIG. 4 is a schematic view of an exemplary dish-washing machine 400, or dishwasher, having a dishware compartment 410, in which spray arms 412, 414 are arranged. Washing fluid, such as water, can be supplied via an inlet 416, at which a valve 418 is provided, and can be discharged via the outlet 422 by means of a drain pump 420. A system 428 for delimiting can be provided in the dish-washing machine 400. During operation, washing fluid is pressurised by the circulation pump 424 and is fed to the spray arms 412, 414 via a heater 426. After falling through the dishware compartment 410, the washing fluid reaches a sump 430 via a filter 432. In this embodiment, the detergent detector 100 is located in the sump 430. The light-emitting portion (not shown) and the light-receiving portion (not shown) are provided at such locations relative to each other that any light emitted by the turbidity sensor passes through the washing fluid. By its construction, notably by the placement of inlets and outlets, the sump 430 is generally fluid-filled up to a certain level during operation of the dish-washing machine 400. By placing both the light-emitting portion and the light-receiving portion of the turbidity sensor 110 below this level, a suitable optical path between these can be achieved. It may be advantageous to place the turbidity sensor 120 downstream of the filter 432, because coarse particles are then removed and cannot disadvantageously perturb the measurement. It may further be advantageous to place the turbidity sensor 110 in a region of the sump 430 in which the current velocity during operation of the dish-washing machine 400 is relatively high, because this reduces the rate of deposition on light-emitting and light-receiving surfaces (not shown) of the turbidity sensor. It also ensures that the composition - and consequently the turbidity - of that fluid 110 which is in contact with the sensor 120 (on which the measurements are

based) is approximately identical to the composition of that fluid 110 which is in contact with the dishware. Alternatively, the turbidity sensor 110 can be placed around a portion of the hydraulic path between the sump 430 and any of the spray arms 412, 414.

[0044] FIG. 5 illustrates a certain embodiment of a method 500 for detecting the presence of detergent in a fluid contained in a dish-washing machine. In the disclosed embodiment, the method comprises an initial step 510 of emitting light from a light source, the light having an intensity I_0 . In a second step 512, light emitted by the light source is received at a location to which the emitted light propagates through the fluid, and its radiant intensity I is measured. Subsequently, in step 514, the intensity I of the received light can be divided by the intensity I_0 of the emitted light to yield the transmittance, as per the equation $T = I/I_0$. In a step 516, a measured turbidity corresponding to the transmittance can be calculated and, hence, a turbidity value can be determined. Thus, in steps 510-516, a turbidity value of a fluid can be determined. This is performed during a predetermined time period subsequently to a release of detergent into the fluid. This predetermined time period is relatively short (e.g. 120-300 seconds as described previously) and, accordingly, the turbidity is a sufficiently reliable indication of the presence of detergent in the fluid. In a final step 518, the determined turbidity value is interpreted as an indication of the presence of detergent.

[0045] In one embodiment, the measurement comprises continuously measuring the turbidity of the fluid, so that turbidity variations can thereby be monitored over the predetermined time period.

[0046] Still further, in one embodiment the method comprises the additional step 520 of controlling a washing program of the dish-washing machine in dependence of the indication of the presence of detergent.

[0047] Also, the method may additionally comprise a step 522 for communicating a signal indicative of the presence of detergent to a user interface for thereby indicating the presence of detergent to a user.

[0048] The disclosed method 500 may be performed by software instructions included in a computer program product, which, as used herein, may be a computer-readable medium having software instructions stored thereon. By way of example, computer readable mediums may comprise computer storage media and communication media. As is well known to a person skilled in the art, computer storage media includes volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer readable instructions, data structures, program modules or other data. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information

and which can be accessed by a computer. Further, it is known to the skilled person that communication media typically embodies computer readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave or other transport mechanism and includes any information delivery media.

[0049] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiment. It is understood that some components that are included in the disclosed embodiments are optional. For example, the focusing and collimating means may sometimes be superfluous; this is the case, at least, in embodiments having naturally collimated light-sources, such as certain types of lasers. Furthermore, the turbidity sensor 120 may be of a type having a radiant intensity which is variable and the processor 130 may include or be connected to a control unit, which is configured to adjust, by selecting one intensity level out of a plurality of predetermined intensity levels, the radiant intensity of the light emitted by the light source 211 in dependence of the measured radiant intensity of light received at the light-sensitive element 221. Such a turbidity sensor is described in more detail in pending European patent application no. 08019303.0.

[0050] Still further, the inventors have realized that it may be advantageous to detect detergent presence during pre-wash washing cycles as well. Many of today's dish-washing machines have dishwashing programs including both a main washing phase/cycle and, additionally, a so-called pre-wash phase/cycle. Generally, the pre-wash takes place just before the main washing. During pre-wash, water is generally sprayed at the dishware contained in the dish-washing machine and soil removal is only, or at least mostly, caused by the mechanical action taking place in the dish-washing machine as the water jets hit the dishware. Normally, the water is not heated during pre-wash and detergent is not dispensed in the water either. Although it is recommended not to use detergent during pre-wash, it has turned out that some users do add detergent directly into the dish-washing machine container containing the dishware. The use of detergent generally requires heated water in order for the detergent enzymes to be active and, thus, to react on the soil. However, as mentioned above the water is generally not heated during pre-wash. Accordingly, the addition of detergent during this pre-wash phase is normally a waste. Even though this does not damage the washing or cleaning performance, it leads to wasteful detergent use, which in turn can be environment unfriendly. However, the inventors have found that the turbidity of the fluid contained in the dish-washing machine is a reliable indication of the presence of detergent also during pre-wash, at least for a relatively short time period (e.g. less than or equal to 120seconds) subsequent to the operation start of the dish-washing machine. Within this relatively short time period, very little or no soil is dissolved in the cold or non-

heated dish-washing water. Consequently, an initial increase in turbidity of the dish-washing water is, for the major part, due to the presence of undissolved solid detergent particles (if detergent is added). On the other hand, if detergent is missing, there will be no or very little turbidity during this relatively short time period. Hence, by monitoring the turbidity of the fluid during the relatively short time period directly after the operation start of the dish-washing machine, it is possible to establish or detect whether detergent has been added or not. If it has been detected that detergent has been added during pre-wash, the controller of the dish-washing machine can be configured to control the washing program of the dish-washing machine such that the pre-wash converts to a main-wash time period. Consequently, wasteful usage of detergent during pre-wash can be avoided or at least reduced and, accordingly, an environment friendly detergent detector can be provided.

[0051] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

30 Claims

1. A detergent detector (100) for detection of the presence of detergent in a fluid (110) contained in a dish-washing machine, **characterized in that** the detergent detector (100) comprises:

a turbidity sensor (120) configured to measure the turbidity of a fluid (110) during a predetermined time period subsequent to an expected release of detergent into the fluid (110), the turbidity being indicative of the presence of detergent in the fluid; and

a processor (130) communicatively connected to the turbidity sensor (120), the processor (130) being configured to determine a turbidity value based on the measured turbidity and to interpret the turbidity value as an indication of the presence of detergent.

2. The detergent detector (100) according to claim 1, wherein the predetermined time period is less than or equal to 300 seconds, such as less than or equal to 120 seconds.
3. The detergent detector (100) according to of claim 1 or 2, wherein:

the turbidity sensor (120) is configured to meas-

ure the turbidity of the fluid continuously, so that turbidity variations can thereby be monitored over the predetermined time period.

4. The detergent detector (100) according to any one of claims 1-3, wherein the processor (130) is configured to communicate a signal indicative of the presence of detergent to a controller forming part of a dish-washing machine, the controller being communicatively connected to the processor and configured to control a washing program of the dish-washing machine in dependence of the indication of the presence of detergent.

5. The detergent detector (100) according to any of the claims 1-4, wherein:

the turbidity sensor (120) comprises a light source (211) for emitting light, the light having a radiant intensity, and a light-sensitive element (221) for receiving light emitted from the light source (211), the light source (211) and the light-sensitive element (221) being positioned relative to each other so that, when the light source (211) is in operation, light emitted from the light source (211) propagates through the fluid on its way to the light sensitive element (221), wherein the light-sensitive element (221) is configured to measure the radiant intensity of light received at the light-sensitive element (221); and wherein:

the processor (130) is configured to compare the radiant intensity of the light emitted from the light source (211) with the radiant intensity of the light received at the light-sensitive element (221) and to determine, based on this comparison, the turbidity value.

6. The detergent detector according to any one of the claims 1-5, wherein the processor (130) is configured to communicate a signal indicative of the presence of detergent to a user interface (301), the user interface (301) being communicatively connected to the processor (130) and configured to indicate the presence of detergent to a user.

7. A dish-washing machine (400) comprising a detergent detector (100) according to any of the claims 1-6.

8. A method for detecting the presence of detergent in a fluid contained in a dish-washing machine, characterized by:

measuring (510-516) the turbidity of a fluid dur-

ing a predetermined time period subsequent to an expected release of detergent into the fluid, the turbidity being indicative of the presence of detergent in the fluid,

determining (516) a turbidity value based on the measured turbidity of the fluid, and interpreting (518) the turbidity value as an indication of the presence of detergent.

9. The method according to claim 8, wherein the predetermined time period is less than or equal to 300 seconds, such as less than or equal to 120 seconds.

10. The method according to claim 8 or 9, wherein:

the step of measuring (510-516) comprises continuously measuring the turbidity of the fluid, so that turbidity variations can thereby be monitored over the predetermined time period.

11. The method according to any one of claims 8-10, comprising:

controlling (520) a washing program of the dish-washing machine in dependence of the indication of the presence of detergent.

12. The method according to any of the claims 8-11, comprising:

emitting light (510), having a radiant intensity, at a light source;
receiving (512) light from the light source, at a location to which the light propagates through the fluid, and measuring the radiant intensity of the received light, and
comparing (514-516) the radiant intensity of the light emitted from the light source with the radiant intensity of the light received at the light-sensitive element for determining the turbidity value.

13. The method according to any one of the claims 8-12, comprising:

communicating (522) a signal indicative of the presence of detergent to a user interface for indicating the presence of detergent to a user.

14. A computer-program product comprising software instructions which, when executed in an apparatus having computing capabilities, perform the method according to any one of claims 8-13.

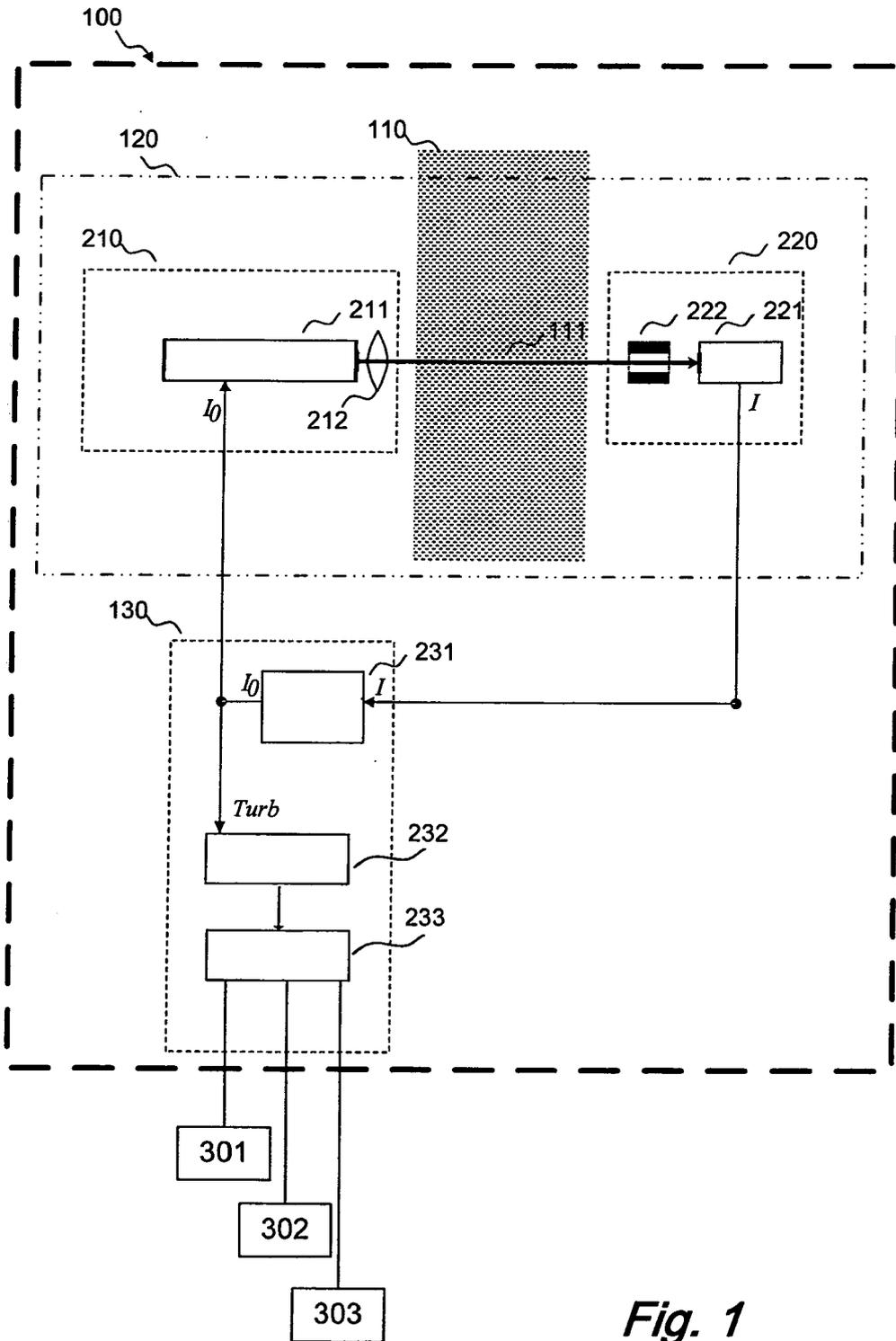


Fig. 1

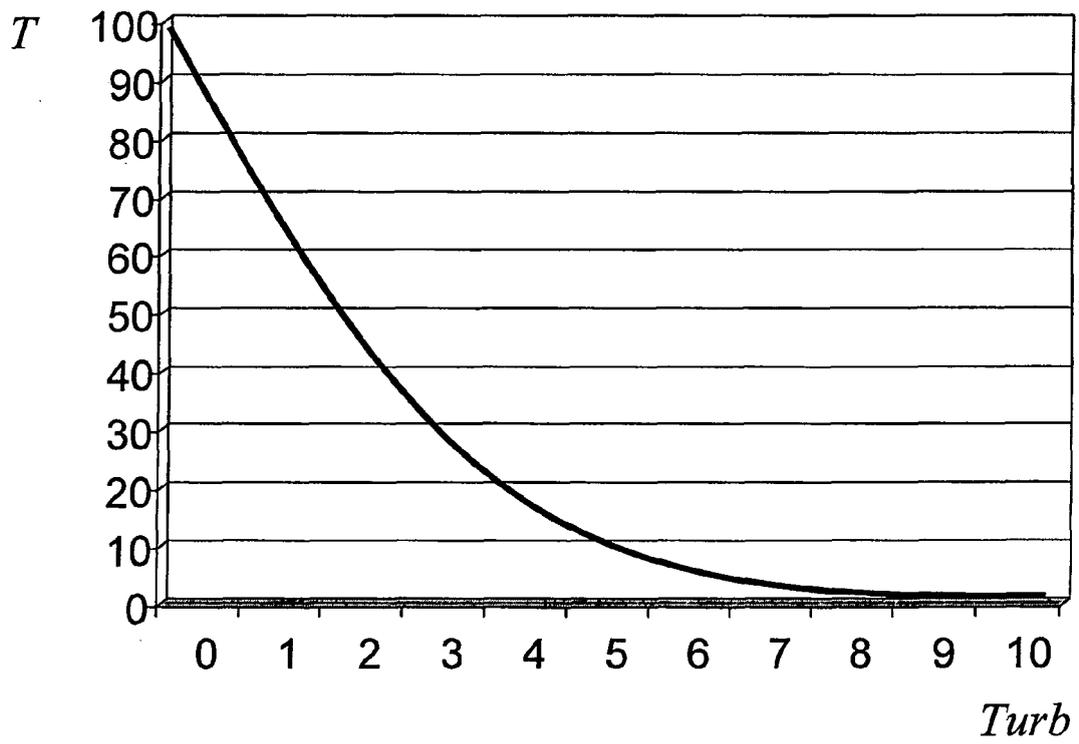


Fig. 2

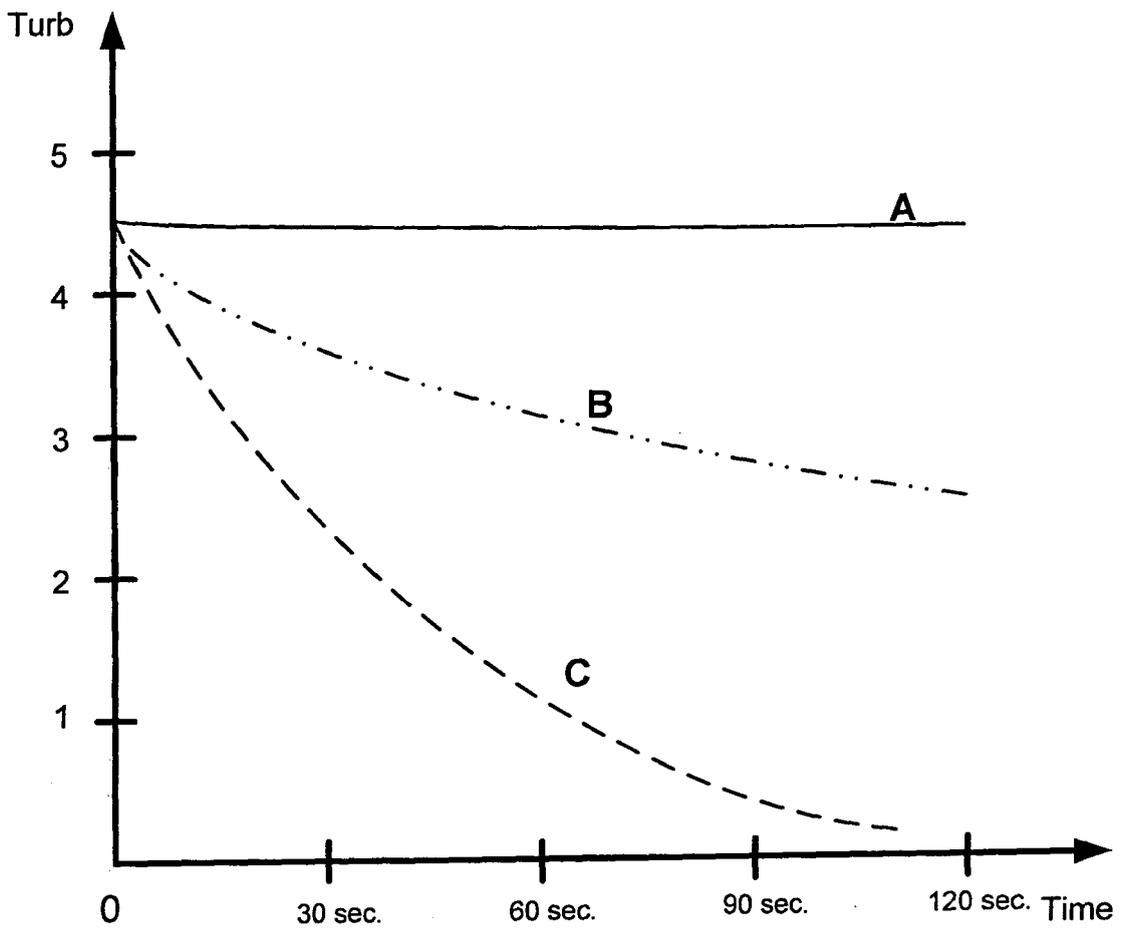


Fig. 3

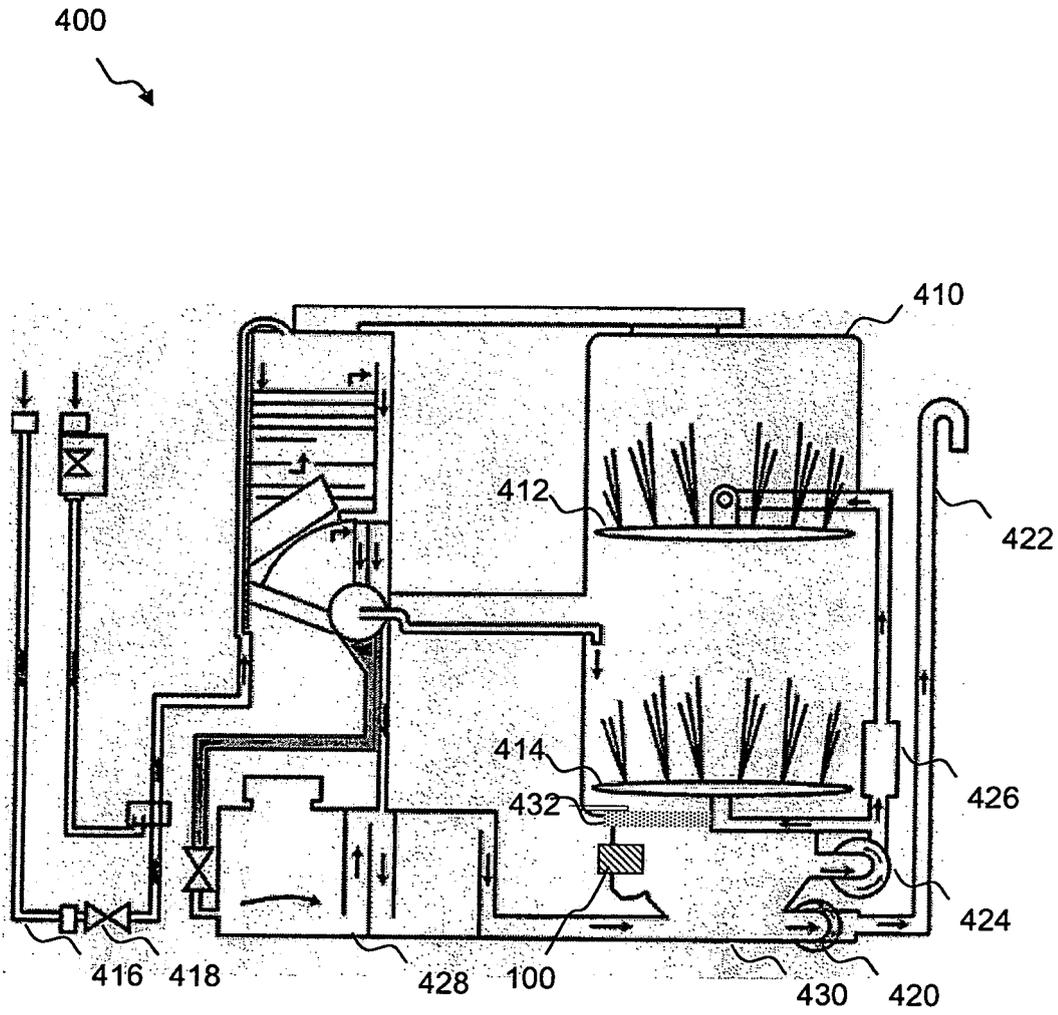


Fig. 4

500

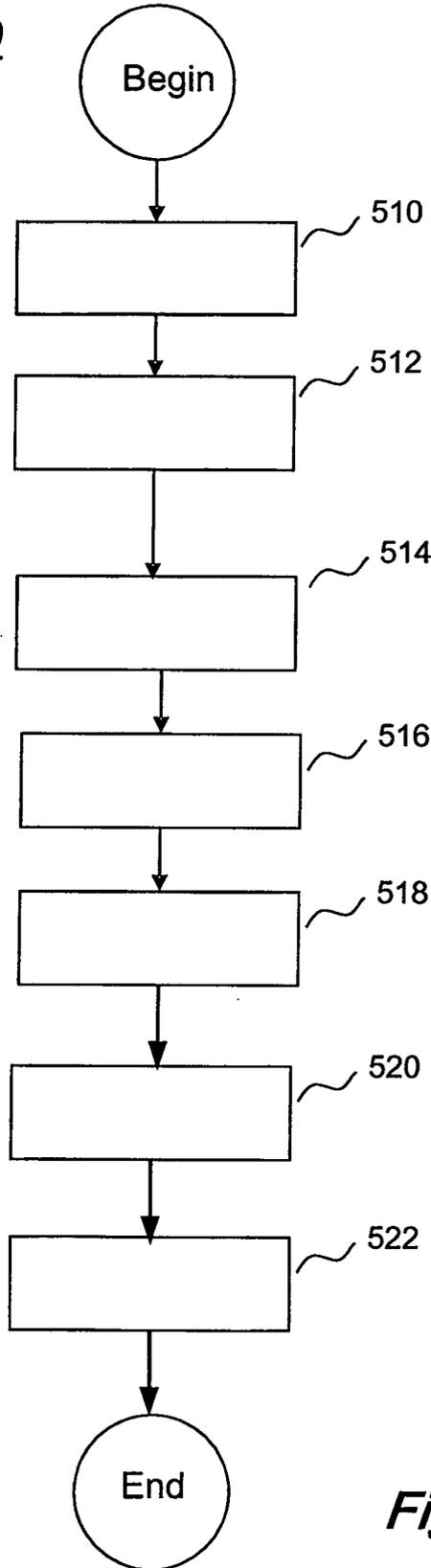


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 09 00 0087

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2003/196278 A1 (DURFEE ANTHONY L [US]) 23 October 2003 (2003-10-23)	1-4, 6-11,13, 14	INV. A47L15/42 A47L15/44
Y	* paragraphs [0013] - [0019]; claim 4 * -----	5,12	
X	DE 10 2005 050183 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 26 April 2007 (2007-04-26) * paragraphs [0015] - [0032]; figure 2 * -----	1-4, 6-11,13, 14	
X	DE 102 57 826 A1 (ELECTROLUX HOME PROD CORP [BE]) 27 November 2003 (2003-11-27) * paragraph [0011] * -----	1,3,8,10	
Y	DE 10 2006 052892 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 15 May 2008 (2008-05-15) * abstract * -----	5,12	
A	EP 1 180 344 A (MIELE & CIE [DE]) 20 February 2002 (2002-02-20) * paragraphs [0006] - [0016] * -----	1-14	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			A47L D06F
Place of search		Date of completion of the search	Examiner
Munich		26 February 2009	Martin Gonzalez, G
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

1
EPO FORM 1503 03/82 (F04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 00 0087

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

26-02-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003196278 A1	23-10-2003	CA 2421531 A1	19-10-2003
DE 102005050183 A1	26-04-2007	CN 101291613 A EP 1945089 A1 WO 2007045560 A1	22-10-2008 23-07-2008 26-04-2007
DE 10257826 A1	27-11-2003	NONE	
DE 102006052892 A1	15-05-2008	NONE	
EP 1180344 A	20-02-2002	DE 10040483 A1	07-03-2002

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 08019303 A [0049]