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(54) Title: METHOD FOR CONTROLLING OPERATING PARAMETERS OF A CLOTHES DRYER OR WASHING/DRYING MACHINE, AND MACHINE USING SAID METHOD

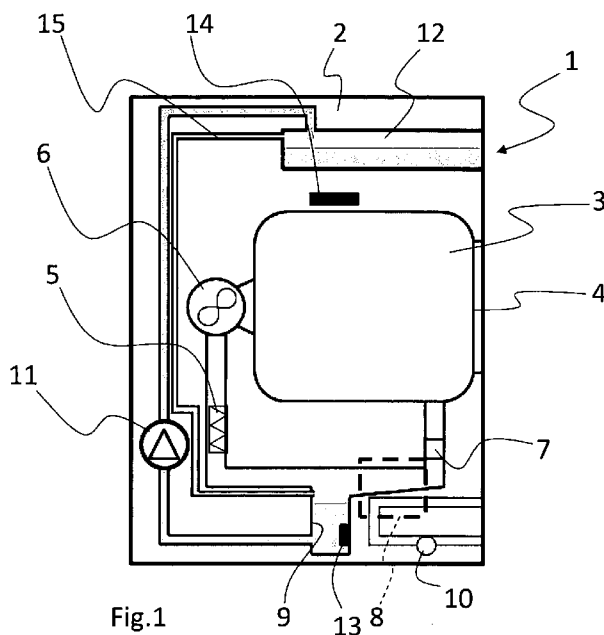


Fig.1

(57) Abstract: The present invention relates to a method for controlling operating parameters in a condensation-type clothes dryer or washing/drying machine, as well as to a clothes dryer or washing/drying machine using said method. In particular, a pressure sensor installed in the well that collects the condensed water measures the pressure of the fluid, i.e. water or air, depending on whether the well is full or empty. The method controls the time intervals for activating the well drain pump and generates alarms indicating the machine status for signalling that the tray must be emptied and/or an air filter must be cleaned in accordance with the pressure value detected.

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-1-

## **METHOD FOR CONTROLLING OPERATING PARAMETERS OF A CLOTHES DRYER OR WASHING/DRYING MACHINE, AND MACHINE USING SAID METHOD**

### **DESCRIPTION**

The present invention relates to a method for controlling operating parameters in a clothes dryer or washing/drying machine, as well as to a clothes dryer or washing/drying machine using said method.

5 The clothes dryer or washing/drying machine of the present invention is of the condensation type, in accordance with the preamble of the first claim.

Machines of this kind are per se known and typically comprise a drum containing clothes which are dried by an air flow generated by a fan and heated by an electric resistance.

10 The hot air jet flows through the clothes in the drum, thus subtracting moisture from them, and goes through a filter for lint removal and then enters a heat exchanger in which, through the effect of thermal exchange with colder environmental air, it is cooled down and condenses, thereby yielding water that flows into a collecting well located in the lower portion of the machine; from there, the water is conveyed by a pump into a removable tray usually arranged in the upper portion of the machine in a position easily accessible to a user, who can then periodically remove and empty said tray.

15 For these machines to operate properly, a number of operating parameters must be controlled, such as: the clothes drying degree, in order to avoid unnecessary long drying processes, the well and tray filling levels, in order to avoid any unwanted stopping of the machine, and sometimes also the filter condition.

20 A typical example of such clothes dryers is described in European patent EP 481561 to Whirlpool International B.V.; in this case, the clothes drying degree is evaluated by checking the variation of the quantity of extracted water over time; to this end, two different types of solutions may be employed: direct ones, wherein the variation of the quantity of water in the collecting well is measured as the pump is operating (by using a dynamometer, or a capacitor, or a resistor, or a float-type electromechanical system), and  
25 indirect ones, which measure the variation of the quantities involved in the pump that conveys the water from the well to the tray (change in the current drawn by the pump,

variation of pump rpm, variation of the revolution speed of an impeller in the water duct). It should be noted that the pump that drains the well and fills the tray is turned on cyclically at time intervals set by a timer, so that the water quantity variation is measured at predetermined time intervals.

5 Although it allows to detect variations of the quantity of water extracted from the clothes, and therefore to know the drying degree of the latter, this solution however involves a certain number of drawbacks: first of all, the pump is turned on regardless of the well filling level; hence the volume of the well must be greater than the maximum volume of the water extracted between two successive pump activations in order to prevent water  
10 from overflowing from the well.

It also follows that (although not taught in the aforementioned document), in order to prevent the tray from overflowing, it is necessary to fit it with at least one float which detects when the maximum filling level is reached, so that the drying cycle can be interrupted and the user can be warned that the tray should be emptied.

15 In addition, this solution does not allow to evaluate other operating parameters of the machine such as, for example, the cleanliness of the air filter (if present); for this purpose, the user is usually recommended to inspect the filter at predetermined time intervals.

The present invention aims at solving this and other problems through a method for  
20 controlling operating parameters in a clothes dryer or washing/drying machine according to the first claim.

The idea at the basis of the present invention is to control a certain number of operating parameters of the machine by measuring only one quantity, i.e. by measuring only the pressure of the fluid in the well; to this end, the well is equipped with a pressure sensor  
25 which measures any variation of pressure on the well bottom, and hence the level of the fluid in which it is immersed, whether it is water (when there is water in the well) or air (when the well is empty).

As described below, by knowing the pressure in the well it is possible to control various operating parameters, such as: pump operation, well and tray filling levels, and air filter  
30 condition.

The following description will also illustrate how a pressure sensor can be used to

advantage in combination with a return duct running from the tray to the well for the purpose of knowing the instant at which the tray achieves the maximum filling condition. Further advantageous features will be set out in the appended claims.

These features and further objects of the present invention will become more apparent from the following description of an embodiment of the method according to the invention provided by way of example with reference to the annexed drawings, wherein:

Fig. 1 is a diagrammatic view of a clothes dryer according to the present invention;

Fig. 2 is a general diagram that illustrates the operation of the pressure sensor used in the clothes dryer according to the invention;

Fig. 3 is a sectional view of the condensed water collecting well equipped with the pressure sensor of the clothes dryer of Fig. 1;

Fig. 4 diagrammatically shows a linear pressure switch included in the aforementioned pressure sensor.

Referring now to Fig. 1, there is shown a condensation-type clothes dryer or washing/drying machine 1 which comprises a frame 2 that houses a drum 3 containing clothes to be dried (not shown); said drum 3 is accessible from the outside through a door 4 typically equipped with sealing gaskets.

Drum 3 is supplied with air heated by electric resistance 5 and circulated by fan 6; the air is blown around and through the clothes in drum 3, thus heating them and subtracting moisture therefrom; when exiting drum 3, the damp air goes through filter 7 and reaches exchanger 8, where it condenses; the condensed water is then collected in well 9, while the air flows on to resistance 5 to start a new cycle.

In exchanger 8, the hot damp air is cooled down through thermal exchange with cold air (usually at ambient temperature) conveyed by fan 10.

The water in well 9 is conveyed by pump 11 into tray 12, where it is collected; tray 12 is a removable one and can therefore be removed to be emptied.

The above description has illustrated the basic operation principle of a condensation-type clothes dryer or washing/drying machine; in practice, machine 1 may be equipped with additional components (especially when it is a washing/drying machine), which have been omitted herein for simplicity's sake.

According to the present invention, in well 9 there is a pressure sensor 13 which

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measures the pressure (or pressure variations) of the fluid in the well, whether the latter is empty or full of water.

In accordance with a preferred embodiment of the invention, sensor 13 is a bell-type sensor, as will be further explained below; it outputs a frequency-modulated voltage  
5 signal to a control unit 14 of pump 11.

Pump 11 is controlled by control unit 14, which is inputted the data detected by pressure sensor 13: when there is no water in the well (or at most only a small quantity of water on the bottom thereof), pump 11 is off and sensor 13, which is not submerged, is subjected to a pressure of approximately 0.1 MPa (atmospheric pressure), referred to as  $P_{atm}$  in Fig.

10 2.

When the water coming from condenser 8 flows into well 9, the latter begins to fill, so that sensor 13 is submerged and starts detecting pressure values which increase over time (proportionally to the level of the liquid over sensor 13); when a first threshold value  $P_1$  in Fig. 2 is reached, e.g. corresponding to a well filling volume of about  $0.2 \text{ dm}^3$  of water,  
15 pump 11 is switched on in order to drain the water from well 9 to tray 12.

Of course, the pressure sensor detects pressure values only, and sends them in the form of readable data to control unit 14, which then compares such data with preset threshold values ( $P_1, P_2, P_3, P_4$ ) and turns on or off both pump 11 and machine 1 accordingly, as will be described later on.

20 Following the activation of pump 11, well 9 begins to empty and the pressure drops below value  $P_1$ ; when pressure sensor 13 detects a pressure  $P_{atm}$  again, it means that the well has become empty again and that the desired quantity of water has been drained into tray 12; at this point pump 11 is stopped.

It should be pointed out that the quantity of water pumped each time into tray 12 is  
25 substantially constant, just because the activation of pump 11 is controlled as a function of a threshold pressure value  $P_1$ , corresponding to a certain water level in well 9; this did not happen in prior-art machines, wherein the pump was controlled by a timer.

Although as well 9 is being drained machine 1 keeps operating, thus conveying condensed water even when pump 11 is on, the speed at which the latter sucks water  
30 from well 9 is nonetheless much higher than the speed at which the well is filled; therefore, this may only cause a very small approximation error in the calculation of the

quantity of water delivered to the tray.

Tray 12 has a capacity of about 5 dm<sup>3</sup>; it follows that several activations of the pump are required (approx. 15 to 25 activations, depending on the quantity of water pumped at each activation) in order to reach the maximum filling condition of tray 12.

5 The quantity of water contained in the tray can be known at any time with good approximation by counting the number of times that pump 11 is turned on, since during each activation period substantially the same quantity of water is delivered from well 9 to tray 12, and consequently it is possible to generate an alarm signal when a certain water volume in the tray is reached (corresponding to a certain number of activations of pump  
10 11); to this end, control unit 14 is equipped with a simple counter for counting the number of pump activations; when the tray is removed, the pump activation counter is reset; for this purpose, the machine may for example be provided with a simple switch adapted to notify the control unit that the tray has been removed from the machine frame. Thanks to the large capacity of the tray, the clothes drying cycle normally ends before the  
15 tray is completely filled with water, so that the user is only required to empty the tray between two distinct drying cycles, without the aforementioned alarm signal being triggered.

It may however occur that clothes made of a certain fabric become soaked with a quantity of water which exceeds (within one complete drying cycle) the capacity of tray 12; in  
20 such a case, the alarm signal should prevent the tray from overflowing.

It may also happen that a user removes the tray but does not empty it (or empties it only partially), so that the number of pump activations will not indicate the actual water volume in the tray, or there may be a case wherein the machine (for reasons of construction simplicity) is fitted neither with a pump activation counter nor with a tray  
25 removal switch for resetting the counter: in these cases, the water volume delivered to tray 12 is not checked.

In such cases, however, it is possible to prevent the tray from overflowing by providing it with a return duct 15 arranged at an overflow height and leading to well 9: in this manner, when the water in tray 12 reaches a certain level, the excess water will be  
30 conveyed back to well 9.

When during any activation stage of pump 11 the level of the water in the tray reaches the

overflow height, it is drained back to well 9 (typically by gravity) through return duct 15, and pressure sensor 13 detects that, although pump 11 is operating, the pressure in the well is not decreasing or only decreases by a certain amount and then remains substantially constant, above value  $P_{atm}$ , or is even increasing (due to the condensed water that keeps flowing into the well); in this condition, it is apparent that tray 12 has reached its the maximum filling level, so that an alarm can be triggered in order to warn the user that the tray must be emptied, thus stopping the drying cycle.

As an alternative, the drying cycle may be continued by using the volume of well 9 for collecting the excess water coming from the tray before stopping the drying cycle: to this end, well 9 has a total volume of, for example, approximately  $1.5 \text{ dm}^3$ ; when tray 12 is full, the water level in the well rises, until sensor 13 detects a second pressure threshold  $P_2$  in Fig. 2, substantially corresponding to the moment at which well 9 is also full of water; in this condition, therefore, both tray 12 and well 9 are using their maximum capacity; hence, the drying cycle is stopped and the user is warned that it is necessary to empty tray 12.

At the next drying cycle restart, the water in well 9 will be drained into tray 12 by pump 11 until the pressure sensor indicates that a pressure  $P_{atm}$  has been reached (the well is substantially empty and the sensor is not submerged).

With reference to the above description, let us now take into consideration pressure sensor 13 especially conceived for this invention, which is shown in Fig. 3.

The sensor comprises a bell 20 whose open lower edge 21 is close to the bottom of well 9; at its upper end, bell 20 communicates with a linear pressure switch 25 through a tube 22, preferably a hosepipe.

In this example, bell 20 is secured to a horizontal septum 26 which de facto is the cover of the well; this septum is also used as a support for pump 11 that delivers condensed water from well 9 to upper tray 12 of the clothes dryer. When a closed well 9 like the one shown by way of explanatory but not limiting example in Fig. 3 is employed, the condensate enters well 9 through a hole 77 obtained in one of the well walls (preferably the back wall, i.e. the one facing the rear of machine 1). Walls 83 that surround hole 77 are advantageously somewhat inclined relative to the well bottom, so as to facilitate the delivery of condensate into well 9.

Linear pressure switch 25 is a per se known transducer device which comprises a diaphragm 30 whose deformations, due to pressure variations which will be further discussed below, determine a linear movement of a ferromagnetic element 31, thereby altering the magnetic field of a coil 32 associated therewith and inducing a corresponding voltage signal.

Said signal is then processed in a per se known modulated form by an electronic circuit 33 associated with the coil, and is subsequently sent to control unit 14; in Fig. 4, the dashed-dotted line outlines of housing 35 of pressure switch 25, wherein the various aforementioned components are arranged.

Linear pressure switches like the one described above are commercially available in Italy from ITW Metalflex, Invensys and Bitron; of course, pressure switches of different types may be used as well, so long as that they allow to detect pressure as explained below.

In fact, the water level within bell 20 changes with the water level in well 9 (in Fig. 3 the surface of the water in the bell is indicated through a dashed line); as a consequence, this causes a variation of the pressure of the air contained inside the bell, which is transmitted through tube 22 to linear pressure switch 25.

The latter detects such pressure variations and sends a corresponding modulated voltage signal of the PWM type (Pulse Width Modulation) to control unit 14, which operates as already explained above. Otherwise, the output signal generated by linear pressure switch 25 and sent to control unit 14 is a frequency-modulated signal, since an oscillator circuit known in the art is associated with linear pressure switch 25.

As regards the possibility of detecting the clogging degree of filter 7, it is appropriate to point out that the path followed by the air flowing in drum 3 is a closed circuit, and therefore it has a substantially constant pressure approximately equal to the atmospheric pressure  $P_{atm}$  in the absence of any disturbance.

It should also be noted that when filter 7 is clogged there is a pressure drop (below the reference value  $P_{atm}$ ) in the air circuit portion downstream of the filter and upstream of fan 6, which is due to the fact that, as fan 6 is sucking air in order to blow it into the drum, a load loss occurs at clogged filter 7; well 9 is located (with reference to the direction of the air flow within the circuit) just downstream of filter 7 and upstream of fan 6, i.e. in the circuit portion where said pressure drop occurs.

When it is not submerged (e.g. immediately after well 9 has been drained), pressure sensor 13 is subjected to the air pressure at the well itself, and therefore it can detect any pressure drops indicating that the filter has become clogged; it is also possible to generate an alarm, for example, as soon as a third threshold value  $P_3$  (obviously lower than  $P_{atm}$ ) of Fig. 2 is reached, in order to warn the user that filter 7 is clogged and should be replaced or cleaned.

If the filter is not cleaned or replaced, the load loss will keep increasing, and consequently the pressure value detected by the sensor will keep decreasing past threshold value  $P_3$  and down to a fourth threshold value  $P_4$  in Fig.2, at which machine 1 will be stopped in order to prevent it from suffering any damage.

According to a particularly advantageous variant, pressure value  $P_{atm}$  detected in the well may be measured when machine 1 is started for the first time (i.e. when filter 7 is absolutely clean) and then stored, for example, in a non-volatile memory unit included in control unit 14.

Thus, all pressure values detected when pressure sensor 13 is not submerged can be compared with the value stored when the machine was first started, for the purpose of evaluating the filter clogging degree.

This option is particularly interesting in that it allows to calibrate the filter clogging degree evaluation directly with reference to the specific characteristics of every single machine type: in fact, as can be intuitively understood, (small) pressure drops may be detected in the well area when clothes are loaded into the drum even if the filter is clean, which can thus be taken into account by measuring the air pressure in the well when the machine is started for the first time and by comparing each subsequent reading with that value; moreover, this option simplifies the filter checking operation when the same system is installed in two different machines in which the air circuit has different aerodynamic characteristics, because it allows that same system to automatically learn pressure value  $P_{atm}$ .

The well pressure measurement (whether pertaining to air or water) may be carried out by using a pressure sensor which provides either an absolute reading (i.e. which detects the absolute well pressure value) or a relative reading (i.e. which detects pressure variations). In the case of the present invention, since the pressure variations occurring in the well are

- very small, typically in the range of a few thousands of Pascals at most, it is preferable to measure pressure variations through a pressure sensor consisting of a pressure transducer adapted to measure variations in the range of 0-3,000 Pa and capable of emitting (in response to a variation of the pressure of the fluid in which it is submerged) an electric
- 5 voltage signal having a certain frequency; more in particular, it is preferable to employ transducers having a linear transfer function or Pressure-Frequency characteristic (the frequency of the voltage signal emitted by the pressure sensor decreases linearly as the measured pressure variation grows), and specifically having a sensitivity of approximately 0.002 Hz/Pa.
- 10 Of course, pressure sensor 13 may either be inserted in well 9 or be external thereto and communicating with the inside thereof, so as to detect the pressure therein, preferably at a height substantially coinciding with that of the well bottom.

**CLAIMS**

1. Method for controlling the operation of a condensation clothes dryer or washing/drying machine (1), wherein a heated air flow, after having been blown against the clothes to be dried, yields water by condensation, which is collected in a well (9) that is drained periodically, characterized in that the level of the water in the well (9) is detected as the machine is operating.  
5
2. Method according to claim 1, wherein the water level is detected as a function of a pressure value.
3. Method according to claim 1, wherein the well (9) is drained when a preset higher pressure value is reached.
- 10 4. Method according to claim 1 or 2, wherein the pressure trend over time is detected in order to check the flow rate of the water entering the well (9) as a function of time.
5. Method according to claim 4, wherein a drying cycle is ended when a value below a predetermined pressure variation over time ( $\Delta P/\Delta t$ ) is detected.
6. Method according to any of the preceding claims, wherein the pressure is detected  
15 substantially at the bottom of the well (9).
7. Method according to any of the preceding claims, wherein the number of well (9) drain operations is detected.
8. Method according to claim 7, wherein the number of well (9) drain operations is detected as a function of the number of activations of a pump (11) associated therewith.
- 20 9. Method according to claim 8, wherein the well (9) is drained by the associated pump (11) into a vessel (12) included in the clothes dryer or washing/drying machine (1).
10. Method according to claim 9, comprising the step of letting the water exceeding the maximum filling level of the vessel (12) overflow into the well (9).
11. Method according to any of the preceding claims, comprising the step of checking the  
25 operating conditions of a filter (7) through which the heated air flows when a predetermined lower pressure value is reached within the well (9).
12. Method according to any of the preceding claims, wherein the detected pressure value pertains to air or any other gas being present inside a volume (20, 22) communicating with the well (9), and is used for the purpose of letting water flow in and out of the latter.
- 30 13. Method according to claim 12, wherein the volume comprises a bell (20) arranged in

the well (9).

14. Clothes dryer or washing/drying machine adapted to implement the method according to any of the preceding claims, characterized by comprising a pressure sensor (13) for detecting the level of the water in the well (9).

5 15. Clothes dryer according to claim 14, wherein the pressure sensor (13) detects the pressure of a gas being present inside a volume (20, 22) communicating with the well (9), for the purpose of letting water flow in and out of the latter.

16. Machine according to claim 15, wherein the volume containing said gas comprises a bell (20) located inside the well (9).

10 17. Machine (1) according to any of claims 14 to 16, comprising a control unit (14) adapted to receive at least the data detected by the pressure sensor (13) for the purpose of activating or deactivating a pump (7) adapted to drain the well (9).

18. Machine (1) according to claim 17, further comprising a counter for counting the number of activations of the pump (11).

15 19. Machine according to claim 18, comprising an alarm system which is triggered as soon as a preset number of activations of the pump (11) is reached.

20. Machine (1) according to one or more of claims from 17 to 19, comprising a vessel (12) arranged downstream of the pump (11) and communicating with the well (9), so that any excess water in the vessel (12) can flow back to the well (9).

20 21. Machine (1) according to one or more of the preceding claims, wherein the vessel (12) has a volume of about  $5 \text{ dm}^3$ , the well has a volume of about  $1.5 \text{ dm}^3$ , and the quantity of water pumped at each pump activation varies substantially from  $0.1$  to  $0.4 \text{ dm}^3$ .

25 22. Machine (1) according to one or more of the preceding claims, further comprising a filter (7) for cleaning the air that is blown against the clothes to be dried, and wherein the well (9) is located between the filter (7) and a forced circulation fan (6) in a closed circuit within the machine (1) in which the air flows.

30 23. Machine (1) according to one or more of the preceding claims, wherein the pressure sensor (13) is adapted to detect pressure variations in the range of  $0$ – $3,000 \text{ Pa}$ , and features a linear transfer function and a sensitivity of approximately  $0.002 \text{ Hz/Pa}$ .

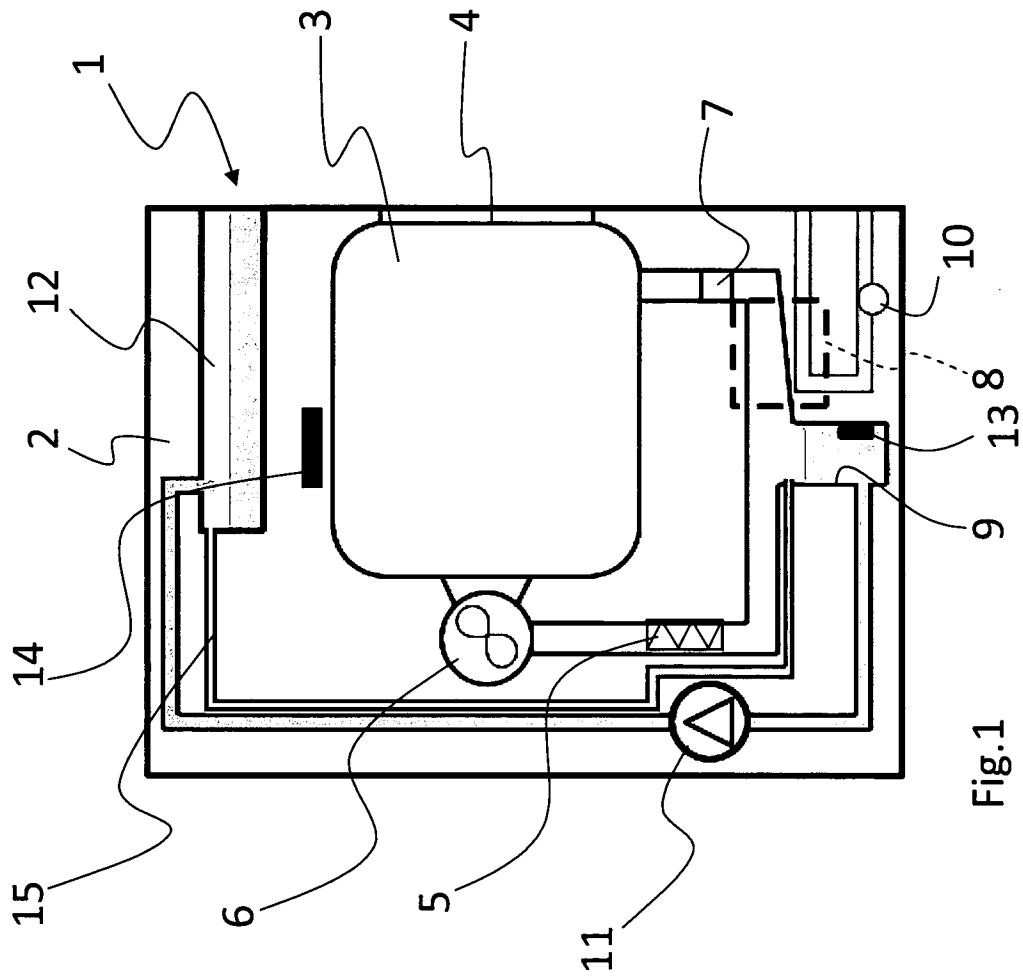


Fig.1

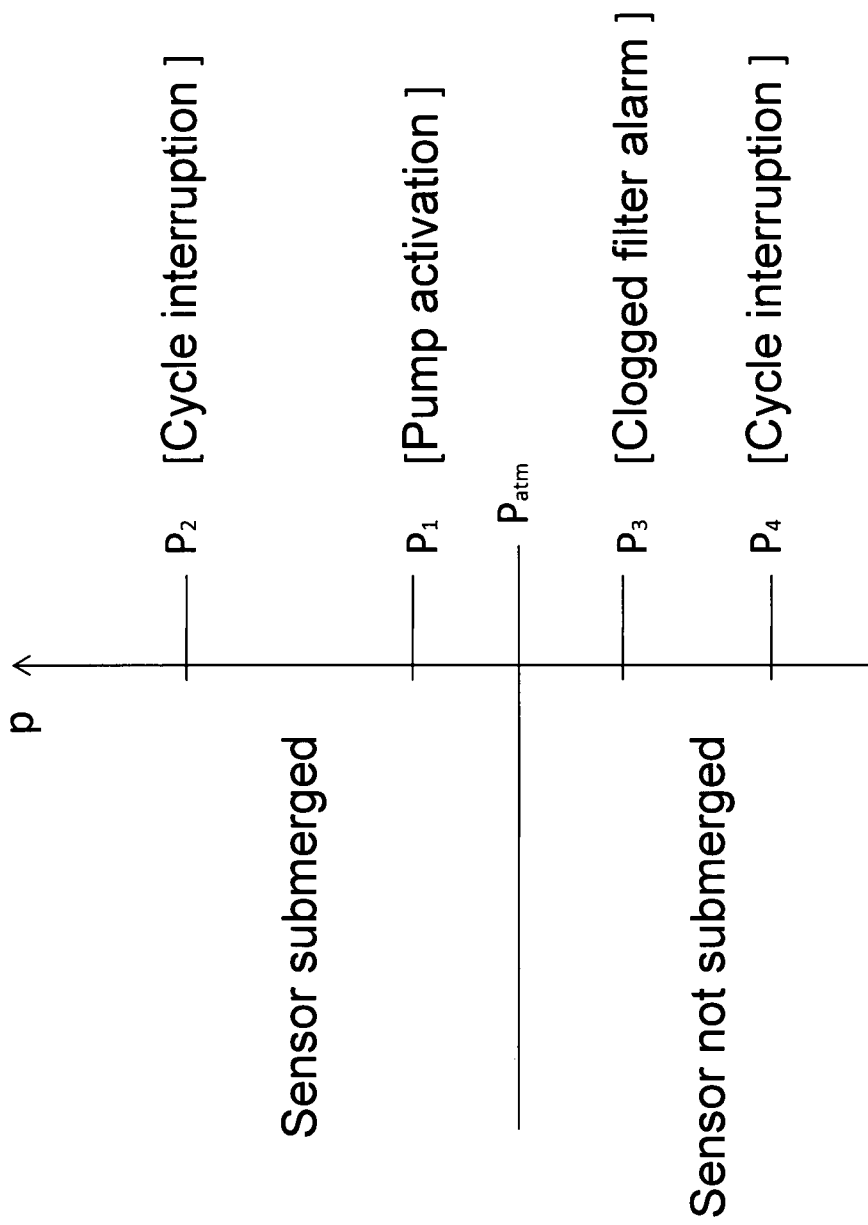
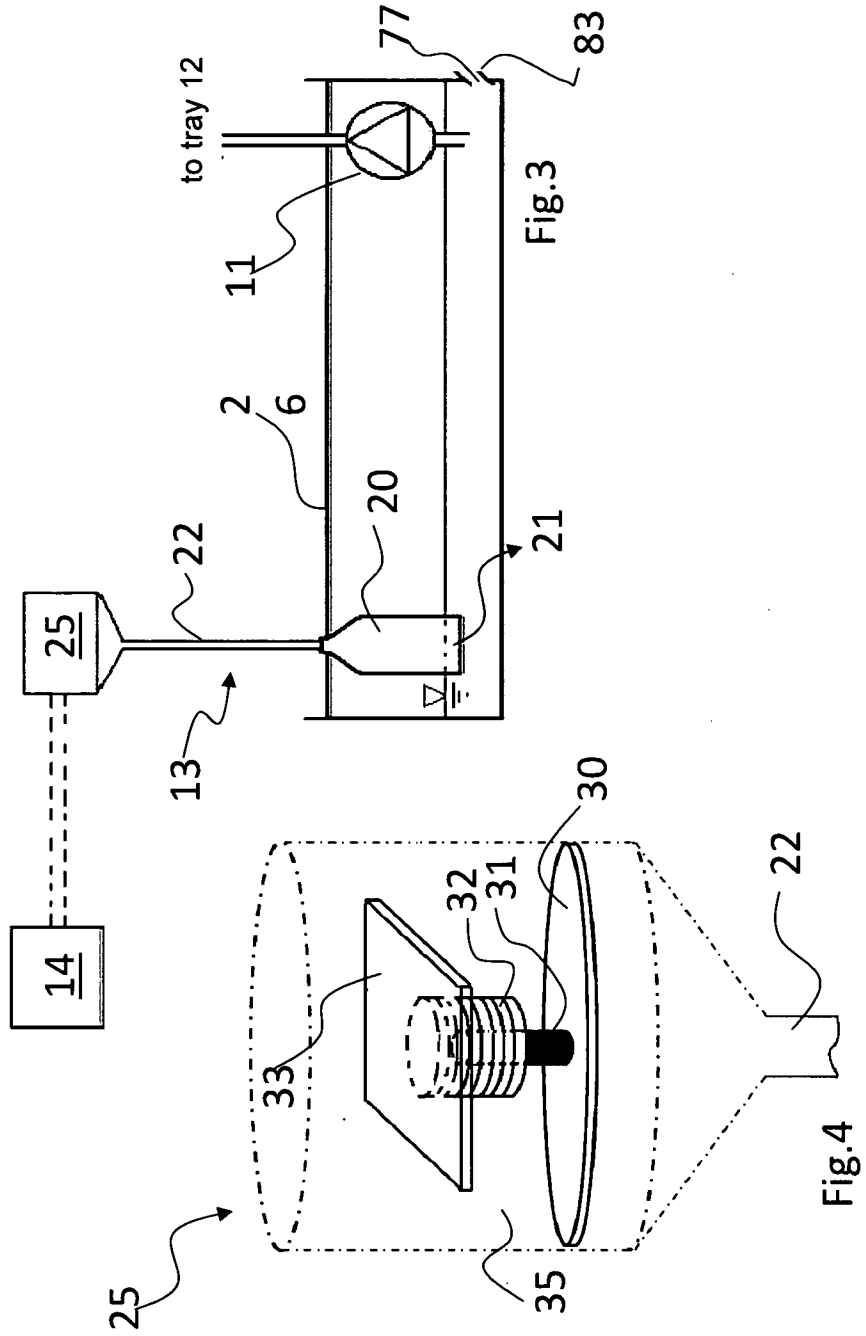


Fig.2

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**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/IB2008/003617

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. D06F58/24 D06F58/28

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)  
D06F

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

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

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	DE 33 15 754 A1 (LICENTIA GMBH [DE]) 31 October 1984 (1984-10-31) page 6, line 6 - page 6, line 19; figure 1	1-3 14
X A	DE 22 32 911 B1 (LICENTIA PATENT-VERWALTUNGS-GMBH, 6000 FRANKFURT) 27 September 1973 (1973-09-27) column 3, line 14 - column 4, line 5; figure 1	1,3 14
A	EP 0 481 561 A (WHIRLPOOL INT [NL] WHIRLPOOL EUROP [NL]) 22 April 1992 (1992-04-22) cited in the application column 2, line 18 - column 2, line 32; figures 1-5	1,14

Further documents are listed in the continuation of Box C.       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	*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
*E* earlier document but published on or after the international filing date	*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
*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)	*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.
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*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  17 April 2009	Date of mailing of the international search report  27/04/2009
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Fachin, Fabiano
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/IB2008/003617
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