



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.10.2018 Bulletin 2018/40

(51) Int Cl.:
D06F 33/02 (2006.01)
D06F 35/00 (2006.01)
D06F 39/06 (2006.01)

(21) Application number: **17162965.2**

(22) Date of filing: **27.03.2017**

(84) Designated Contracting States:
AL 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 RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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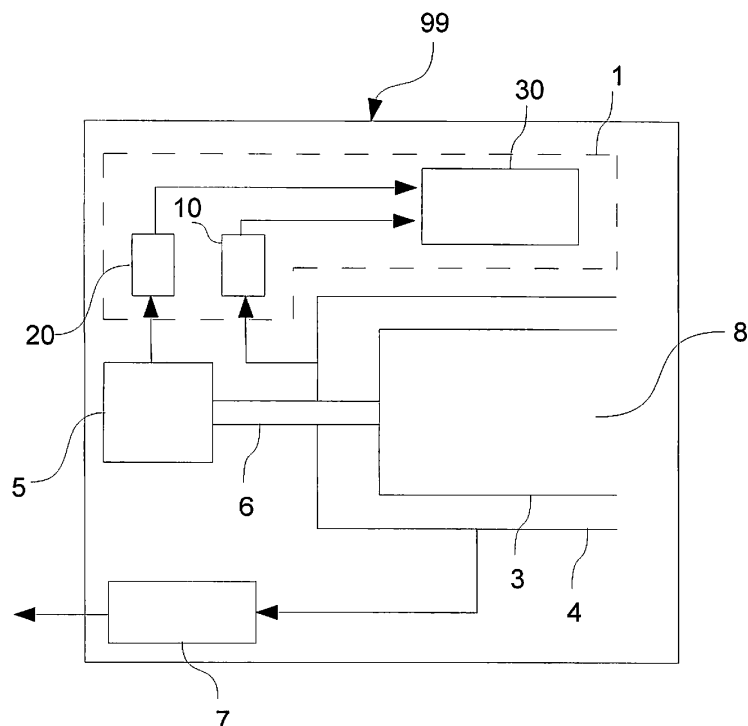
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(54) **METHOD FOR DETERMINING FOAM IN A WASHING MACHINE**

(57) The present invention refers to a method for determining foam during spin cycle of operation in a drum-type washing machine (99). In the technique, a foam level is detected (110) by a foam sensor (10), based on sensing of pressure of a detergent solution tub (4). Simultaneously, a rotational speed of the drive motor (5) is detected (120). The foam level and the rotational speed of the drive motor (5) are detected (110,120) for a given

time instance. Thereafter, a threshold value corresponding to the rotational speed of the drive motor (5) is determined (130). Finally, the foam level detected (110) by the foam sensor (10) is compared (140) to the threshold value. The foam is determined to be present in the washing machine (99) if the foam level detected by the foam sensor (10) is equal to or greater than the threshold value.

FIG 3



Description

[0001] The invention refers to a method for determining foam according to claim 1, an arrangement for determining foam according to claim 9, and a washing machine according to claim 15.

Background of the Invention

[0002] Washing detergents, and other similar products such as fabric softeners, etc are used in washing laundry in a washing machine. The user adds the detergents and other optional washing or laundry treatment agents, such as fabric softeners, to the washing machine before commencing washing operation of the washing machine. Although most such detergents and other agents carry specific instructions on amounts to be used for different loads, different types of laundry i.e. how dirty or clean the clothes are, and different washing operations for example washing using hot water at 60°C or washing using non heated water or washing using water at 45°C, and so on and so forth, often it is difficult to exactly add an optimum amount of detergent. Furthermore, even if same amount of detergent is added in different runs of the washing machine, the action and consumption of the detergent may be different owing to different modes/operations selected by the user to perform washing, and other factors such as water hardness, or interplay between different agents added for example between a detergent and fabric softener, and thus the detergent and other chemical agents aiding washing may not be present in optimal amounts.

[0003] After the washing cycle in a washing machine commences the spin cycle. The spin cycle involves high speed rotation of the drum to remove residual water and detergents from the laundry and leave the laundry in with as little water as possible at the end of the spin cycle. The highest speed rotation of the drum during end of spin cycle is performed to remove residual water, as at this stage the laundry is assumed or intended to be free of detergents, and optionally added other chemical agents aiding washing, which have been attempted to be removed from the laundry towards the end of washing cycle or before commencement of the spin cycle at highest rotation speeds, by rinsing the laundry and removing the wash liquor, i.e. solution of detergent and other optionally added chemical agents to aid washing, one or more times.

[0004] However, in spite of intended removal of detergents in the form of wash liquor, due to non optimal amount of detergents added, or due to lesser water supply than to the laundry during rinsing of the laundry, some residual amount of detergents may be left in the laundry, drum or external tub, and this causes undesired foaming in the washing machine during spin cycle.

[0005] Furthermore, excessive foam formation may also result due to using more than optimal amount of detergent during the wash cycle and this excessive foam

may stand and not be cleared during the washing cycle.

[0006] Excessive amount of foam causes several problems in the washing machine. One disadvantage is that the laundry may be contaminated by the foam after completion of the spin cycle and conclusion of the washing machine operation, and this is undesired as it defeats the purpose of getting clean detergent free laundry at the end of washing machine operation. Another disadvantage is that foam causes hindrance to rotation of the drum during the spin cycle in form of braking effect on the drum, thus making the maximum intended rotational speeds unattainable. The braking effect also causes undesired load on the motor and thus reducing the component life of the motor. Furthermore, foam may leak into parts of the washing machine and causing problems in those parts or even out of the washing machine thereby spoiling the surrounding area outside the washing machine.

[0007] Thus there exists various techniques to sense the amount of foam in the washing machine and to remove the foam or destroy the foam when undesired amount of foam is detected in the washing machine. An example of such technique is presented in prior art document WO2009016009 which presents a method for eliminating foam in a drum washing machine. The washing machine of WO2009016009 includes a sensor for determining a foam level and/or a negative time gradient of the foam level present in the detergent solution tub, wherein a small amount of water is added continuously or discontinuously, with a detergent solution pump switched on continuously or discontinuously, when foam, i.e. liquid-air mixture, is detected by the sensor during a spinning run-up of the drum, that is, a continuous or continuous increase in the rotational speed of the drum. Other prior arts also use a similar foam sensor. Such foam sensors are based on pressure sensing or measuring a pressure in the external tub, also referred to as the suds container or tub. The foam amounts are sensed as corresponding to an increase in pressure of the external tub. These conventional techniques for foam detection based on pressure sensing i.e. excessive foam is detected to be present when pressure as sensed by the foam sensor exceeds a limit or a threshold. which is used to register the presence of foam, and generally for triggering a foam elimination measure. Such foam sensor generally includes a housing and an air pipe or tubing connected to an air dome or container that is in turn connected to the drum or the external tub i.e. the suds container. The air is compressed in the air tubing resulting from the pressure inside the drum or the external tub and thus pressure is sensed by the pressure sensor.

[0008] However, the aforementioned sensing technique is prone to errors, i.e. to providing wrong conclusions. This is because the pressure as detected by the foam sensor may result from other factors besides aggregation or buildup of foam such as, by increased air pressure within the suds container or external tub resulting from rotation of the drum and by residual water arising during the spin cycle and which instead of getting drained

out of the washing machine gets trapped within the drum or suds container due to inertia of rotation. A increased pressure sensed by the foam sensor due to the aforementioned factors result in a false detection of foam amount in the washing machine, although there may not be excessive amounts of foam present.

[0009] Thus there exists a need for a technique for detecting foam in a washing machine that takes into consideration the aforementioned other factors during detection or determination of foam in the washing machine.

Object of the Invention

[0010] It is therefore an object of the present invention is to provide a technique of foam detection that reduces chances of false detection of foam level thresholds.

Description of the Invention

[0011] The aforementioned object is achieved by a method for determining foam according to claim 1 of the present technique, which presents a first aspect of the present technique.

[0012] The basic idea of the present technique is to perform a foam determination based on a spin speed i.e. rotational speed of a drive motor that spins the drum accordingly and on output of a foam sensor. The threshold level for determining the presence of excessive amount of foam and thus consequently determining that a foam elimination mechanism needs to be engaged is different for different motor spin speeds. Thus at lower spin speed of the motor, a threshold level, for example a first threshold level, of pressure for deriving or determining presence of excessive amount of foam and thus consequently engaging a foam elimination mechanism is lesser than a threshold level, for example a second threshold level, of pressure for deriving or determining presence of excessive amount of foam and thus consequently engaging the foam elimination mechanism when the drum is being rotated at higher spin speed or rotational speed. A controller or control unit of the washing machine checks the rotational speed of the motor and the corresponding threshold level of pressure and compares a reading or output of the foam sensor with this threshold level to determine if there is a need to engage a foam elimination mechanism or not. Thus, the false positive readings of the foam sensor caused due to the different air pressure within a detergent solution tub or suds container/external tub resulting from rotation of the drum and due to spinning residual water arising during the spin cycle and which instead of getting drained out of the washing machine gets trapped within the drum or detergent solution tub due to inertia of rotation, are eliminated.

[0013] In the present disclosure, the phrases 'motor speed', 'spin speed of the motor', 'motor spin speed', 'rotational speed of the motor', or simply 'speed of the motor' or 'motor speed' mean one and the same thing,

and may be understood as the rate of rotations performed by the motor driving the rotation of the drum.

[0014] In the method for determining foam in a drum-type washing machine during spin cycle of operation of the washing machine is presented. The washing machine has a controller, a drum rotatable mounted in a detergent solution tub, a wash solution discharge system, a drive motor for rotation of the drum, and a pressure based foam sensor for detecting a level of foam based on sensing pressure. In the method of the invention, a foam level is detected by the foam sensor. The foam sensor detects the level of foam based on sensing of pressure of the detergent solution tub. The foam sensor determines or detects or senses the level or amount of foam, and any such specific determination or detected reading is referred to as the foam level. Thus in the method, the foam level is detected for a given time instance. Simultaneously a rotational speed of the drive motor is detected. The rotational speed of the drive motor is detected also for the given time instance i.e. the foam level and the rotational speed correspond to the same time instance, or in other words are detected at the same time instance.

[0015] Thereafter, in the method of the present invention, a threshold value corresponding to the rotational speed of the drive motor so detected is determined. Subsequently, using the controller, the foam level detected by the foam sensor for the given time instance is compared to the threshold value so determined for the given time instance. According to the method of the invention, the controller is programmed to conclude that foam is determined as present in the washing machine, if the foam level detected by the foam sensor is equal to or greater than the threshold value. The corresponding threshold value for a given rotational speed of the drum is so decided or fixed or predetermined so as to include due consideration of the effects of rotation of the drum on the pressure inside the drum. The phrase 'determined as present' and like phrases with respect to the foam mean present in such an amount or to such a level or degree so as to require initiation or implementation or continuation of foam eliminating mechanism within the washing machine.

[0016] As compared to the conventionally known techniques for determining presence of foam, the method of the present technique ensures that in determining presence of the foam, the effects of rotation of the drum are considered, through fixing an appropriate threshold value for a given rotational speed. As aforementioned these effects of rotation of the drum include increased air pressure within the detergent solution tub, also otherwise known as the suds container or external tub, and increased air pressure due to spinning residual water arising during the spin cycle and which instead of getting drained out of the washing machine gets trapped within the detergent solution tub and/or the drum due to inertia of rotation of the drum.

[0017] In an embodiment of the method, the rotational speed is detected by measuring the rotational speed by

using a tachometer or a tachometer generator. This provides a simple and cost effective way of implementing the method, as tachometers and tachometer generators, also known as tachogenerators, are well known, easy to operate and integrate, are cost effective and have small footprints. The tachometer or the tachometer generator may be contact type or non-contact type.

[0018] In another embodiment of the invention, the foam sensor is calibrated prior to detecting the foam level by the foam sensor for the given time instance. The foam sensor is calibrated after the wash solution is drained out through the wash solution discharge system i.e. when there is substantially no water or very minimal water or wash liquor present in the drum and the detergent solution tub. Thus the foam sensor reading offsets any effect of previously present water or wash liquor in the drum and the detergent solution tub that is drained out before the foam level is detected for the given time instance. In a related embodiment of the method, the foam sensor is calibrated while the drum is stationary. Thus the foam sensor reading offsets any effect of increased pressure resulting from the rotation of the drum before the foam level is detected for the given time instance.

[0019] In another embodiment of the method, the threshold value corresponding to the rotational speed of the drive motor is determined by using a lookup table enlisting different rotational speeds of the drive motor and a corresponding threshold value for each of the different rotational speeds. This is a simple array indexing operation as compared to runtime computation and thus the method is quicker and computationally less intensive.

[0020] In another embodiment of the invention, the threshold value corresponding to the rotational speed of the drive motor is determined by computing using linear regression. Thus obviating the requirement of predetermining and storing threshold values corresponding to each and every possible rotational speed.

[0021] The aforementioned objective is also achieved by an arrangement for determining foam according to claim 9, which presents a second aspect of the present technique. The arrangement is for determining foam in a drum-type washing machine during spin cycle of operation of the washing machine is presented. The washing machine includes a drum rotatable mounted in a detergent solution tub, a wash solution discharge system, and a drive motor for rotation of the drum. The arrangement includes a foam sensor, a rotational speed detecting mechanism, and a controller. The foam sensor detects level of foam based on sensing of pressure of the detergent solution tub. The foam sensor determines or detects or senses the level or amount of foam, and any such specific determination or detected reading is referred to as the foam level. Thus in the present technique, for the arrangement as well as the aforementioned method of the present technique, the level or amount of foam detected at a given time instance is referred to as the foam level detected for the given time instance or the foam level detected at the given time instance or the foam level

corresponding to the given time instance, and similar phrases.

[0022] The rotational speed detecting mechanism detects a speed of rotation of the drive motor. The rotational speed detecting mechanism determines or detects or senses the speed of rotation of the drive motor, and any such specific determination or detected reading is referred to as the rotational speed. Thus in the present technique, for the arrangement as well as the aforementioned method of the present technique, the speed of rotation of the drive motor detected at a given time instance is referred to as the rotational speed detected for the given time instance or the rotational speed detected at the given time instance or the rotational speed corresponding to the given time instance, and similar phrases.

[0023] The controller, for example but not limited to a processor, a FPGA, a microprocessor, controls the foam sensor and the rotational speed detecting mechanism such that a foam level is detected by the foam sensor and a rotational speed of the drive motor is detected by the rotational speed detecting mechanism for a given time instance, i.e. the foam level and the rotational speed are detected simultaneously. In other words, the foam level and the rotational speed correspond to the same time instance, or are detected at the same time instance. Furthermore the controller determines a threshold value corresponding to the rotational speed of the drive motor detected by the rotational speed detecting mechanism and thereafter compares the foam level detected by the foam sensor to the threshold value so determined. The controller assess or concludes that foam is present or foam is determined to be present in the washing machine if the foam level detected by the foam sensor is equal to or greater than the threshold value. As aforementioned, the phrase 'determined as present' or 'determined to be present' and like phrases with respect to the foam mean present or existing in such an amount or to such a level or degree so as to require initiation or implementation or continuation of foam eliminating mechanism within the washing machine.

[0024] As compared to the conventionally known arrangements and systems for determining presence of foam, the arrangement of the present technique ensures that in determining presence of the foam, the effects of rotation of the drum are considered, through fixing an appropriate threshold value for a given rotational speed.

[0025] In an embodiment of the arrangement, the rotational speed detecting mechanism is a tachometer or a tachometer generator. The tachometer or the tachometer generator may be contact type or non-contact type. This provides a simple, efficient and cost effective arrangement, as tachometers and tachometer generators are well known, easy to operate and integrate, are cost effective, energy efficient and have small footprints.

[0026] In another embodiment, the arrangement includes a memory module. The memory module stores a lookup table. The lookup table enlists different rotational speeds of the drive motor and a corresponding threshold

value for each of the different rotational speeds. In this embodiment of the arrangement, the controller determines the threshold value corresponding to the rotational speed of the drive motor by using the lookup table. Thus the controller performs a simpler array indexing operation as compared to runtime computation and thus the functioning of the controller is quicker and computationally less intensive.

[0027] In a further embodiment of the arrangement, the controller determines the threshold value corresponding to the rotational speed of the drive motor by computing using linear regression. Thus obviating the requirement of predetermining and storing threshold values in the arrangement corresponding to each and every possible rotational speed.

[0028] The aforementioned objective is also achieved by a drum-type washing machine according to claim 15, which presents a third aspect of the present technique. The drum-type washing machine, hereinafter also referred to as the washing machine, includes a drum rotatable mounted in a detergent solution tub, a wash solution discharge system, and a drive motor for rotation of the drum and an arrangement for determining foam in during spin cycle of operation of the washing machine according to the aforementioned second aspect of the present technique.

[0029] Further benefits, goals and features of the present invention will be described by the following specification of the attached figures, in which components of the invention are exemplarily illustrated. Components of the devices and method according to the inventions, which match at least essentially with respect to their function can be marked with the same reference sign, wherein such components do not have to be marked or described in all figures.

[0030] The invention is just exemplarily described with respect to the attached figures in the following.

Brief Description of the Drawings

[0031]

- Fig. 1 depicts a flow chart of an exemplary embodiment of a method for determining foam according to the present invention;
- Fig. 2 shows schematically an arrangement for determining foam according to the present invention; and
- Fig. 3 shows schematically a drum-type washing machine, according to the present invention, having the arrangement for determining foam of the present invention.

Detailed Description of the Drawings

[0032] It may be noted that in the present disclosure,

the terms 'first', 'second', etc. are used herein only to facilitate discussion and carry no particular temporal or chronological significance unless otherwise indicated.

[0033] Fig. 1 presents a flow chart representing an exemplary embodiment of a method 100 of the present technique. The method 100 is explained hereinafter in combination with an arrangement 1 of Fig. 2 and a drum-type washing machine 99 of Fig. 3 in which the arrangement 1 is present.

[0034] As shown in Fig. 3, the drum-type washing machine 99, hereinafter also referred to as the washing machine 99 includes a detergent solution tub 4, also referred to as an external tub or suds container, a drum 3 for accommodating laundry through an opening 8 of the drum 3. The drum 3 is rotatable mounted within the detergent solution tub 4, hereinafter also referred to as the tub 4. The washing machine 99 also includes a drive motor 5. From the drive motor 5 extends a drive shaft 6. The drive shaft 6 passes through the tub 4 and connects to the drum 3. The drive shaft 6 rotationally couples the drum 3 with the drive motor 5. The washing machine 99 has a wash solution discharge system 7 through which wash liquor is drained out of the washing machine 99. The washing machine 99 also comprises other parts (not shown) that are required for functioning of such washing machines, such as inlet water pipe, detergent delivery mechanisms, water heating elements, etc.

[0035] The arrangement 1 shown in Fig. 2 includes a foam sensor 10, a rotational speed detection mechanism 20 and a controller 30. The arrangement 1 may optionally include a memory module 40. The arrangement 1 is employed for determining foam in the washing machine 99 during spin cycle of operation of the washing machine 99. The arrangement 1 forms a part of the washing machine 99 as shown schematically in Fig 3. The controller 30 of the arrangement 1 may be part of control console (not shown) of the washing machine 99. The control console receives user selected inputs, for example washing time, washing water temperature, amount of water, washing intensity, etc, and runs the successive cycles of the washing machine 99 operation accordingly.

[0036] The foam sensor 10 is generally an inductive sensor that detects level of foam based on sensing of pressure of the detergent solution tub 4 by determining differential pressure between the inside of the washing machine 99 i.e. inside the tub 4, and external air i.e. the ambient pressure outside the controlled internal environment of the washing machine 99. The foam sensor 10 determines or detects or senses the level or amount of foam, and any such specific determination or detected reading is referred to as the foam level. The foam sensor 10 continuously or intermittently senses or detects the pressure at different time instances during operation of the washing machine 99 and communicates the detected output i.e. the pressure readings to the controller 30. The pressure readings are indicative of an amount or level of foam that may be present or is preset in the tub 4. The reading of the foam sensor 10 indicative of the level of

foam is referred to as a foam level. The foam level corresponds to a time instance when the pressure that resulted in the foam level reading, was sensed. At different operational stages and at different time instances within a particular operation stage different foam levels are provided by the foam sensor 10 as output or output signal or reading to the controller 30. Each foam level so detected by the foam sensor 10 corresponds to a specific time instance. Alternatively or additionally, the controller 30 may request from the foam level from the foam sensor 10 at any time instance.

[0037] The rotational speed detecting mechanism 20 detects a speed of rotation of the drive motor 5. The rotational speed detecting mechanism 20 determines or detects or senses the speed of rotation of the drive motor 5 or the drive shaft 6. Specific determination or detection is referred to as the rotational speed. The rotational speed detected also had a time parameter i.e. the rotational speed at a specific time. The rotational speed detection mechanism 20 detect the actual rotation speed, which may be different or same as the intended or programmed rotational speed of the drive motor 5. The actual rotational speed of the drive motor 5, hereinafter also referred to as the motor 5, may differ from the intended or the programmed motor speed due to drop in performance of the motor 5 owing to wear and tear, or due to other braking factors which affect the speed of rotation such as excessive foam build up, or overloaded laundry, and so on and so forth. The rotational speed detecting mechanism may be a tachometer or a tachometer generator, also called as tachogenerator. The tachometer or the tachogenerator may be contact type or non-contact type. The non-contact type may be fully electronic tachometer based on optical or electromagnetic sensing mechanisms. Such tachometers or tachometer generators, their constructions, principal of operation and way of usage for measuring rotational speeds or frequencies of a rotating body such as the drive motor 5 or the drive shaft 6 are well known in the art of engineering, especially mechanical or electro-mechanical fields, and thus have not been described herein in further details for sake of brevity.

[0038] The rotational speed detection mechanism 20 continuously or intermittently senses or detects the rotational speeds of the drive motor 5 at different time instances during operation of the washing machine 99 and communicates the detected output i.e. the rotational speed readings to the controller 30. The rotational speed corresponds to a time instance when the speed of rotation of the motor 5 that resulted in the rotational speed reading was sensed. Alternatively or additionally, the controller 30 may request from the foam level from the foam sensor 10 at any time instance.

[0039] The controller 30 controls the foam sensor 10 and the rotational speed detecting mechanism 20 such that a foam level is detected by the foam sensor 10 and a rotational speed of the drive motor 5 is detected by the rotational speed detecting mechanism 20 for a given time instance, i.e. the foam level and the rotational speed are

detected simultaneously or at the same time. The controller 30 may exercise this control over the foam sensor 10 and/or the rotational speed detecting mechanism in one or more of the following four ways.

[0040] In a first way, where the foam sensor 10 and the rotation speed detection mechanism 20 are continuously sending readings pertaining to the foam level and the rotational speed to the controller 30, the controller may simply receive these readings and match them with each based on that time instance to which both the readings correspond to. As a result of this matching, the foam level and the rotational speed corresponding to the same time instance are matched and recognized or grouped.

[0041] In a second way, where the foam sensor 10 is continuously sending readings pertaining to the foam level to the controller 30 but the rotation speed detection mechanism 20 is not continuously sending readings pertaining to the rotational speed of the motor 5, the controller 30 after receiving the foam level reading corresponding to a time instance may request from a log of the rotation speed detection mechanism 20 the rotational speed reading corresponding to the same time instance. Such logs are then required to be maintained in the rotational speed detection mechanism 20.

[0042] In a third way, where the rotational speed detection mechanism 20 is continuously sending readings pertaining to the rotational speed of the motor 5 to the controller 30 but the foam sensor 10 is not continuously sending readings pertaining to the foam level, the controller 30 after receiving the rotational speed reading corresponding to a time instance may request from a log of the foam sensor 10 the foam level reading corresponding to the same time instance.

[0043] In a fourth way, the controller 30 may request the foam sensor 10 and the rotation speed detection mechanism 20 to detect and communicate the corresponding readings to the controller such that the foam level reading and the rotational speed reading correspond to the same time instance. Alternatively, the controller 30 may request readings pertaining to the foam level and to the rotational speed corresponding to the same time instance from respective logs of the foam sensor 10 and the rotation speed detection mechanism 20.

[0044] Furthermore the controller 30 determines a threshold value corresponding to the rotational speed of the drive motor 5 detected by the rotational speed detecting mechanism 20. The determination of the threshold value may be performed by the controller 30 by executing runtime computations, for example by using linear regression, or by an array index operation, for example by using a lookup table, or by a combination thereof. The lookup table enlisting different rotational speeds of the drive motor and a corresponding threshold value for each of the different rotational speeds has to be provided to the washing machine 99 stored in the memory module 40. To enable the controller 30 for carrying out runtime computations suitable algorithm needs to be provided to the controller 30. Subsequently, the controller 30 com-

compares the foam level detected by the foam sensor 10 to the threshold value so determined. The controller 30 assess or concludes that foam is present in the washing machine 99 if the foam level detected by the foam sensor is equal to or greater than the threshold value.

[0045] The method 100 for determining foam in the washing machine 99 during spin cycle of operation of the washing machine 99 is explained hereinafter with reference to flow chart of Fig 1. The method 100 of Fig. 1 is implemented by the arrangement 1 of Fig 2.

[0046] In the method 100, in a step 110 the foam sensor 10 detects the level of foam as explained herein earlier. Simultaneously in the method 100, in a step 120 the rotational speed of the drive motor 5 is detected. As aforementioned, the foam level is detected 110 and the rotational speed is detected 120 in such a way that the foam level and the rotational speed correspond to the same time instance, for example a given time instance for which the technique of the present invention is being used to determine the foam. The rotational speed is measured by using a tachometer or a tachometer generator, as explained earlier in relation to Fig. 2.

[0047] In an exemplary embodiment of the method 100, in a step 105 the foam sensor 10 is calibrated. The calibration 105 is performed prior to detecting 110 the foam level for the given time instance. The foam sensor 10 is calibrated 105 after the wash solution or wash liquor is drained out through the wash solution discharge system 7 as shown by an arrow directed outside of the washing machine 99. Additionally, the calibration 105 may be performed while the drum 4 is stationary i.e. when the motor 5 is not rotating the drum 3, for example before commencement of spin in the spin cycle.

[0048] Thereafter, in the method 100, a threshold value corresponding to the rotational speed of the drive motor 5 so detected is determined in a step 130. The determination of the threshold value is performed by using lookup table and/or by using runtime computation, as explained hereinabove with relation to Fig 2.

[0049] Subsequently in the method 100, in a step 140 the foam level detected by the foam sensor 10 for the given time instance is compared to the threshold value so determined for the given time instance. The comparing 140 is performed by the controller 30. In the method 100, the foam is determined as present in the washing machine 99 if the foam level detected by the foam sensor 10 is equal to or greater than the threshold value.

[0050] Thus, the present invention refers to a method for determining foam during spin cycle of operation in a drum-type washing machine 99, wherein a foam level is detected at step 110 by a foam sensor 10, based on sensing of the pressure of a detergent solution tub 4. Simultaneously, a rotational speed of the drive motor 5 is detected at step 120. The foam level and the rotational speed of the drive motor 5 are detected at steps 110,120 for a given time instance. Thereafter, a threshold value corresponding to the rotational speed of the drive motor 5 is determined at step 130. Finally, the foam level de-

tected at step 110 by the foam sensor 10 is compared at step 140 to the threshold value. The foam is determined to be present in the washing machine 99, if the foam level detected by the foam sensor 10 is equal to or greater than the threshold value.

List of reference numbers

[0051]

1	Arrangement for determining foam
3	drum
4	detergent solution tub
5	drive motor
6	drive shaft
7	wash solution discharge system
8	opening of the drum
10	foam sensor
20	rotational speed detection mechanism
30	controller
40	memory module
99	washing machine
100	method for determining foam
105	calibrating the foam sensor
110	detecting the foam level
120	detecting the rotational speed
130	determining the threshold value
140	comparing the foam level to the threshold value

Claims

1. Method (100) for determining foam in a drum-type washing machine (99) during spin cycle of operation of the washing machine (99), the washing machine (99) having a controller (30), a drum (3) rotatable mounted in a detergent solution tub (4), a drive motor for rotation of the drum (5), a wash solution discharge system (7), and a pressure based foam sensor (10) for detecting a level of foam based on sensing pressure, the method (100) comprising:

- detecting (110) a foam level by the foam sensor (10), wherein the foam level is detected based on sensing of pressure of the detergent solution tub (4);
- detecting (120) a rotational speed of the drive motor (5), wherein the foam level and the rotational speed of the drive motor (5) are detected (110,120) for a given time instance;
- determining (130) a threshold value corresponding to the rotational speed of the drive motor (5) so detected; and
- comparing (140), by the controller (30), the foam level detected (110) by the foam sensor (10) to the threshold value so determined;

wherein the foam is determined, by the controller

- (30), to be present in the washing machine (99) if the foam level detected by the foam sensor (10) is equal to or greater than the threshold value.
2. The method (100) according to claim 1, wherein the rotational speed is detected (120) by measuring the rotational speed by using a tachometer or a tachometer generator. 5
 3. The method (100) according to claim 2, wherein the tachometer or the tachometer generator is contact type. 10
 4. The method (100) according to claim 2, wherein the tachometer or the tachometer generator is non-contact type. 15
 5. The method (100) according to any of claims 1 to 4, comprising: 20
 - calibrating (105) the foam sensor (10) prior to detecting (110) the foam level by the foam sensor (10) for the given time instance, wherein the foam sensor (10) is calibrated (105) after the wash solution is drained out through the wash solution discharge system (7). 25
 6. The method (100) according to claims 5, wherein the foam sensor (10) is calibrated (105) while the drum (3) is stationary. 30
 7. The method (100) according to any of claims 1 to 6, wherein the threshold value corresponding to the rotational speed of the drive motor (5) is determined (130) by using a lookup table enlisting different rotational speeds of the drive motor (5) and a corresponding threshold value for each of the different rotational speeds. 35
 8. The method (100) according to any of claims 1 to 6, wherein the threshold value corresponding to the rotational speed of the drive motor (5) is determined (130) by computing using linear regression. 40
 9. Arrangement (1) for determining foam in a drum-type washing machine during spin cycle of operation of the washing machine, the washing machine having a drum rotatable mounted in a detergent solution tub, a wash solution discharge system, and a drive motor for rotation of the drum, the arrangement comprising: 45
 - a foam sensor configured to detect a level of foam based on sensing of pressure of the detergent solution tub;
 - a rotational speed detecting mechanism configured to detect a speed of rotation of the drive motor; and
 - a controller configured 50
 - to control the foam sensor and the rotational speed detecting mechanism such that a foam level is detected by the foam sensor and a rotational speed of the drive motor is detected by the rotational speed detecting mechanism for a given time instance,
 - to determine a threshold value corresponding to the rotational speed of the drive motor detected by the rotational speed detecting mechanism,
 - to compare the foam level detected by the foam sensor to the threshold value so determined, and
 - to assess foam as determined to be present in the washing machine if the foam level detected by the foam sensor is equal to or greater than the threshold value.
 10. The arrangement according to claim 9, wherein the rotational speed detecting mechanism is a tachometer or a tachometer generator.
 11. The arrangement according to claim 10, wherein the tachometer or the tachometer generator is contact type.
 12. The arrangement according to claim 10, wherein the tachometer or the tachometer generator is non-contact type.
 13. The arrangement according to any of claims 9 to 12, comprising a memory module configured to store a lookup table enlisting different rotational speeds of the drive motor and a corresponding threshold value for each of the different rotational speeds, and wherein the controller is further configured to determine the threshold value corresponding to the rotational speed of the drive motor by using the lookup table.
 14. The arrangement according to any of claims 9 to 12, wherein the controller is configured to determine the threshold value corresponding to the rotational speed of the drive motor by computing using linear regression.
 15. A drum-type washing machine comprising a drum rotatable mounted in a detergent solution tub, a wash solution discharge system, and a drive motor for rotation of the drum and an arrangement according to any of claims 9 to 14 for determining foam in during spin cycle of operation of the washing machine.

FIG 1

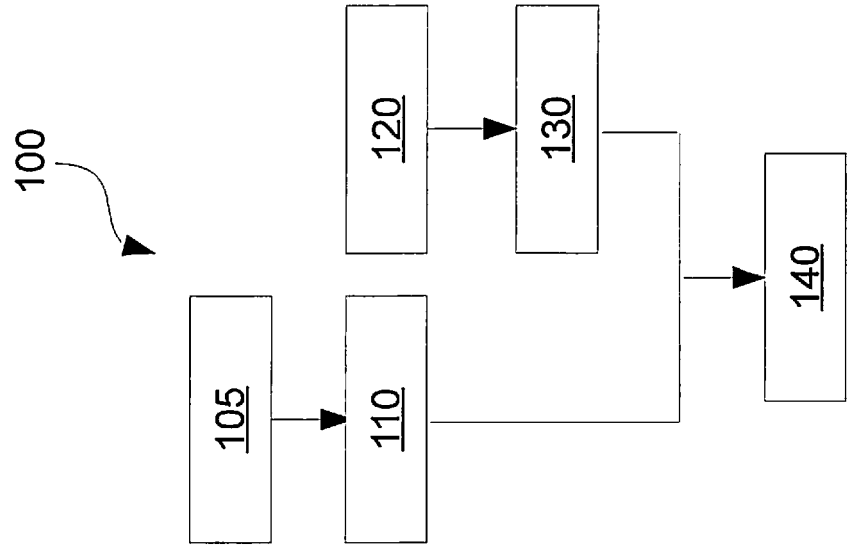


FIG 2

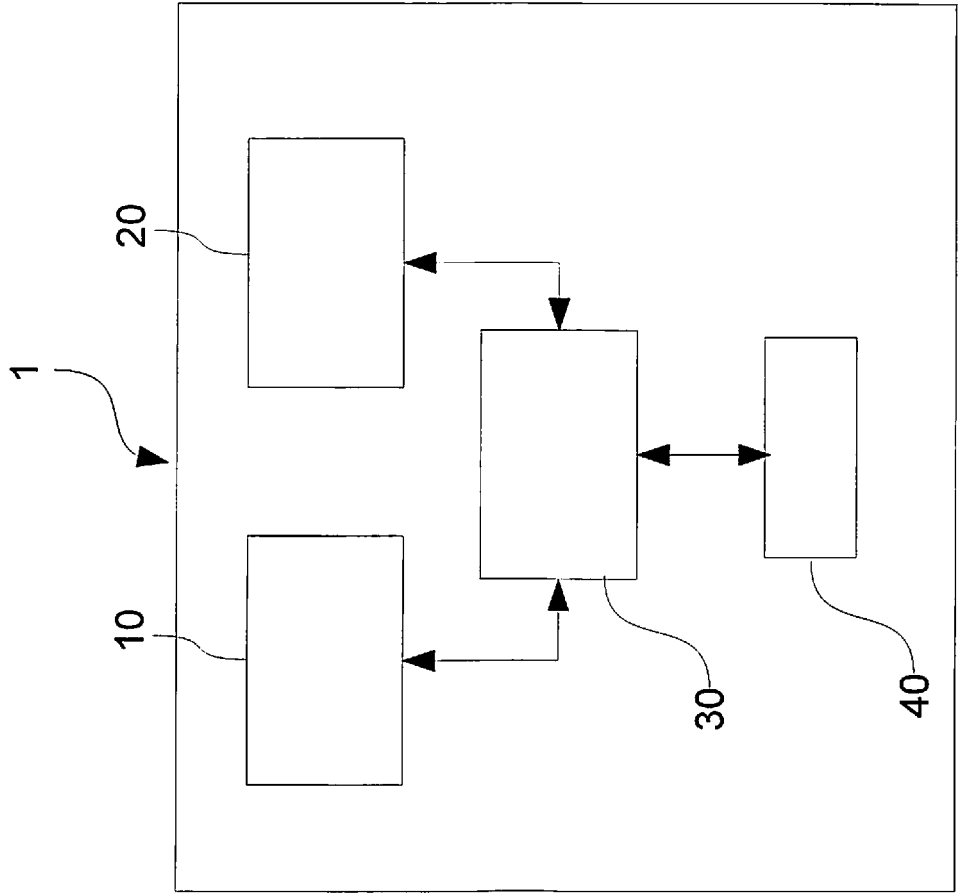
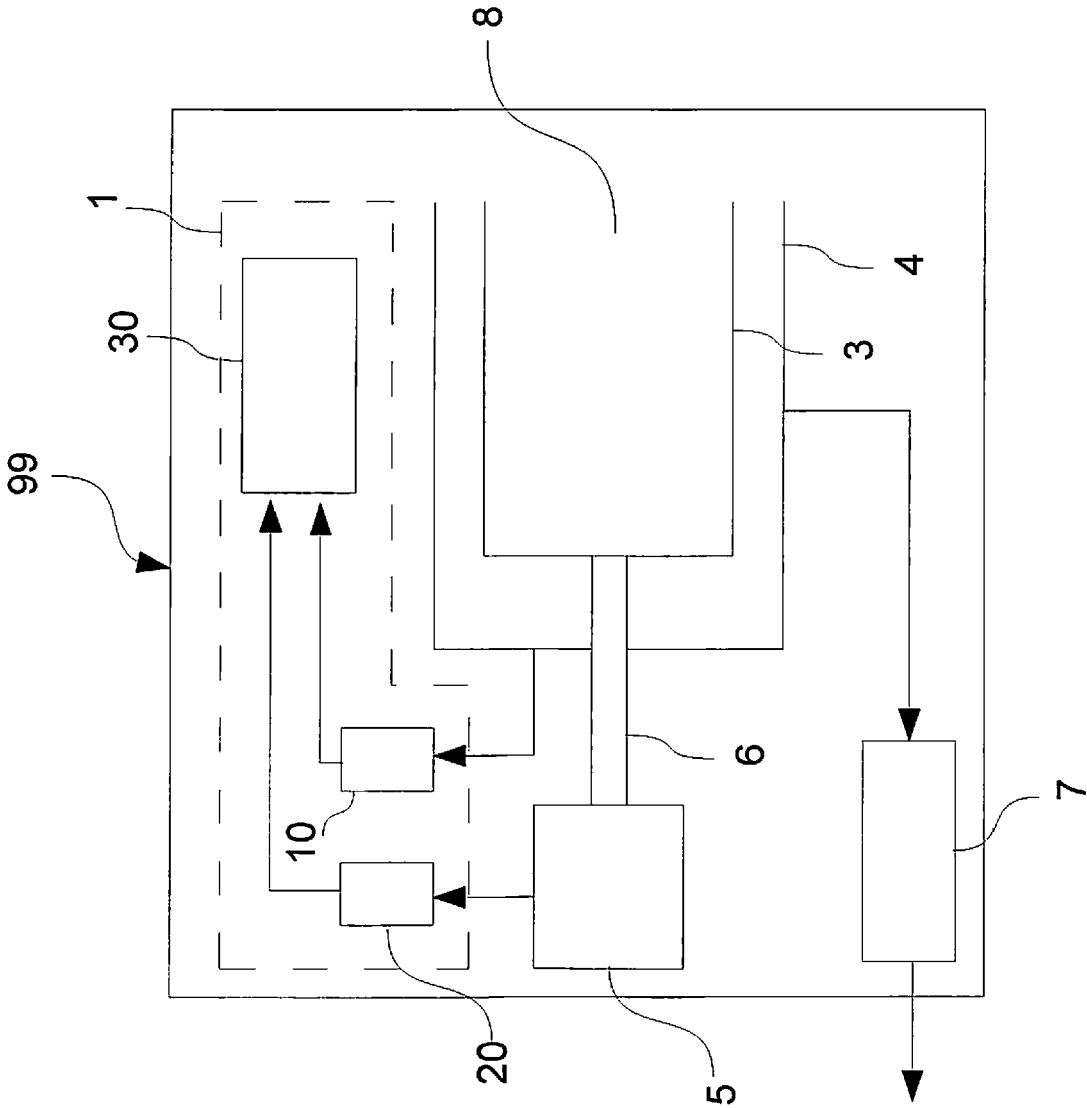


FIG 3





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Place of search Munich		Date of completion of the search 16 June 2017	Examiner Kising, Axel
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