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(54) **HOME APPLIANCE WITH BALL BALANCER AND FLUID VISCOSITY CONTROL**

(57) The disclosure relates to a home appliance (100), in particular a washing machine and/or a dryer, comprising: a rotary drum (101) fillable with laundry (102); a ball balancer (103) attached around the rotary drum (101), wherein the ball balancer (103) is at least partially filled with a fluid (104) embedding one or more free moving balancer balls (105) to balance a laundry (102) unbalance of the rotary drum (101); a sensor (106) configured to sense an overlay signal (107) generated due to an overlay of the laundry (102) unbalance with an unbalance of the one or more balancer balls (105); and a controller (108) configured to determine a viscosity of the fluid (104) based on a predetermined correlation of the viscosity of the fluid (104) with the overlay signal (107).

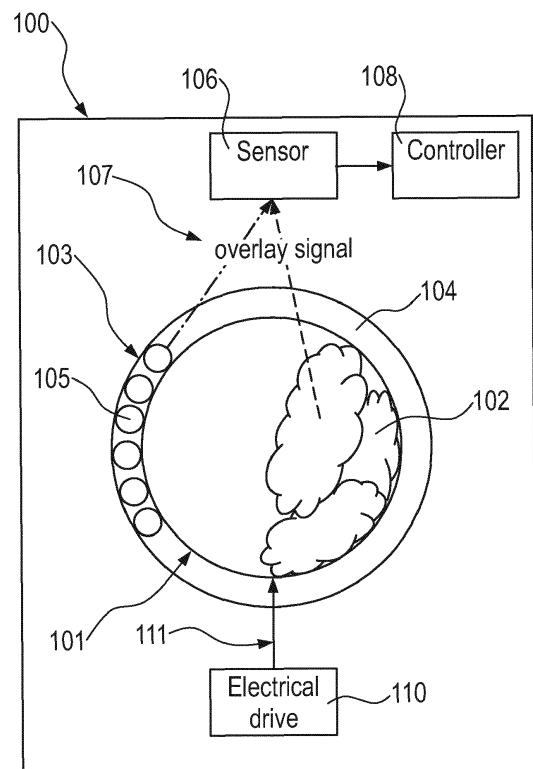


Fig. 1

Description

TECHNICAL FIELD

[0001] The disclosure relates to a home appliance such as a washing machine and/or dryer with ball balancer and controller for determining the viscosity of a fluid filled in the ball balancer and to a corresponding method. The disclosure particularly relates to techniques for determination of the actual viscosity by evaluating the period length of the envelope curve of an oscillation signal generated by the home appliance in operation.

BACKGROUND

[0002] Drum washing machines garments are usually unevenly distributed in the drum, in particular when wet garments are embedded in the drum. Thus, the rotating garments in the drum are in unbalance condition, when the drum is rotating at high speed around a horizontal axis. Usually the rotational speed of the drum has a resonance point between the start and about 200 rpm to 400 rpm. Due to the generation vibrations, noise and an increase in energy consumption caused by the vibrations, the drum can hardly be applied at high rotation speed. Therefore, the conventional drum washing machine includes a rotator control device, also referred to as the ball balancer. If the rotation speed of the drum is higher than a natural frequency of the drum, a ball in the ball balancer moves into a reverse position with respect to a movement of the laundry in the drum to eliminate the unbalance caused by the laundry.

[0003] That is, the behavior of the ball in the ball balancer is controlled so that the ball is arranged on a correct position with respect to the displacement of the laundry, whereby the drum vibration caused by the unbalance state is suppressed.

[0004] In addition to the ball a fluid such as silicone oil, for example, is sealed brought in the ball balancer. This allows the prevention of collision noise of the ball and stabilization of the ball movement in the ball balancer.

[0005] An optimal control of the washing machine hence depends on knowledge about the ball position in the ball balancer and the position of the laundry in the drum.

SUMMARY OF THE INVENTION

[0006] It is the object of the present invention to provide a concept for an optimal control of a home appliance such as a washing machine and/or dryer using a ball balancer as described above.

[0007] The foregoing and other objects are achieved by the subject matter of the independent claims. Further implementation forms are apparent from the dependent claims, the description and the figures.

[0008] The disclosure is based on the idea that by determining an actual viscosity and/or damping factor (cor-

responding to a temperature) of the fluid, e.g. oil, in the ball balancer, the following spin cycle of the respective appliance can be adapted and thus the appliance can be optimally controlled.

[0009] The idea is to determine the viscosity and/or damping of the oil by evaluating the oscillation signals of the oscillating system. These oscillations are caused by unbalances in spinning which are always existing. In the special case of a balancer appliance, the oscillation caused by the laundry unbalance is overlayed by an unbalance oscillation caused by the rotating balancer balls. For a certain constant under-critical speed, the periodical addition and subtraction of the laundry and ball unbalance there is a so-called envelope curve in the observed signal (e.g. motor current, speed, displacement, etc.).

[0010] This is resulting from the difference in circumferential speed between the drum speed and the speed of the balancer balls. The movement of the balls is influenced by friction, the weight of the balls, damping of the oil and so on, and is less than the drum speed. By detecting the minima and maxima of the envelope curve, the period length can be calculated. The resulting period length is depending on mechanical properties (filling level, surface of the ring, distance between balls and raceway, etc.), the nominal viscosity of the oil at room temperature and the temperature behavior of it and the actual temperature. All influences except the temperature are fixed for certain appliances and the behavior can be determined by experiments. So, the temperature and the corresponding actual viscosity of the oil is proportional to the period length of the envelope curve and can be calculated by a predefined correlation. Based on this information, important decisions about the following spin cycle can be made, e.g. a good starting point and gradient can be chosen for the resonance pass through.

[0011] The implementation of the above described idea provides a novel mechanism and function to realize a controlled resonance pass through in ball balancer appliances. Such a function facilitates the spinning of small items and reduces the number of needed spin attempts. The actual viscosity/damping is necessary as an input to this function. Additionally, a temperature function may be provided that can avoid the necessity of a direct measurement of temperature, e.g. by using additional sensors.

[0012] The appliances and devices described herein-after may be of various types. For example, program-controlled domestic or home appliances may include washing machines, clothes dryers, combined washing/drying machines, drying cabinets, etc. The individual control elements described may be realized by hardware or software components, for example electronic components that can be manufactured by various technologies and include, for example, semiconductor chips, ASICs, microprocessors, digital signal processors, integrated electrical circuits, electro-optical circuits and/or passive components.

[0013] According to a first aspect the invention relates to a home appliance, comprising: a rotary drum fillable

with laundry; a ball balancer attached around the rotary drum, wherein the ball balancer is at least partially filled with a fluid embedding one or more free moving balancer balls to balance a laundry unbalance of the rotary drum; a sensor configured to sense an overlay signal generated due to an overlay of the laundry unbalance with an unbalance of the one or more balancer balls; and a controller configured to determine a viscosity of the fluid based on a predetermined correlation of the viscosity of the fluid with the overlay signal.

[0014] Such a home appliance and corresponding controller provide a novel mechanism and function to realize a controlled resonance pass through in ball balancer appliances. Spinning of small items is facilitated and the number of needed spin attempts can be reduced thereby increasing efficiency of the home appliance.

[0015] In an exemplary implementation form of the home appliance, the controller is configured to determine the viscosity of the fluid based on a characteristic oscillation of the overlay signal.

[0016] This provides the advantage that a known correlation of the characteristic oscillation with the viscosity of the fluid in the ball balancer can be exploited to simplify the control of the home appliance.

[0017] In an exemplary implementation form of the home appliance, the controller is configured to determine the viscosity of the fluid based on an envelope curve of the overlay signal.

[0018] This provides the advantage that the envelope curve of the overlay signal can be easily determined by tracking the overlay signal. Thus, an efficient control of the home appliance with low computational complexity can be provided.

[0019] In an exemplary implementation form of the home appliance, the controller is configured to determine the viscosity of the fluid based on a period length of the envelope curve.

[0020] This provides the advantage that the period length can be easily computed from the envelope curve of the overlay signal. Thus an efficient control of the home appliance with low computational complexity can be provided.

[0021] In an exemplary implementation form of the home appliance, the controller is configured to determine the period length of the envelope curve based on detection of maxima and/or minima of the envelope curve.

[0022] This provides the advantage that the period length of the envelope curve is easy to determine, thereby providing efficient control of the home appliance.

[0023] In an exemplary implementation form of the home appliance, the controller is configured to determine the viscosity of the fluid based on a predetermined proportionality relation of the viscosity of the fluid with the period length of the envelope curve.

[0024] This provides the advantage that the proportionality relation of the viscosity of the fluid with the period length of the envelope curve is known and can be for example stored in a memory of the home appliance for

realizing efficient and low complex control of the home appliance.

[0025] In an exemplary implementation form of the home appliance, the controller is configured to determine the period length of the envelope curve based on predetermined mechanical properties of the home appliance, a filling level of the fluid within the ball balancer, a nominal viscosity of the fluid at room temperature, a known temperature behavior of the fluid and a temperature of the fluid.

[0026] This provides the advantage that these parameters are known in advance and can be easily provided to the controller.

[0027] In an exemplary implementation form of the home appliance, the controller is further configured to determine a temperature of the fluid based on a predetermined correlation of the fluid with the overlay signal.

[0028] This provides the advantage that the temperature of the fluid can be easily determined by tracking the overlay signal. Hence, no temperature sensor is required which simplifies the design of the home appliance.

[0029] In an exemplary implementation form of the home appliance, the controller is configured to determine the temperature of the fluid based on a predetermined proportionality relation of the temperature of the fluid with a period length of an envelope curve of the overlay signal.

[0030] This provides the advantage that the period length can be easily computed from the envelope curve of the overlay signal. Thus, an efficient detection of the temperature of the fluid can be provided without the need of expensive temperature sensors.

[0031] In an exemplary implementation form of the home appliance, the sensor is configured to sense an electrical drive signal of the rotary drum as the overlay signal.

[0032] This provides the advantage that the electrical drive signal can be efficiently sensed, e.g. by using current sensor or voltage sensor or power sensor. The oscillations of the home appliance are mirrored in the electrical drive signal.

[0033] In an exemplary implementation form of the home appliance, the controller is configured to control an electrical drive signal of the rotary drum based on the determined viscosity of the fluid.

[0034] This provides the advantage that the drum can be optimally controlled in order to reduce or even avoid unbalance states at resonance frequencies of the home appliance.

[0035] In an exemplary implementation form of the home appliance, the controller is configured to control a spin cycle of the rotary drum based on the determined viscosity of the fluid.

[0036] This provides the advantage that the number of needed spin attempts can be reduced thereby increasing efficiency of the home appliance. In particular, spinning of small laundry items can be facilitated.

[0037] In an exemplary implementation form of the home appliance, the controller is configured to control a

resonance pass through of the home appliance based on the determined viscosity of the fluid.

[0038] This provides the advantage that the resonance pass through can be performed in minima of the oscillation signal thereby reducing the required energy and saving the home appliance against mechanical stress situations.

[0039] In an exemplary implementation form of the home appliance, the controller is configured to determine a starting point of the rotary drum and a gradient of an electrical signal driving the rotary drum for the resonance pass through of the home appliance.

[0040] This provides the advantage that the home appliance can be controlled to pass through system resonances in minima of the oscillations which can reduce the number of needed spin attempts and extend the life span of the home appliance.

[0041] According to a second aspect, the invention relates to a method for controlling a home appliance comprising a rotary drum fillable with laundry and a ball balancer attached around the rotary drum, wherein the ball balancer is at least partially filled with a fluid embedding one or more free moving balancer balls to balance a laundry unbalance of the rotary drum, wherein the method comprises: sensing an overlay signal generated due to an overlay of the laundry unbalance with an unbalance of the one or more balancer balls; determining a viscosity of the fluid based on a predetermined correlation of the viscosity of the fluid with the overlay signal; and controlling the home appliance based on the determined viscosity of the fluid.

[0042] Such a method for controlling a home appliance provides a novel mechanism and function to realize a controlled resonance pass through in ball balancer appliances. Spinning of small items is facilitated and the number of needed spin attempts can be reduced thereby increasing efficiency of the method.

[0043] According to a third aspect, the invention relates to a controller for controlling a home appliance comprising a rotary drum fillable with laundry and a ball balancer attached around the rotary drum, wherein the ball balancer is at least partially filled with a fluid embedding one or more free moving balancer balls to balance a laundry unbalance of the rotary drum, wherein the controller comprises a circuitry for receiving an overlay signal from a sensor which overlay signal is generated due to an overlay of the laundry unbalance with an unbalance of the one or more balancer balls; a circuitry for determining a viscosity of the fluid based on a predetermined correlation of the viscosity of the fluid with the overlay signal; and a circuitry for controlling the home appliance based on the determined viscosity of the fluid.

[0044] Such a controller for a home appliance provides a novel mechanism and function to realize a controlled resonance pass through in ball balancer appliances. Spinning of small items is facilitated and the number of needed spin attempts can be reduced thereby increasing efficiency of the home appliance.

[0045] According to a fourth aspect, the invention relates to a computer readable non-transitory medium on which computer instructions are stored which when executed by a computer cause the computer to perform the method according to the second aspect.

[0046] Embodiments of the invention can be implemented in hardware and/or software.

BRIEF DESCRIPTION OF THE DRAWINGS

[0047] Further embodiments of the invention will be described with respect to the following figures, wherein:

Fig. 1 shows a schematic diagram illustrating a home appliance 100 according to the disclosure;

Fig. 2 shows a schematic diagram illustrating an exemplary oscillation signal 200 generated by a home appliance when the appliance is in operation;

Fig. 3a shows exemplary correlations of the period length of an oscillation signal generated by the home appliance with the temperature for three different rotation speeds of the drum;

Fig. 3b shows exemplary correlations of the period length of the oscillation signal with the viscosity of the oil within the ball balancer of the home appliance for the three different rotation speeds of the drum; and

Fig. 4 shows a schematic diagram illustrating an exemplary method 400 for controlling a home appliance 100 according to the disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0048] In the following detailed description, reference is made to the accompanying drawings, which form part of the disclosure, and in which are shown, by way of illustration, specific aspects in which the present invention may be placed. It is understood that other aspects may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, as the scope of the present invention is defined by the appended claims.

[0049] For instance, it is understood that a disclosure in connection with a described method may also hold true for a corresponding device or system configured to perform the method and vice versa. For example, if a specific method step is described, a corresponding device may include a unit to perform the described method step, even if such unit is not explicitly described or illustrated in the figures. Further, it is understood that the features of the various exemplary aspects described herein may be combined with each other, unless specifically noted otherwise.

[0050] In the following, home or domestic appliances are described such as washing machines, clothes dryers, combined washing/drying machines, drying cabinets, etc. which include a ball balancer.

[0051] Domestic or home appliances are electrical/mechanical machines which accomplish some household functions, such as cleaning or drying. Given a broad usage, the domestic application attached to "home appliance" is tied to the definition of appliance as "an instrument or device designed for a particular use or function". More specifically, "home appliance" can be defined as: "devices or machines, usually electrical, that are in your home and which you use to do jobs such as cleaning or drying". Home appliances with ball balancer usually include washing machines, dryers or combinations thereof.

[0052] Fig. 1 shows a schematic diagram illustrating a home appliance 100 according to the disclosure. The home appliance 100 may for example be a washing machine or dryer or a washing/drying combination. The home appliance 100 comprises a rotary drum 101 fillable with laundry 102, a ball balancer 103, a sensor 106, a controller 108 and an electrical drive 110. The ball balancer 103 is attached around the rotary drum 101. The ball balancer 103 is at least partially filled with a fluid 104, e.g. oil, embedding one or more free moving balancer balls 105 to balance a laundry 102 unbalance of the rotary drum 101. The drum 101 may be a cylindrical metal sheet in which mechanical recesses or openings may be formed for attaching the balls 105. The balls 105 may for example be included in a ring around the rotary drum 101 which is at least partially filled with the fluid 104, e.g. oil. The ball balancer may be attached at the top or bottom or along a circumference of the cylindrically shaped rotary drum 101.

[0053] The sensor 106 is configured to sense an overlay signal 107 which is generated due to an overlay of the laundry 102 unbalance with an unbalance of the one or more balancer balls 105.

[0054] The controller 108 is configured to determine a viscosity of the fluid 104 based on a predetermined correlation of the viscosity of the fluid 104 with the overlay signal 107, e.g. according to the exemplary curves depicted in Fig. 3b.

[0055] The controller 108 may determine the viscosity of the fluid (104) based on a characteristic oscillation of the overlay signal 107, e.g. a characteristic oscillation 200 as illustrated in Fig. 2. The controller 108 may determine the viscosity of the fluid 104 based on an envelope curve of the overlay signal 107, e.g. an envelope curve 206 as illustrated in Fig. 2. The controller 108 may determine the viscosity of the fluid 104 based on a period length of the envelope curve 206, e.g. a period length 205 as shown in Fig. 2. The controller 108 may determine the period length 205 of the envelope curve 206 for example based on detection of maxima 202 and/or minima 201 of the envelope curve 206 as shown in Fig. 2.

[0056] The controller 108 may be configured to determine the viscosity of the fluid 104 based on a predeter-

mined proportionality relation of the viscosity of the fluid 104 with the period length 205 of the envelope curve 206, e.g. a proportionality relation as shown in Fig. 3b.

[0057] The controller 108 may be configured to determine the period length 205 of the envelope curve 206 for example based on predetermined mechanical properties of the home appliance 100, a filling level of the fluid 104 within the ball balancer 103, a nominal viscosity of the fluid 104 at room temperature, a known temperature behavior of the fluid 104 and a temperature of the fluid 104.

[0058] The controller 108 may further be configured to determine a temperature of the fluid 104 based on a predetermined correlation of the fluid 104 with the overlay signal 107, e.g. a predetermined correlation as shown in Fig. 3a. The controller 108 may be configured to determine the temperature of the fluid 104 based on a predetermined proportionality relation of the temperature of the fluid 104 with a period length 205 of an envelope curve 206 of the overlay signal 107, e.g. as shown in Figs. 2 and 3a.

[0059] The sensor 106 may be configured to sense an electrical drive signal 111 of the rotary drum 101 as the overlay signal 107. The electrical drive signal 111 can be generated by an electrical motor driving the rotary drum 101. This electrical drive signal 111 includes the oscillation property as shown in Fig. 2 and can be used to detect the period length of the oscillation envelope.

[0060] Based on the determined viscosity of the fluid 104, the controller 108 can control the electrical drive signal 111 of the rotary drum 101, e.g. such that an optimal control of the home appliance with respect to energy efficiency can be achieved. In particular, the controller 108 may be configured to control a spin cycle of the rotary drum 101 based on the determined viscosity of the fluid 104.

[0061] The controller 108 may be configured to control a resonance pass through of the home appliance 100 based on the determined viscosity of the fluid 104. The controller 108 may determine a starting point of the rotary drum 101 and a gradient of an electrical signal 111 driving the rotary drum 101 for the resonance pass through of the home appliance 100. Such function of the controller can guarantee an optimal control of the home appliance 100.

[0062] The implementation of the above home appliance provides a novel mechanism and function to realize a controlled resonance pass through in ball balancer appliances. Such a function facilitates the spinning of small items and reduces the number of needed spin attempts. The actual viscosity/damping is necessary as an input to this function. Additionally, a temperature function may be provided that can avoid the necessity of a direct measurement of temperature, e.g. by using additional sensors.

[0063] Fig. 2 shows a schematic diagram illustrating an exemplary oscillation signal 200 generated by a home appliance when the appliance is in operation. The oscillation signal 200 may be a motor current, speed, displacement, etc. The oscillation signal 200 depicted in Fig.

2 illustrates the process how to determine the viscosity and/or damping of the oil. Such an oscillation signal 200 may be caused by unbalances in spinning which are always existing. In the special case of a balancer appliance as shown in Fig. 1, the oscillation caused by the laundry 102 unbalance is overlayed by an unbalance oscillation caused by the rotating balancer balls 105. For a certain constant under-critical speed, the periodical addition and subtraction of the laundry 102 and ball 105 unbalance there is a so-called envelope curve 206 in the observed signal 200 as can be seen from Fig. 2. This is resulting from the difference in circumferential speed between the drum speed and the speed of the balancer balls 105. The movement of the balls 105 is influenced by friction, the weight of the balls 105, damping of the oil or fluid 104 and so on, and is less than the drum speed.

[0064] By detecting the minima 201 and maxima 202 of the envelope curve 206, the period length 205 can be calculated. For example, by tracking the minima 201 of the oscillation signal 200, e.g. the speed 203, the lower envelope curve can be detected from which the amplitude 204 can be calculated. Alternatively, by tracking the maxima 202 of the oscillation signal 200, the upper envelope curve can be detected from which the amplitude 204 can be calculated. The distance in time between two lower (or higher) amplitude values 204 corresponds to the period length 205 as shown in Fig. 2.

[0065] The resulting period length 205 is depending on mechanical properties (filling level, surface of the ring, distance between balls 105 and raceway, etc.), the nominal viscosity of the oil or fluid 104 at room temperature and the temperature behavior of it and the actual temperature. All influences except the temperature are fixed for certain appliances and the behavior can be determined by experiments. So, the temperature and the corresponding actual viscosity of the oil or fluid 104 is proportional to the period length 205 of the envelope curve 206 and can be calculated by a predefined correlation, e.g. as shown in Fig. 3b. Based on this information, important decisions about the following spin cycle can be made, e.g. a good starting point and gradient can be chosen for the resonance pass through.

[0066] The balls 105 are arranged at the optimum position in the ball balancer 103 when a balanced state is reached in which the balls 105 are arranged at the position opposite of the unbalance condition of laundry 102. Such a balanced state is reached at the minima of the oscillation curve 200 depicted in Fig. 2. In contrast, at the maxima of the oscillation curve 200, balancer balls 105 and laundry 102 are located at the same rotational position which increases the system unbalance.

[0067] Fig. 3a shows exemplary correlations of the period length of an oscillation signal generated by the home appliance with the temperature for three different rotation speeds of the drum. A first correlation curve 301 is measured at a speed of 100 rotations per minute (rpm). A second correlation curve 302 is measured at a speed of 110 rpm and a third correlation curve 303 is measured at a

speed of 120 rpm. The time axis indicates the period length. For example, at a speed of 120 rpm, the third correlation curve 303 indicates that a temperature of 50 °C is correlated with a period length of 15 seconds. For example, at a speed of 110 rpm, the second correlation curve 302 indicates that a temperature of 50 °C is correlated with a period length of 10 seconds. Thus, determining the period length results in the corresponding temperature when looking up the respective correlation curves 301, 302, 303.

[0068] Fig. 3b shows exemplary correlations of the period length of the oscillation signal with the viscosity of the oil within the ball balancer of the home appliance for the three different rotation speeds of the drum. A first correlation curve 304 is measured at a speed of 100 rotations per minute (rpm). A second correlation curve 305 is measured at a speed of 110 rpm and a third correlation curve 306 is measured at a speed of 120 rpm. The time axis indicates the period length. For example, at a speed of 110 rpm, the second correlation curve 305 indicates that a viscosity of about 155 square mm per second is correlated with a period length of 15 seconds and a viscosity of about 95 square mm per second is correlated with a period length of 10 seconds. For example, at a speed of 100 rpm, the first correlation curve 304 indicates that a viscosity of about 80 square mm per second is correlated with a period length of about 7,5 seconds. Thus, determining the period length results in the corresponding viscosity when looking up the respective correlation curves 304, 305, 306.

[0069] In Figures 3a and 3b the correlation curves were gathered with fluid 104 or oil filled in the ball balancer up to a level of 50%.

[0070] Fig. 4 shows a schematic diagram illustrating an exemplary method 400 for controlling a home appliance 100 according to the disclosure. The method 400 may be applied for controlling a home appliance 100 as shown in Fig. 1 comprising a rotary drum 101 fillable with laundry 102 and a ball balancer 103 attached around the rotary drum 101, wherein the ball balancer 103 is at least partially filled with a fluid 104, e.g. oil, embedding one or more free moving balancer balls 105 to balance a laundry 102 unbalance of the rotary drum 101.

[0071] The method 400 comprises sensing 401 an overlay signal 107 generated due to an overlay of the laundry 102 unbalance with an unbalance of the one or more balancer balls 105.

[0072] The method 400 comprises determining 402 a viscosity of the fluid 104 based on a predetermined correlation of the viscosity of the fluid 104 with the overlay signal 107, e.g. as shown in Figure 3b.

[0073] The method 400 comprises controlling 403 the home appliance 100 based on the determined viscosity of the fluid 104, e.g. as described above with respect to Fig. 1.

[0074] Another aspect of the disclosure is related to a computer program product comprising program code for performing the methods and procedures or the function-

alities described above, when executed on a computer or a processor. The method may be implemented as program code that may be stored on a non-transitory computer medium. The computer program product may implement the techniques described above. Another aspect of the disclosure is related to a computer readable non-transitory medium on which computer instructions are stored which when executed by a computer cause the computer to perform the method 400 as described above.

[0075] While a particular feature or aspect of the disclosure may have been disclosed with respect to only one of several implementations or embodiments, such feature or aspect may be combined with one or more other features or aspects of the other implementations or embodiments as may be desired and advantageous for any given or particular application. Furthermore, to the extent that the terms "include", "have", "with", or other variants thereof are used in either the detailed description or the claims, such terms are intended to be inclusive in a manner similar to the term "comprise". Also, the terms "exemplary", "for example" and "e.g." are merely meant as an example, rather than the best or optimal. The terms "coupled" and "connected", along with derivatives may have been used. It should be understood that these terms may have been used to indicate that two elements co-operate or interact with each other regardless whether they are in direct physical or electrical contact, or they are not in direct contact with each other.

[0076] Although specific aspects have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations may be substituted for the specific aspects shown and described without departing from the scope of the present disclosure. This application is intended to cover any adaptations or variations of the specific aspects discussed herein.

[0077] Although the elements in the following claims are recited in a particular sequence, unless the claim recitations otherwise imply a particular sequence for implementing some or all of those elements, those elements are not necessarily intended to be limited to being implemented in that particular sequence.

[0078] Many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the above teachings. Of course, those skilled in the art readily recognize that there are numerous applications of the invention beyond those described herein. While the present invention has been described with reference to one or more particular embodiments, those skilled in the art recognize that many changes may be made thereto without departing from the scope of the present invention. It is therefore to be understood that within the scope of the appended claims and their equivalents, the invention may be practiced otherwise than as specifically described herein.

Claims

1. A home appliance (100), comprising:

5 a rotary drum (101) fillable with laundry (102);
a ball balancer (103) attached around the rotary drum (101), wherein the ball balancer (103) is at least partially filled with a fluid (104) embedding one or more free moving balancer balls (105) to balance a laundry (102) unbalance of the rotary drum (101);
10 a sensor (106) configured to sense an overlay signal (107) generated due to an overlay of the laundry (102) unbalance with an unbalance of the one or more balancer balls (105); and
15 a controller (108) configured to determine a viscosity of the fluid (104) based on a predetermined correlation of the viscosity of the fluid (104) with the overlay signal (107).

2. The home appliance (100) of claim 1, wherein the controller (108) is configured to determine the viscosity of the fluid (104) based on a characteristic oscillation (200) of the overlay signal (107).

3. The home appliance (100) of claim 1 or 2, wherein the controller (108) is configured to determine the viscosity of the fluid (104) based on an envelope curve (206) of the overlay signal (107).

4. The home appliance (100) of claim 3, wherein the controller (108) is configured to determine the viscosity of the fluid (104) based on a period length (205) of the envelope curve (206).

5. The home appliance (100) of claim 4, wherein the controller (108) is configured to determine the period length (205) of the envelope curve (206) based on detection of maxima (202) and/or minima (201) of the envelope curve (206).

6. The home appliance (100) of claim 4 or 5, wherein the controller (108) is configured to determine the viscosity of the fluid (104) based on a predetermined proportionality relation of the viscosity of the fluid (104) with the period length (205) of the envelope curve (206).

7. The home appliance (100) of one of claims 4 to 6, wherein the controller (108) is configured to determine the period length (205) of the envelope curve (206) based on predetermined mechanical properties of the home appliance (100), a filling level of the fluid (104) within the ball balancer (103), a nominal viscosity of the fluid (104) at room temperature, a known temperature behavior of the fluid (104) and a temperature of the fluid (104).

8. The home appliance (100) of one of the preceding claims,
wherein the controller (108) is further configured to determine a temperature of the fluid (104) based on a predetermined correlation of the fluid (104) with the overlay signal (107). 5
9. The home appliance (100) of claim 8,
wherein the controller (108) is configured to determine the temperature of the fluid (104) based on a predetermined proportionality relation of the temperature of the fluid (104) with a period length (205) of an envelope curve (206) of the overlay signal (107). 10
10. The home appliance (100) of one of the preceding claims,
wherein the sensor (106) is configured to sense an electrical drive signal (111) of the rotary drum (101) as the overlay signal (107). 15
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11. The home appliance (100) of one of the preceding claims,
wherein the controller (108) is configured to control an electrical drive signal (111) of the rotary drum (101) based on the determined viscosity of the fluid (104). 25
12. The home appliance (100) of one of the preceding claims,
wherein the controller (108) is configured to control a spin cycle of the rotary drum (101) based on the determined viscosity of the fluid (104). 30
13. The home appliance (100) of one of the preceding claims,
wherein the controller (108) is configured to control a resonance pass through of the home appliance (100) based on the determined viscosity of the fluid (104). 35
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14. The home appliance (100) of claim 13,
wherein the controller (108) is configured to determine a starting point of the rotary drum (101) and a gradient of an electrical signal (111) driving the rotary drum (101) for the resonance pass through of the home appliance (100). 45
15. A method (400) for controlling a home appliance (100) comprising a rotary drum (101) fillable with laundry (102) and a ball balancer (103) attached around the rotary drum (101), wherein the ball balancer (103) is at least partially filled with a fluid (104) embedding one or more free moving balancer balls (105) to balance a laundry (102) unbalance of the rotary drum (101), wherein the method (400) comprises: 50
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sensing (401) an overlay signal (107) generated

due to an overlay of the laundry (102) unbalance with an unbalance of the one or more balancer balls (105);
determining (402) a viscosity of the fluid (104) based on a predetermined correlation of the viscosity of the fluid (104) with the overlay signal (107); and
controlling (403) the home appliance (100) based on the determined viscosity of the fluid (104).

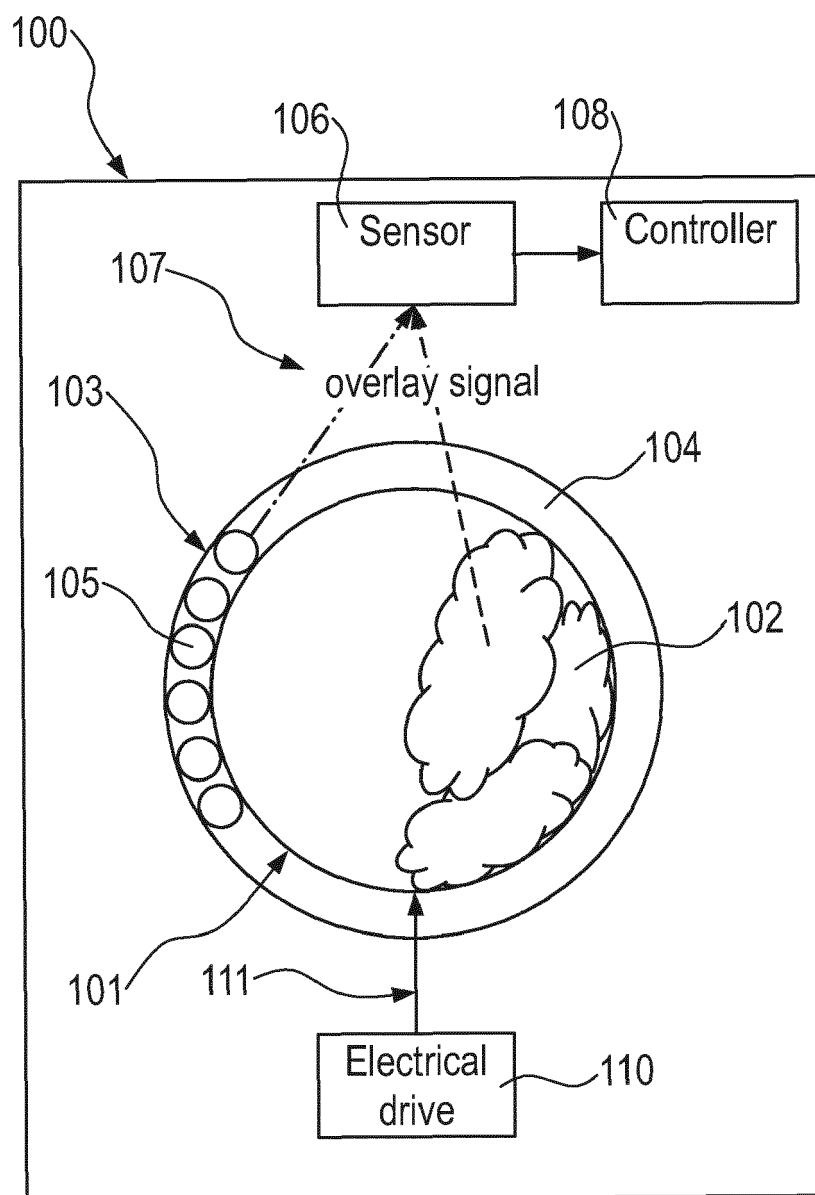


Fig. 1

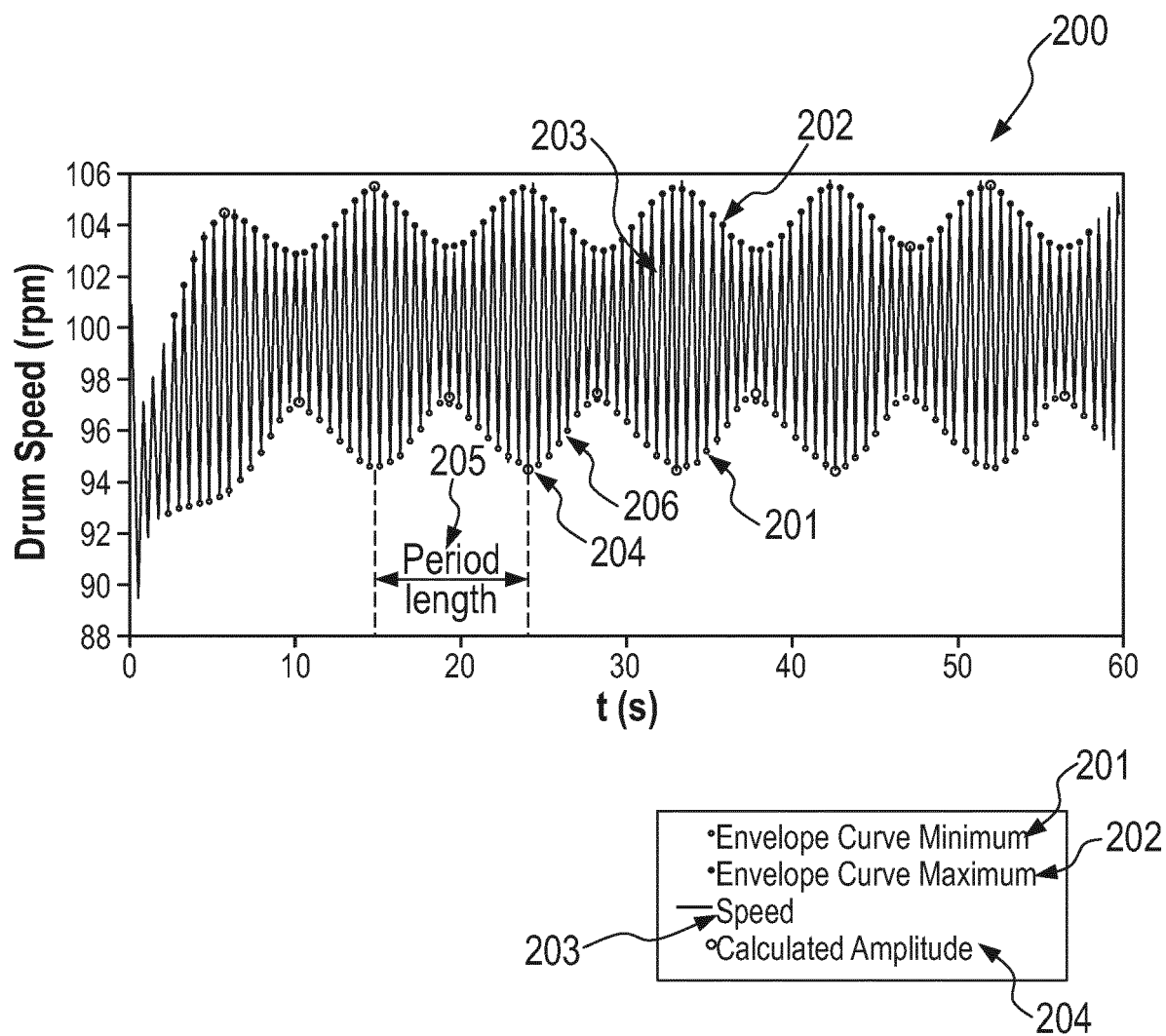
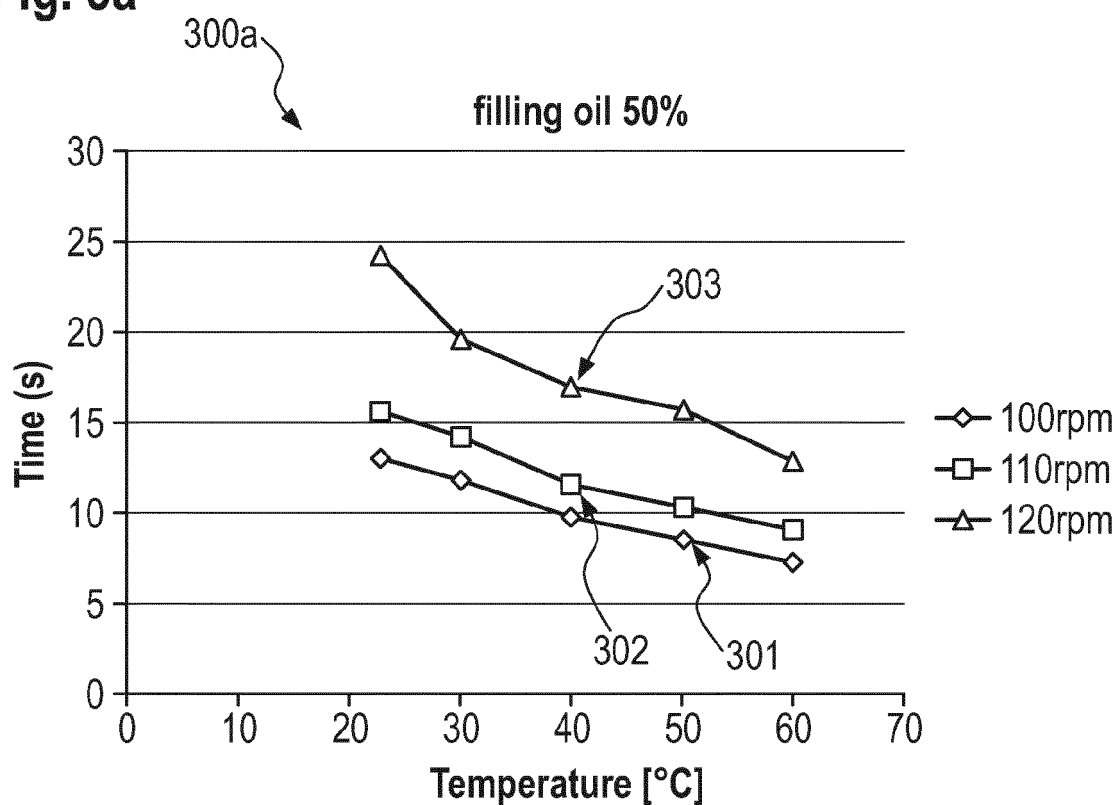
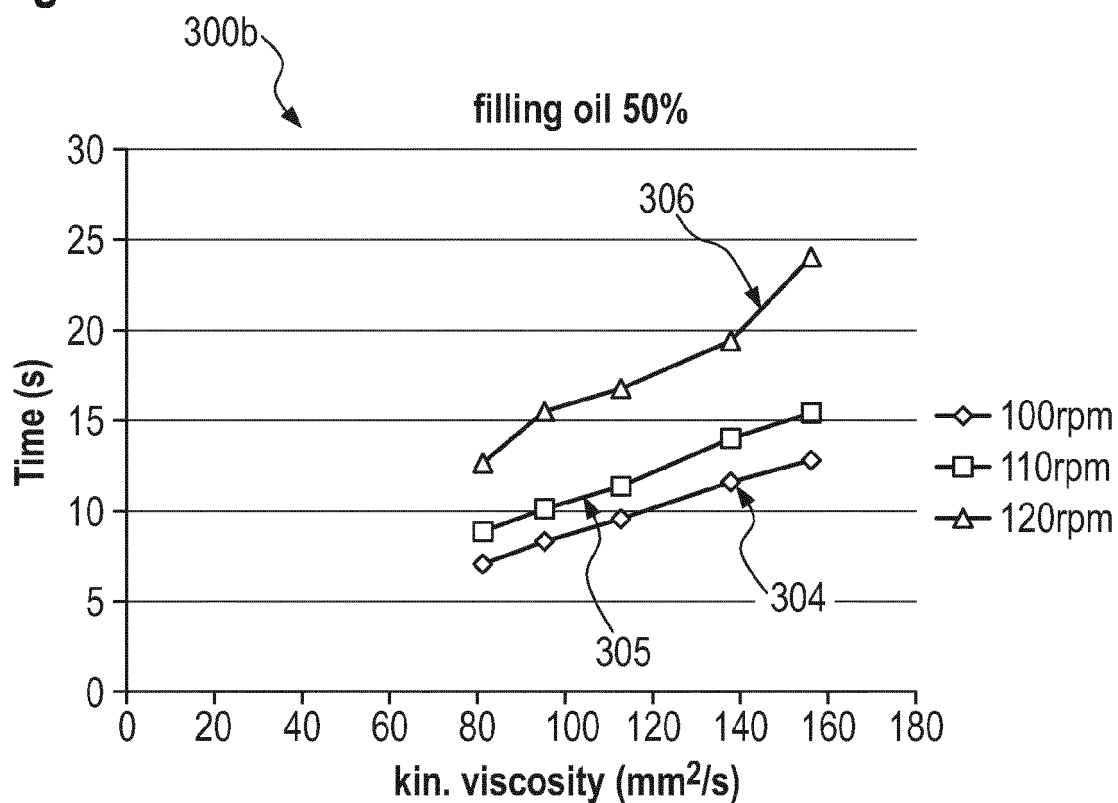


Fig. 2

Fig. 3a**Fig. 3b**

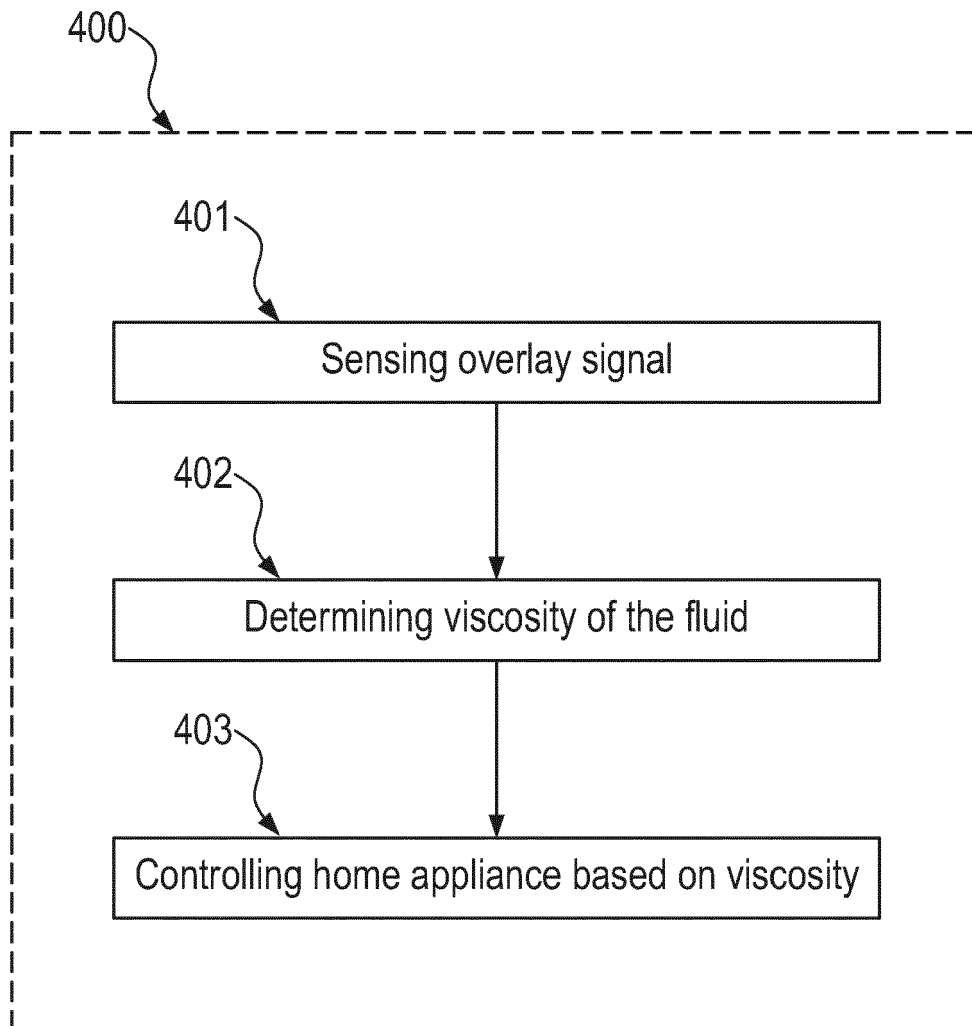


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 19 15 9962

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CATEGORY OF CITED DOCUMENTS 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 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			

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