



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
17.01.2024 Bulletin 2024/03

(21) Application number: **23183402.9**

(22) Date of filing: **04.07.2023**

(51) International Patent Classification (IPC):
D06F 33/48 ^(2020.01) **D06F 23/02** ^(2006.01)
D06F 25/00 ^(2006.01) **D06F 34/16** ^(2020.01)
D06F 103/04 ^(2020.01) **D06F 105/46** ^(2020.01)
D06F 105/52 ^(2020.01)

(52) Cooperative Patent Classification (CPC):
D06F 33/48; D06F 34/16; D06F 23/02; D06F 25/00;
D06F 58/52; D06F 2103/04; D06F 2105/46;
D06F 2105/52

(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 ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **12.07.2022 IT 202200014575**

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(54) **METHOD FOR BALANCING THE LOAD OF LINEN IN A LINEN TREATMENT MACHINE, AND A LINEN TREATMENT MACHINE**

(57) A method for balancing the load of linen in a linen drum (5) in a washing machine (1) or tumble dryer, comprises

- before performing a spinning step (27), carrying out a linen load balancing check step (29) and a linen mass determination step (31), and:

- in the case of a balanced load, perform the spinning step (27),

- in the case of an unbalanced load, not enabling the spinning step (27) and performing a linen load balancing step (29) through a sequence of movements of the linen drum (5) at lower speeds than the rotation speed of the linen drum (5) during the spinning step (27) and, after the balancing step (29), repeating the linen load balancing check step (28) until the load of linen is balanced with respect to the balancing check step (29),

- in the case of an unbalanced load, before performing the linen load balancing step (29), comparing (32) the determined mass of linen with a reference mass value indicative of a low load of linen, and

- if the determined mass of linen is greater than the reference mass value, performing the linen load balancing step (29) through a first drum movement sequence (29'),

- if the determined mass of linen is less than the reference mass value, performing the linen load balancing step (29) through a second drum movement sequence (29'') dif-

ferent from the first sequence of movements.

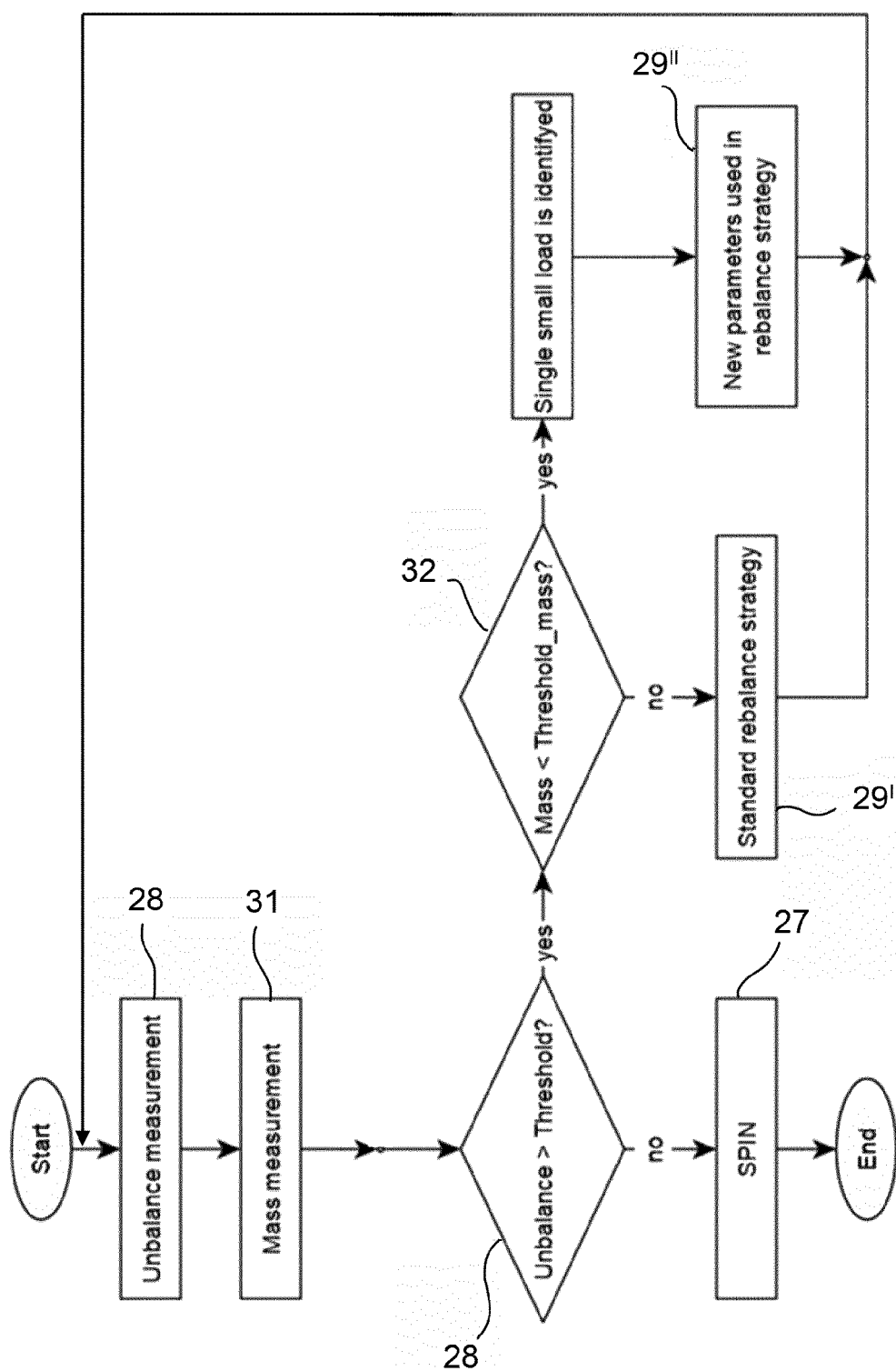


FIG. 5

Description

[0001] The present invention relates to a method for balancing the load of linen in a linen treatment machine, in particular a washing machine or tumble dryer.

[0002] It is known that machines for washing and/or drying linen can include, when performing an operating program thereof, one or more spinning steps, i.e., steps of rotating the drum at a much higher speed than that normally provided during the washing or drying steps. In some linen washing or drying machines, the speed reachable by the drum during the spinning steps can be much higher than 1000 rpm, for example.

[0003] If, during the spinning steps, the linen load is unbalanced, i.e., arranged inside the linen drum in a non-even manner, for example concentrated in some areas and not present in other areas, during the rotation of the drum at high speeds, the load unbalancing could cause significant vibrations, which cannot be tolerated in a domestic environment and are harmful to the appliance itself.

[0004] For this reason, known washing machines or tumble dryers with a spin function implement a linen balancing method in the drum, comprising the steps of:

- before carrying out a spinning step, checking the balance of the linen load, i.e., checking whether the mass of linen is evenly distributed with respect to the rotation axis of the linen drum,
- in the case of a balanced load, enabling the performance of the spinning step,
- in the case of an unbalanced load, not enabling the spinning step and
- performing a linen load balancing step, by a predetermined sequence of movements of the drum and,
- at the end of the balancing step, checking the balance of the linen load again,

until, from the balancing check, the linen load is balanced.

[0005] It is known to carry out the linen load balancing check step by comparing the detected current values of the motor which drives the linen drum with a reference current value.

[0006] It is also known to perform the linen load balancing check step by comparing the detected values of the rotational speed of the linen drum or motor which drives the linen drum with a reference speed value.

[0007] It is also known to perform the linen load balancing check step by comparing the detected values of acceleration of the linen drum with a reference acceleration value.

[0008] Methods and systems are also known for determining the mass of linen or the mass of the combination of linen and linen drum in washing machines or tumble dryers, for example by detecting the weight of the linen drum, or for example by detecting a braking time of the linen drum under predetermined motion conditions, or for example depending on detected electrical quanti-

ties of the drive motor, indicative of the electrical power absorbed by the electric motor to accelerate the rotating linen drum.

[0009] However, known linen balancing methods and systems have some drawbacks, which (according to the inventors) can be especially attributed to the fact that the linen load balancing step consists of a single and unique predetermined drum movement sequence which is repeated without any variation until the linen load is distributed evenly enough.

[0010] The known linen balancing strategy does not take into account the fact that the reasons for the unbalancing of the linen in the washing machine drum can be different, for example rolled-up linen items of different sizes and weights, multiple linen items intertwined or rolled up together, a large single linen item, such as a sweatshirt, a bathrobe, a sheet, etc.

[0011] Furthermore, the known linen balancing strategy does not take into account the degree of linen load unbalancing which can instead vary considerably, for example between an unbalancing just above an acceptable threshold value and an unbalancing much higher than the acceptable threshold value. In concrete physical terms, the center of the overall mass of the drum with the linen can be slightly or very distant from the rotation axis of the drum.

[0012] Since a single, unique, and predetermined sequence of drum balancing movements will not be optimal for all possible linen unbalancing scenarios and reasons, the (repeated) linen balancing steps of the prior art are undesirably time-consuming and expensive in terms of electricity.

[0013] In particular, in the presence of single items (for example a bathrobe), the best strategy for an even distribution of the linen load cannot be that of separating and distributing single (rolled up) items about the rotation axis of the linen drum. On the contrary, in this case it is more convenient to try and open and stretch out the individual large linen item and spread it along the circumference of the linen drum.

[0014] It is thus the object of the present invention to provide an improved method for balancing the linen load in a washing machine or tumble dryer, and an improved washing machine or tumble dryer having features such as to overcome at least partially the drawbacks mentioned with reference to the prior art.

[0015] A particular object of the present invention is to provide a linen balancing method and a linen treatment machine, in particular a linen washing machine or a tumble dryer, having characteristics such as to reduce the time, and possibly the expenditure of electrical energy, required to balance the load of linen in the drum of the machine, in preparation for a drum rotation step at high rotational speed, in particular a spinning step.

[0016] It is a further particular object of the invention to provide a linen balancing method and a linen treatment machine, having features such as to balance the linen in a more targeted manner for the two distinct situations of

a full load with lots of small and medium sized items and a low load with medium or large sized individual items (for example a bathrobe or a sweatshirt).

[0017] These and other objects are achieved by a linen balancing method according to claim 1 and by a washing machine or tumble dryer according to claim 12.

[0018] The dependent claims relate to advantageous and preferred embodiments.

[0019] According to an aspect of the invention, a linen treatment machine comprises:

- a housing,
- a linen drum for containing the linen to be washed, pivotally supported about a rotation axis, where the linen drum delimits a loading opening, closable by means of a door connected to the housing, for the loading and unloading of the linen to be washed,
- an electric motor functionally connected to the linen drum to rotate the linen drum about the rotation axis,
- a linen treatment system configured to perform, on the linen inside the linen drum, one or more treatment steps which are different from the rotation of the linen drum, said treatment steps comprising one or more of:

- washing the linen by means of soaking in water and detergent,
- drying the linen by means of forced ventilation,

- an electronic control system in signal connection with the electric motor, with the treatment system, and with a user interface for the selection of a treatment program from a plurality of treatment programs,

where the electronic control system is configured to control the electric motor and the treatment system depending on the treatment program selected by means of the user interface,

where the electronic control system comprises a balancing check module for the linen in the linen drum, where the user interface is configured to allow the selection and start of a treatment program which comprises a spinning step,

where the electronic control system is configured to carry out, in response to the start of the treatment program which comprises the spinning step, before performing the spinning step, a balancing check of the load of linen, and:

- in the case of a balanced load, enable the performance of the spinning step,
- in the case of an unbalanced load, not enable the spinning step and perform a step of balancing the load of linen, through a sequence of movements of the drum at lower speeds than the rotation speed of the linen drum during the spinning step and, after the balancing step, repeat the balancing check on the load of linen,

until, as a result of the balancing check step, the load of linen is considered balanced,

characterized in that the electronic control system comprises a module for determining the mass of linen contained in the linen drum and is configured to carry out, in response to the start of the treatment program which comprises the spinning step, before performing the spinning step, a determination of the mass of linen contained in the linen drum, and:

- in the case of an unbalanced load, before performing the balancing step of the load of linen, compare the determined mass of linen with a reference mass value indicative of a low load of linen, and:
- if the determined mass of linen is greater than the reference mass value, perform the step of balancing the load of linen through a first sequence of movements of the drum,
- if the determined mass of linen is less than the reference mass value, perform the step of balancing the load of linen through a second sequence of movements of the drum different from the first sequence of movements.

[0020] This allows balancing the linen in a more targeted manner for the two distinct situations of full load with lots of small and medium sized items and low load with medium or large sized individual items (for example a bathrobe or a sweatshirt).

[0021] Due to the differentiated balancing strategy with different and targeted balancing drum movement sequences for different load situations, it is possible to reduce the time, and thus the expenditure of electricity, required to balance the load of linen before the spinning step.

[0022] Likewise, according to a further aspect of the invention, a method for balancing the load of linen in a linen drum in a washing machine or tumble dryer, comprises:

starting a linen treatment program which includes a spinning step, before performing the spinning step, carrying out a balancing check of the load of linen, and:

- in the case of a balanced load, performing the spinning step,
- in the case of an unbalanced load, not enabling the spinning step and performing a step of balancing the load of linen, through a sequence of movements of the drum at lower speeds than the rotation speed of the linen drum during the spinning step and, after the balancing step, repeating the balancing check on the load of linen, until, as a result of the balancing check step, the load of linen is considered balanced,

characterized by carrying out, before the spinning step, a determination of the mass of linen contained in the linen drum, and:

- in the case of an unbalanced load, before performing the balancing step of the load of linen, compare the determined mass of linen with a reference mass value indicative of a low load of linen, and;
- if the determined mass of linen is greater than the reference mass value, perform the step of balancing the load of linen through a first sequence of movements of the drum,
- if the determined mass of linen is less than the reference mass value, perform the step of balancing the load of linen through a second sequence of movements of the drum different from the first sequence of movements.

[0023] Further advantageous aspects of the invention will become apparent from the following description of some embodiments thereof, given by way of non-limiting example, with reference to the accompanying drawings, in which:

- figure 1 is a diagrammatic section view of a washing machine, tumble dryer or washer-dryer according to an embodiment of the invention;
- figures 2 and 3 show diagrams of examples of methods with linen balancing check steps and with linen balancing steps for washing machines or tumble dryers of the prior art, described in EP0732437A1, where the ordinate indicates the rotational speed of a linen drum, the abscissa the time, and the continuous curve indicates predetermined sequences of movement of the drum during balancing check steps and during linen rebalancing steps, while the broken line curved branches indicate the start of a spinning step following the determination that the linen load is sufficiently balanced.

Figure 4 shows a further exemplary diagram of a method with linen balancing check steps and linen balancing steps for washing machines or tumble dryers,

Figure 5 shows a block diagram of the linen load balancing method according to an embodiment of the invention,

Figure 6.1 shows a rotational speed diagram of a linen drum according to a first drum movement sequence of a linen drum balancing step (ordinate = rotational speed of the linen drum, abscissa = time), according to an embodiment,

Figure 6.2 shows a rotational speed diagram of a linen drum according to a second drum movement sequence of a linen drum balancing step (ordinate = rotational speed of the linen drum, abscissa = time), according to an embodiment.

[0024] With reference to the drawings, a washing machine 1 or washer-dryer comprises a supporting and housing structure 2, in which a washing tank 3 is housed, provided with a (frontal or peripheral) opening closable by a door 4, e.g., a porthole door, hinged frontally to or on top of housing 2. A linen drum 5 to accommodate the linen to be washed is housed inside the washing tub 3 in a rotatable manner about a rotation axis R-R, e.g., horizontal or inclined. The linen drum 5 can also delimit a front opening positioned at the opening of the washing tub 3 or a peripheral closable opening, in order to load and unload the linen.

[0025] The washing machine comprises a linen treatment system 3, 6, 7, 8, 9, 12, 13, 18, 20, 21 configured to perform one or more treatment steps on the linen inside the linen drum 5, in particular linen washing steps by soaking in water and detergent and/or linen drying steps by forced ventilation.

[0026] The washing tank 3 is adapted to contain the washing liquid during the linen washing steps.

[0027] A washing water filling system 6 connectable to the water mains is provided to allow filling the washing tank 3 with mains water. The filling system 6 can comprise a plurality of ducts which extend from, for example, one or more, e.g., two, supply solenoid valves 7, 8, directly or through detergent compartments of a detergent tray 9, to the washing tank 3.

[0028] A drainage duct 11 with associated drainage pump 12 which removes the washing liquid from tank 3 and which, together with the supply solenoid valves 7, 8, controls the level of liquid inside tank 3, is connected to the bottom 10 of the washing tank 3.

[0029] An electrical resistor 13 arranged inside the tank 3, in particular at the tank bottom 10, in the gap between the wall of the tank 3 and the linen drum 5, can be provided to heat the washing liquid contained in the tank 3.

[0030] The washing machine 1 can further comprise a dispensing system 18 of the "multiple dose" type for dispensing substances for treating the linen.

[0031] In addition or alternatively to the detergent tray 9, the dispensing system 18 comprises, for example, a plurality of reservoirs 19 for containing the treatment substances, e.g., detergent for resistant white items, detergent for delicate colored items, detergent for wool, perfuming substances, enzymes, fixing substances and/or fabric softener. The plurality of reservoirs 19 can be positioned, for example, in the porthole door 4, in the detergent tray 9, or in the housing 2, and the individual reservoirs 19 are dimensioned to each contain a sufficient volume of the treatment substance for a plurality of washing cycles.

[0032] The washing machine 1 can further comprise a system 20 for recirculating the washing liquid from the bottom of the tank 10 to the linen drum 5.

[0033] The washing machine 1 can further comprise a drying system 21, e.g., a drying air circuit 22 having conveying means 23, air heating means 24, and moisture condensing means 25 of the conveyed air.

[0034] For agitating and remixing the linen with the washing liquid, the linen drum 5 can be driven in rotation by an electric motor 14 and a transmission 15, e.g., a belt transmission.

[0035] The operation of the washing machine 1 is controlled by an electronic control system 16 in signal connection with the electric motor 14, with the treatment system 3, 6, 7, 8, 9, 12, 13, 18, 20, 21 and with a user interface 17 for the selection of a treatment program from a plurality of treatment programs.

[0036] The user interface 17 can be positioned at an outer wall or door 4 of housing 2, or at an electronic device separate from housing 2. In response to the selections made by the user by means of the user interface 17, the control unit 16 drives the various components of the washing machine 1 to automatically wash and/or dry the linen.

[0037] The electronic control system 16 is configured to control the electric motor 14 and the treatment system 3, 6, 7, 8, 9, 12, 13, 18, 20, 21 depending on the treatment program selected by means of the user interface.

[0038] The electronic control system 16 comprises a balancing check module 26 for the linen in the linen drum 5,

[0039] The user interface 17 is configured to allow the selection and start of a treatment program comprising a spinning step 27, where the linen drum 5 is rotated at a spin speed greater than 200 rpm, or at a spin speed in the range of 200 rpm to 1200 or 1600 rpm.

[0040] The electronic control system 16 is configured to carry out, in response to the start of the treatment program which comprises the spinning step 27, before performing the spinning step 27, a balancing check 28 of the load of linen, and:

- in the case of a balanced load, enable and perform the spinning step 27,
- in the case of an unbalanced load, not enable the spinning step 27 and perform a linen load balancing step 29, through a sequence of movements of the linen drum 5 at lower speeds than the rotation speed of the linen drum 5 during the spinning step 27 and, after the balancing step 29, repeat the balancing check 28 of the load of linen until the load of linen is considered balanced by balancing check step 28.

[0041] The electronic control system 16 comprises a module 30 for determining the mass of linen contained in the linen drum 5 and is configured to carry out, in response to the start of the treatment program which includes the spinning step 27, before performing the spinning step 27, a determination 31 of the mass of linen contained in the linen drum 5, and:

- in the case of an unbalanced load, before performing the step 29 of balancing the load of linen, compare (in a mass comparison step 32) the mass of linen determined with an indicative reference mass value

for a low load of linen, and:

- if the determined mass of linen is greater than the reference mass value, perform the step 29 of balancing the load of linen through a first sequence 29' of movements of the linen drum 5,
- if the mass of linen determined is less than the reference mass value, perform the step 29 of balancing the load of linen through a second sequence 29" of movements of the linen drum 5 different from the first sequence 29' of movements.

Description of the balancing check step 28

[0042] Methods and systems for checking the balancing of the load of linen in washing machines or tumble dryers are well known to those skilled in the art, therefore they are not described in detail herein. Such known systems and methods can also be used in the washing machine or tumble dryer according to the invention, as well as in the method according to the invention.

[0043] According to an embodiment, the balancing check step 28 comprises:

- a detection of electric current absorbed by the electric motor 14 which drives the linen drum 5,
- a calculation of a variation of the electric current absorbed depending on the electric current detected, and
- a comparison of the variation of electric current absorbed with a reference current variation value,

where:

- when the calculated electric current variation is greater than the reference current variation value, the load of linen is determined as unbalanced, and
- when the calculated electric current variation is less than the reference current variation value, the load of linen is determined as balanced.

[0044] According to a further embodiment, the balancing check step 28 comprises:

- a detection of a rotational speed of the linen drum 5 or of the electric motor 14 which drives the linen drum 5,
- a calculation of a rotary speed variation depending on the detected rotary speed, and
- a comparison of the calculated variation of rotary speed with a reference speed variation value,

where:

- when the calculated rotary speed variation is greater than the reference speed variation value, the load of linen is determined as unbalanced, and
- when the calculated rotary speed variation is less than the reference speed variation value, the load of

linen is determined as balanced.

[0045] According to a further embodiment, the balancing check step 28 comprises:

- a detection of an acceleration or vibration of the linen drum 5 and
- a comparison of the acceleration or vibration of the linen drum with a reference acceleration or vibration value,

where:

- when the detected acceleration or vibration is greater than the reference acceleration or vibration value, the load of linen is determined as unbalanced, and
- when the detected acceleration or vibration is less than the reference acceleration or vibration value, the load of linen is determined as unbalanced.

Description of the linen mass determination step 30

[0046] Methods and systems for determining the mass of linen in washing machines or tumble dryers are well known to those skilled in the art, therefore they are not described in detail herein. Such known systems and methods can also be used in the washing machine or tumble dryer according to the invention, as well as in the method according to the invention. In the context of the present description, the term "mass of linen" denotes the mass or weight or a parameter indicative of the mass or weight of both the linen alone (i.e., the linen without the linen drum 5) and the assembly of the linen drum 5 and the linen contained therein. Those skilled in the art know that it can be easier to detect or determine the mass of the assembly of drum 5 and linen, rather than the mass of linen alone, but those skilled in the art also know that the former is indicative of the latter and that the mass or weight of the drum is however known.

[0047] According to an embodiment, the linen mass determination step 30 comprises:

- a step of detecting the weight of the linen drum 5 containing the linen, or
- a step of detecting a braking time of the linen drum 5 under predetermined motion conditions and a step of comparing the detected braking time with one or more predetermined braking time values (or curves) indicative of corresponding linen mass values, or

a step of detecting one or more electric magnitudes of the drive motor 14 of the linen drum 5, for example the absorbed electric current, indicative of the electric power absorbed by the electric motor 14 to accelerate the rotating linen drum 5, and a step of comparing the detected electrical magnitude values, or of values calculated depending on them, with reference values indicative of the mass of linen.

Description of the mass comparison step 32

[0048] According to an embodiment, the mass reference value (threshold_mass in figure 5) can be a predetermined value, for example constant, specific for the washing machine 1 or the tumble dryer, lower than a maximum mass of linen provided for the washing machine or tumble dryer, for example a value corresponding to 1/5 or 1/4 of a maximum mass of linen provided for the washing machine or tumble dryer.

[0049] According to an embodiment, the mass reference value is less than a maximum linen mass provided for the washing machine or tumble dryer and is determined according to a calculated linen unbalancing level, e.g., by the balancing check module 26.

[0050] The linen unbalancing level is, for example, the difference between an unbalancing value (for example the aforementioned speed variation value, or current variation absorbed by the electric motor 14, or in the amplitude of vibrations or acceleration of the linen drum 5) and an admissible unbalancing reference value.

[0051] According to an embodiment, for a lower unbalancing level range, the system and method use a lower mass reference value, and for a higher unbalancing level range, greater than the lower unbalancing range, the system and method use a higher mass reference value greater than the lower mass reference value. It is thus possible to take into account the fact that in the presence of high unbalancing levels, the mass threshold between a high mass situation and a low mass situation also shifts upwards.

Description of the first drum movement sequence 29' and the second balancing drum movement sequence 29"

[0052] According to an embodiment, the first drum movement sequence 29' comprises an acceleration value R_Smart of the linen drum 5 with an acceleration value less than a corresponding acceleration value of an acceleration step R_Smart of the linen drum (5) of the second drum movement sequence 29". Higher acceleration has proven to be advantageous for opening and stretching out individual linen items and spreading them along the circumference of the linen drum 5, under conditions in which the linen drum 5 is not very full of linen. On the contrary, lower acceleration has proven to be advantageous for separating and distributing a plurality of linen items in the condition in which the linen drum 5 is very full.

[0053] With further advantage, the first drum movement sequence 29' comprises a step at constant rotation speed S_Reverse, before the aforesaid acceleration step R_Smart, lasting less time than a corresponding step at constant rotation speed S_Reverse, before the aforesaid acceleration step R_Smart, of the second sequence 29" of drum movement (figures 6.1, 6.2).

[0054] Both the first 29' and second 29" drum movement sequences can comprise one or more steps of in-

verting the rotation direction of the linen drum 5. This has proven to be advantageous in the case of high unbalancing values.

[0055] On the contrary, if the system or method determines a low unbalancing value, both the first 29' and second 29" drum movement sequences can be free from rotation direction inversion of the linen drum 5.

[0056] The distinction between a high unbalancing value and a low unbalancing value takes place by comparing the unbalancing value with a predetermined higher threshold value.

[0057] According to embodiments (figures 6.1, 6.2), the first drum movement sequence 29' and the second drum movement sequence 29" both comprise, in the order (figures 6.1 and 6.2, from left to right):

an initial deceleration ramp parameter R_REVERSE_DEC from a check drum speed S_UNB to a stop of the linen drum 5 (this is an acceleration parameter),
 a duration parameter of the drum stop at zero speed (this is a duration parameter),
 a reverse acceleration ramp parameter RAMP R_REVERSE_INV after the drum has stopped at zero speed in the opposite direction to the direction of the check drum speed S_UNB, until a maximum reverse balancing speed is reached S_REVERSE (this is an acceleration parameter),
 a drum rotation duration parameter T_REVERSE at the maximum reverse balancing speed S_REVERSE (this is a duration parameter),
 a reverse balancing maximum speed parameter S_REVERSE (this is a speed parameter),
 a deceleration ramp parameter R_REVERSE_DEC from the reverse balancing maximum speed S_REVERSE to a further stop of the linen drum 5 (this is an acceleration parameter),
 a duration parameter of the further drum stop at zero speed (this is a duration parameter),
 a second acceleration ramp parameter RAMP R_REVERSE_INV after the further drum stop at zero speed in the direction of the check drum speed S_UNB, until an intermediate balancing speed is reached S_REVERSE (this is an acceleration parameter),
 a drum rotation duration parameter at the intermediate balancing speed S_REVERSE (this is a duration parameter),
 a balancing intermediate speed parameter S_REVERSE (this is a speed parameter),
 a third acceleration ramp parameter RAMP R_Smart, after the drum rotation step at the intermediate balancing speed S_REVERSE, in the direction of the check drum speed S_UNB, until the check drum speed S_UNB or a second intermediate balancing speed is reached (not shown), this is an acceleration parameter.

[0058] The check drum speed S_UNB during the balancing check step 28 is preferably invariable.

[0059] According to an embodiment, the sequence of movements of the linen drum 5 during the balancing step 29 is characterized by one or more drum motion parameters selected from the group of:

- rotational acceleration value in a first rotation direction,
- maximum speed value in the first rotation direction,
- value of time spent at maximum speed in the first rotation direction,
- rotational acceleration value in a second rotation direction,
- maximum speed value in the second rotation direction,
- value of time spent at maximum speed in the second rotation direction,
- value of intermediate time spent by the drum at intermediate rotary speed levels (including possible zero speed)
- intermediate speed value of the drum.

[0060] The drum motion parameters of the first drum movement sequence 29' are different from the motion parameters of the second drum movement sequence 29".

Description of the linen balancing method

[0061] According to an aspect of the invention, a method for balancing the load of linen in a linen drum 5 in a washing machine 1 or tumble dryer, comprises:

starting a linen treatment program comprising a spinning step 27, where the linen drum 5 is rotated at a spin speed greater than 200 rpm, or at a spin speed in the range of 200 rpm to 1600 rpm, before performing the spinning step 27, carrying out a balancing check step 29 of the load of linen, and:

- in the case of a balanced load, performing the spinning step 27,
- in the case of an unbalanced load, not enabling the spinning step 27 and performing a linen load balancing step 29, through a sequence of movements of the linen drum 5 at lower speeds than the rotation speed of the linen drum 5 during the spinning step 27 and, after the balancing step 29, repeating the linen load balancing check step 28 until, as a result of the balancing check step 28, the load of linen is considered balanced,
- before the spinning step 27, carrying out a step 31 of determining the mass of linen contained in the linen drum 5, and:
- in the case of an unbalanced load, before per-

forming the linen load balancing step 29, comparing (32) the determined mass of linen with a reference mass value indicative of a low load of linen, and:

- if the determined mass of linen is greater than the reference mass value, performing the linen load balancing step 29 through a first sequence 29' of movements of the drum,
- if the determined mass of linen is less than the reference mass value, performing the linen load balancing step 29 through a second sequence 29" of movements of the drum different from the first sequence 29' of movements.

[0062] The further steps of the method and embodiments of the method are the same as described above with reference to the washing machine 1 or tumble dryer, but with the understanding that not all embodiments require the specific hardware (electronic control system 16, user interface 17, balancing check module 26, linen mass determination module 30), which is thus optional, described in relation to the washing machine 1 and tumble dryer.

List of Reference numerals

[0063]

washing machine 1
 supporting and housing structure 2
 washing tank 3
 door 4
 rotation axis R-R
 linen drum 5
 treatment system 3, 6, 7, 8, 9, 12, 13, 18, 20, 21
 water loading system 6
 supply solenoid valves 7,8
 detergent tray 9
 tank bottom 10
 discharge pipe 11
 discharge pump 12
 electrical resistor 13
 electric motor 14
 transmission 15
 electronic control system 16
 user interface 17
 multiple-dose dispensing system 18
 treatment substance reservoirs 19
 washing liquid recirculation system 20
 drying system 21
 drying air circuit 22
 conveying means 23
 heating means 24
 condensation means 25
 balancing check module 26
 spinning step 27
 balancing check step 28
 balancing step 29

first drum movement sequence 29'
 second drum movement sequence 29"
 linen mass determination module 30
 linen mass determination step 31
 mass comparison step 32

Claims

1. A method for balancing the load of linen in a linen drum (5) in a machine for treating linen, in particular a washing machine (1) or tumble dryer, comprising:
 - before performing a spinning step (27), carrying out a linen load balancing check step (29), and:
 - in the case of a balanced load, performing the spinning step (27),
 - in the case of an unbalanced load, not enabling the spinning step (27) and performing a linen load balancing step (29), through a sequence of movements of the linen drum (5) at lower speeds than the rotation speed of the linen drum (5) during the spinning step (27) and, after the balancing step (29), repeating the linen load balancing check step (28) until, as a result of the balancing check step (28), the load of linen is considered balanced,

characterized by the steps of:

- before the spinning step (27), carrying out a step (31) of determining the mass of linen contained in the linen drum (5) and,
 - in the case of an unbalanced load, before performing the linen load balancing step (29), comparing (32) the determined mass of linen with a reference mass value indicative of a low load of linen, and
 - if the determined mass of linen is greater than the reference mass value, performing the linen load balancing step (29) through a first drum movement sequence (29'),
 - if the determined mass of linen is less than the reference mass value, performing the linen load balancing step (29) through a second drum movement sequence (29") different from the first movement sequence (29').
2. A method according to claim 1, wherein the reference mass value (threshold_mass) is a predetermined constant value, specific for the washing machine (1) or tumble dryer, wherein the reference mass value (threshold_mass) is less than a maximum allowable mass of linen, or a value of 1/5 or 1/4 of the maximum allowable mass of linen.

3. A method according to claim 1 or 2, wherein the reference mass value (threshold_{mass}) is less than a maximum allowable mass of linen and is determined according to a linen balancing value calculated by the balancing check module (26).

4. A method according to any one of the preceding claims, wherein the first drum movement sequence (29') comprises an acceleration value of the linen drum (5) less than a corresponding acceleration value of the linen drum (5) of the second drum movement sequence (29").

5. A method according to any one of the preceding claims, wherein both the first (29') and second (29") drum movement sequences comprise one or more steps of inverting the rotation direction of the linen drum (5) when an unbalancing value of the load of linen is determined as greater than an upper unbalancing threshold.

6. A method according to any one of the preceding claims, wherein both the first (29') and second (29") drum movement sequences are free from rotation direction inversion of the linen drum (5) when an unbalancing value of the load of linen is determined as less than an upper unbalancing threshold and greater than an allowable unbalancing reference value.

7. A method according to any one of the preceding claims, wherein the second drum movement sequence (29") is performed with different speed and acceleration parameters and operating times of the linen drum (5) with respect to the first drum movement sequence (29').

8. A method according to any one of the preceding claims, wherein the balancing check step (28) comprises:

- a detection of electric current absorbed by the electric motor (14) which drives the linen drum (5),
- a calculation of a variation of the electric current absorbed depending on the electric current detected, and
- a comparison of the variation of electric current absorbed with a reference current variation value,

where:

- when the calculated electric current variation is greater than the reference current variation value, the load of linen is determined as unbalanced, and
- when the calculated electric current variation is less than the reference current variation value,

the load of linen is determined as balanced.

9. A method according to any one of claims 1 to 7, wherein the balancing check step (28) comprises:

- a detection of a rotational speed of the linen drum (5) or the electric motor (14) which drives the linen drum (5),
- a calculation of a rotary speed variation depending on the detected rotary speed, and
- a comparison of the calculated variation of rotary speed with a reference speed variation value,

where:

- when the calculated rotary speed variation is greater than the reference speed variation value, the load of linen is determined as unbalanced, and
- when the calculated rotary speed variation is less than the reference speed variation value, the load of linen is determined as balanced.

10. A method according to any one of claims 1 to 7, wherein the balancing check step (28) comprises:

- a detection of an acceleration or vibration of the linen drum (5), and
- a comparison of the acceleration or vibration of the linen drum with a reference acceleration or vibration value,

where:

- when the detected acceleration or vibration is greater than the reference acceleration or vibration value, the load of linen is determined as unbalanced, and
- when the detected acceleration or vibration is less than the reference acceleration or vibration value, the load of linen is determined as unbalanced.

11. A method according to any one of the preceding claims, wherein the step (30) of determining the mass of linen comprises:

- a step of detecting the weight of the linen drum (5) containing the linen, or
- a step of detecting a braking time of the linen drum (5) under predetermined motion conditions and a step of comparing the detected braking time with one or more predetermined braking time values (or curves) indicative of corresponding linen mass values, or
- a step of detecting the electric current absorbed by the electric motor (14) which drives the linen

drum (5) during an acceleration of the linen drum (5) in rotation, and a step of comparing values calculated depending on the detected current with one or more reference values indicative of the mass of linen.

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12. A machine for treating linen, in particular a washing machine (1) or tumble dryer, comprising:

- a housing (2),
- a linen drum (5) for containing the linen to be washed, pivotally supported about a rotation axis (R-R), wherein the linen drum (5) delimits a loading opening, closable by means of a door (4) connected to the housing (2), for loading and unloading the linen to be washed,
- an electric motor (14) functionally connected to the linen drum (5) to rotate the linen drum (5) about the rotation axis (R-R),
- a linen treatment system (3, 6, 7, 8, 9, 12, 13, 18, 20, 21) configured to perform, on the linen inside the linen drum (5), one or more treatment steps which are different from the rotation of the linen drum (5), comprising linen washing steps by means of soaking in water and detergent and/or linen drying steps by means of ventilation,
- an electronic control system (16) in signal connection with the electric motor (14), the treatment system (3, 6, 7, 8, 9, 12, 13, 18, 20, 21) and with a user interface (17) for the selection of a treatment program from a plurality of treatment programs,

wherein the electronic control system (16) is configured to control the electric motor (14) and the treatment system (3, 6, 7, 8, 9, 12, 13, 18, 20, 21) depending on the treatment program selected by means of the user interface (17), wherein the electronic control system (16) comprises a balancing check module (26) for the linen in the linen drum (5), wherein the user interface (17) is configured to allow the selection and start of a treatment program which comprises a spinning step (27), wherein the electronic control system (16) is configured to:

- carry out, in response to the start of the treatment program which comprises the spinning step (27), before performing the spinning step (27), a balancing check (28) of the load of linen, and:
- in the case of a balanced load, perform the spinning step (27),
- in the case of an unbalanced load, not enable the spinning step (27) and perform a linen load balancing step (29), through a sequence of movements of the linen drum (5)

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at lower speeds than the rotation speed of the linen drum (5) during the spinning step (27) and, after the balancing step (29), repeat the balancing check (28), until, as a result of the balancing check step (28), the load of linen is considered balanced.

characterized in that the electronic control system (16) comprises a module (30) for determining the mass of linen in the linen drum (5) and is configured to:

- before performing the spinning step (27), carry out a determination (31) of the mass of linen contained in the linen drum (5),
- in case of an unbalanced load, before performing the step (29) of balancing the load of linen, compare (32) the mass of linen determined with an indicative reference mass value for a low load of linen, and
- if the determined mass of linen is greater than the reference mass value, perform the step (29) of balancing the load of linen through a first movement sequence (29') of the linen drum (5),
- if the mass of linen determined is less than the reference mass value, perform the step (29) of balancing the load of linen through a second movement sequence (29'') of the linen drum (5) different from the first movement sequence (29').

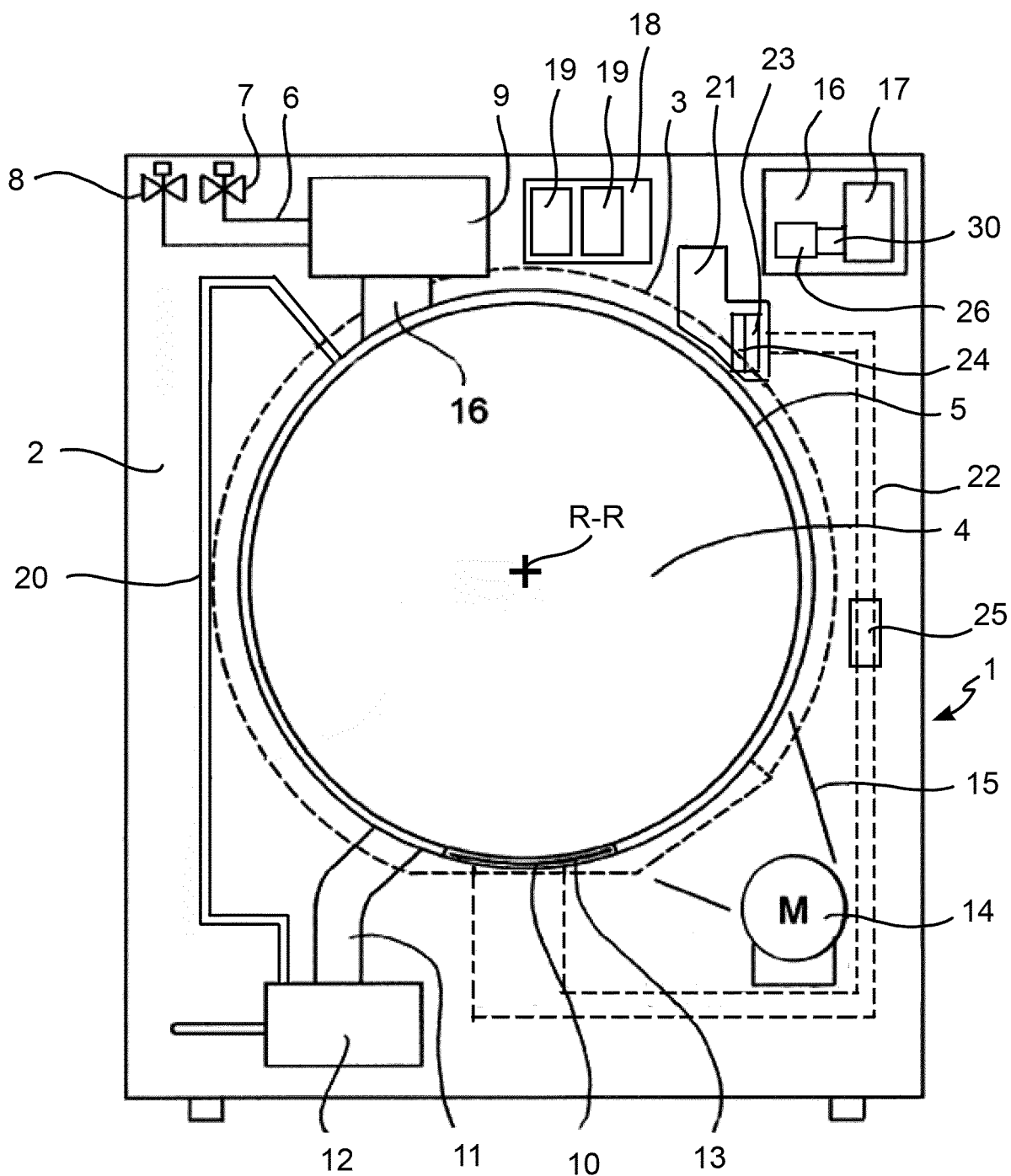


FIG. 1

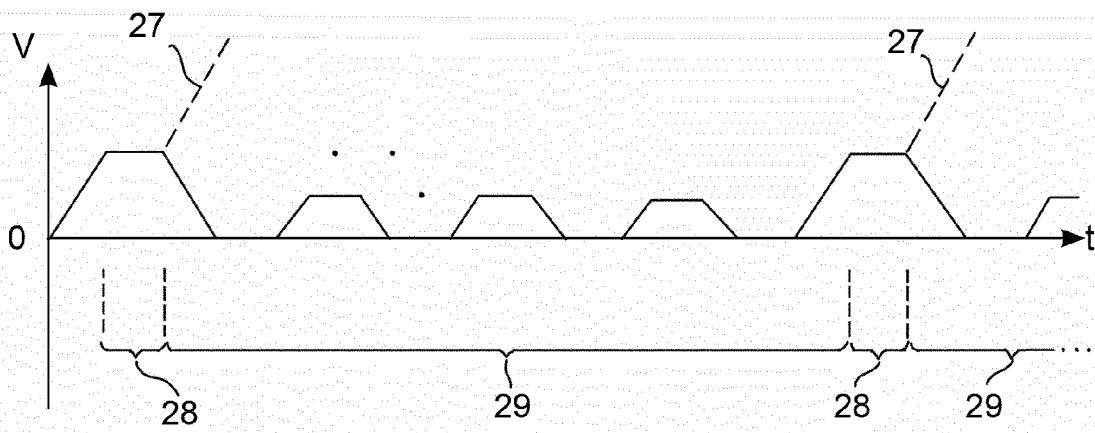


FIG. 2

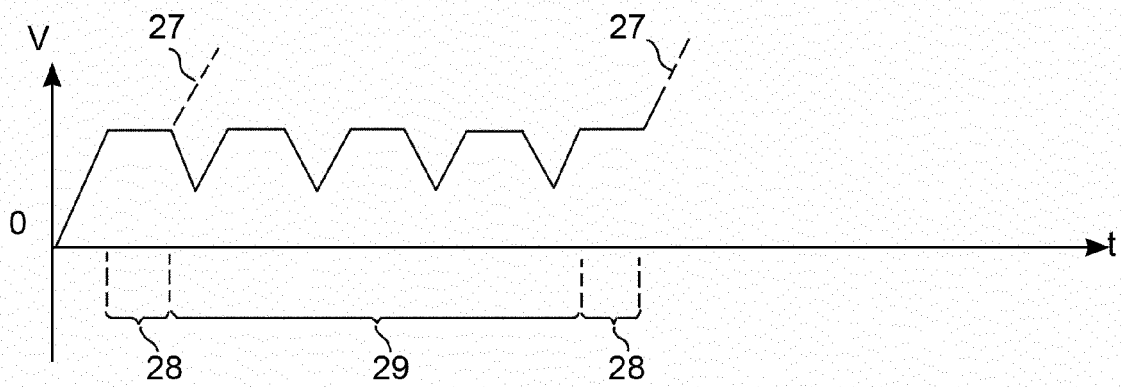


FIG. 3

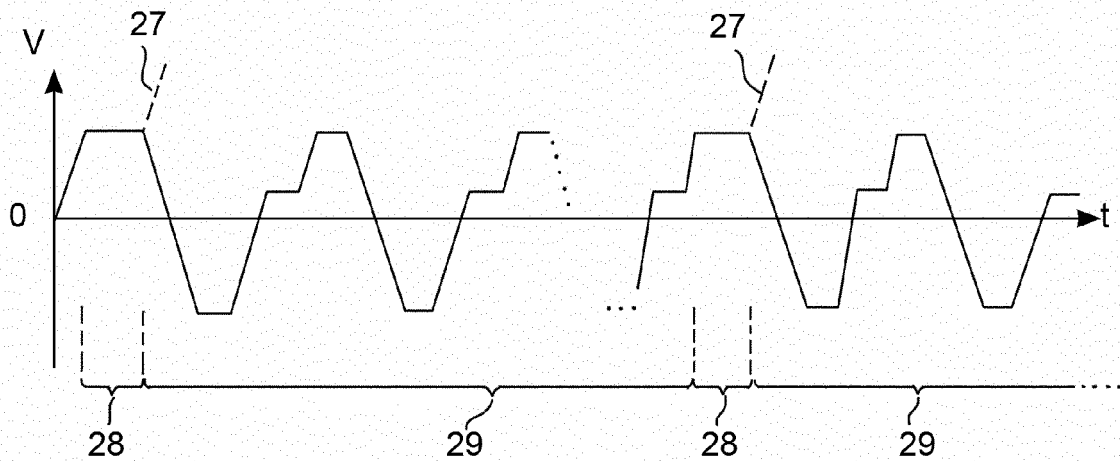


FIG. 4

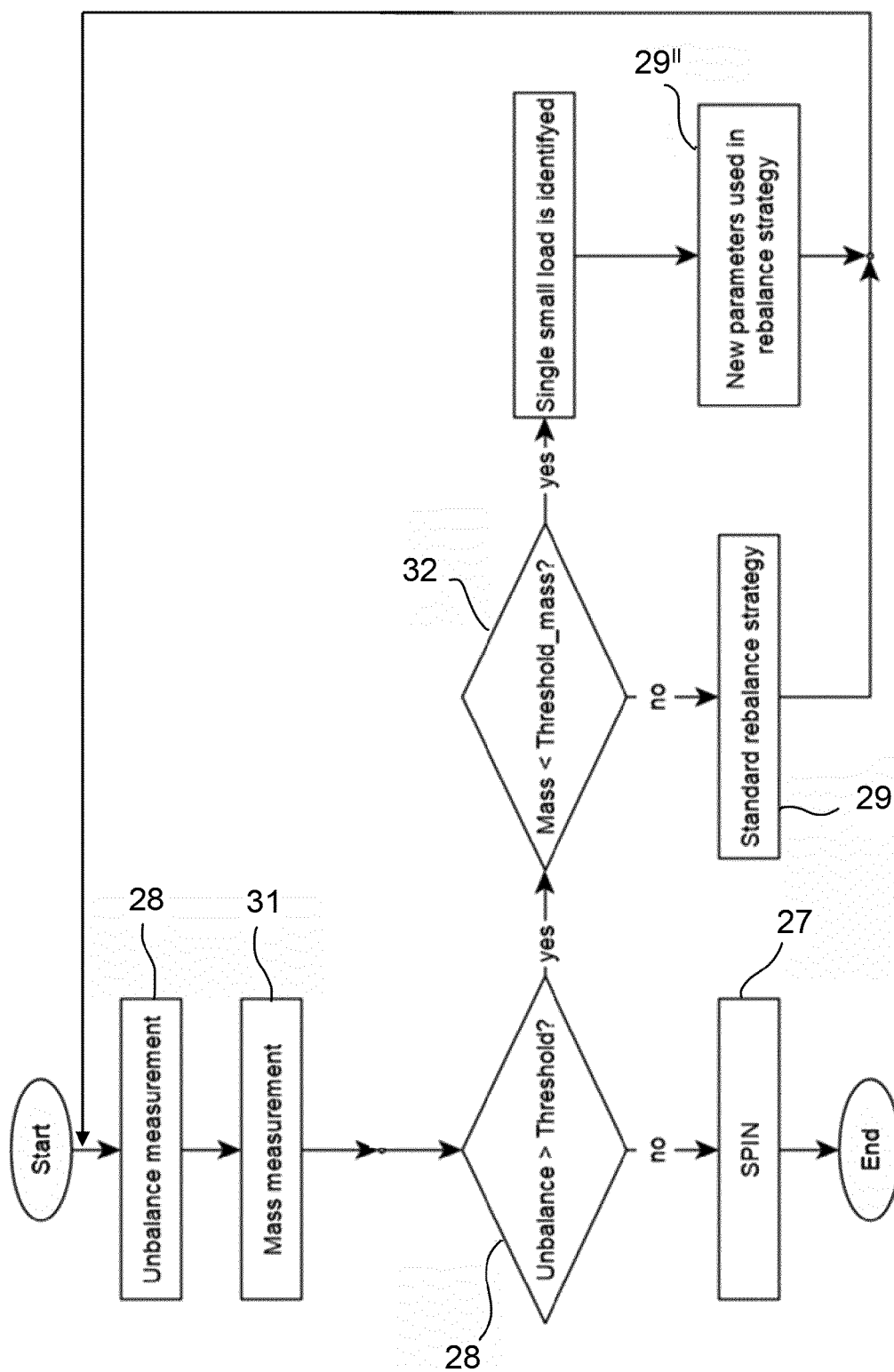


FIG. 5

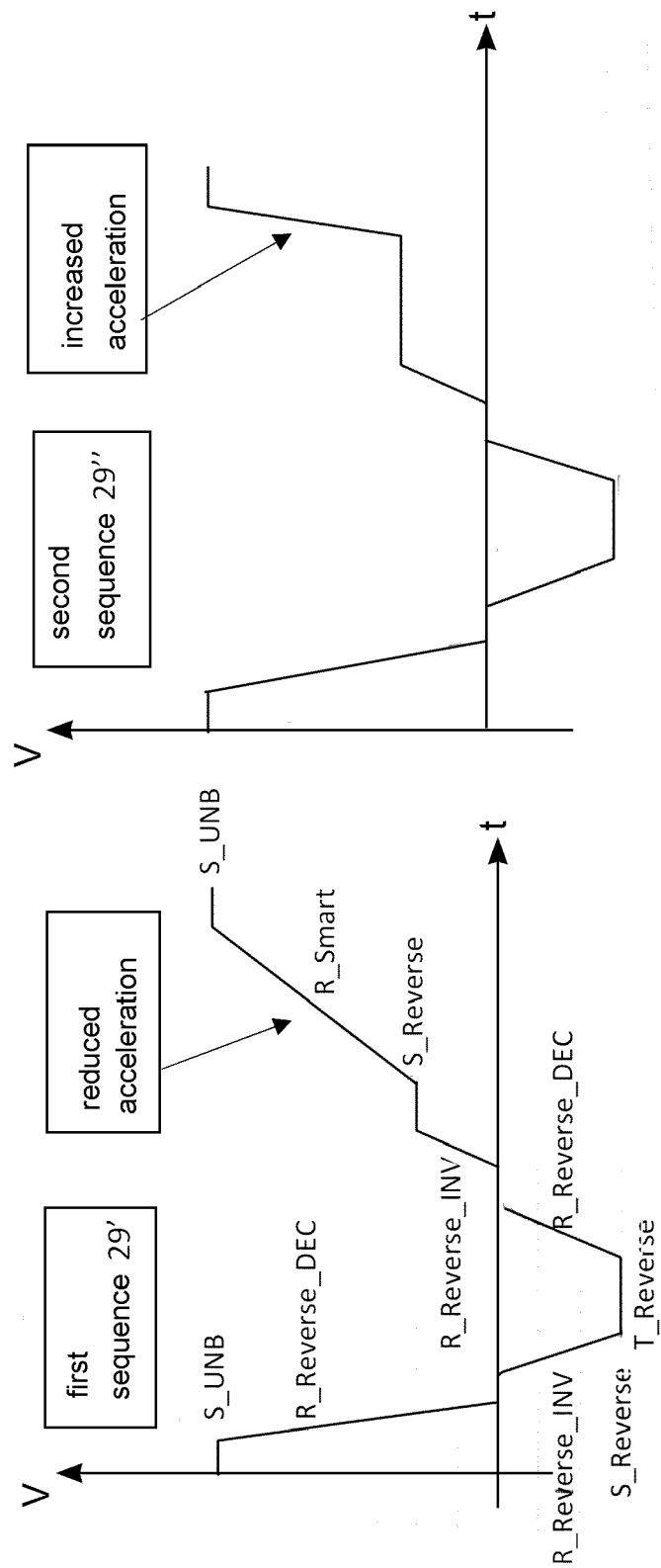


FIG. 6.2

FIG. 6.1



EUROPEAN SEARCH REPORT

Application Number

EP 23 18 3402

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 1 November 2023	Examiner Rakotonanahary, S
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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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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01-11-2023

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