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(54) **A MACHINE FOR TEXTILE PROCESSING, A METHOD OF OPERATION OF THE MACHINE, AND RELATED COMPUTER PROGRAM AND COMPUTER READABLE MEDIUM**

(57) A machine for processing textile products, comprising: - a drum (1) configured for receiving textile products and extending lengthwise between a first end portion (11) and a second end portion (12); - a plurality of contacting elements (4), attached to an inner surface (3) of the drum (1), and configured such that, when the drum rotates at a rotation speed within a predetermined initial range, the contacting elements (4) cause the textile products to move within the drum towards a predetermined end portion of the drum depending on the rotation direction of the drum; and - a plurality of chambers (6, 7) configured to be controllably and selectively filled with a liquid while the drum (1) is rotating, each chamber (6, 7) being arranged such that, when the respective chamber (6, 7) contains liquid, its centre of mass is radially separated from a rotation axis of the drum.

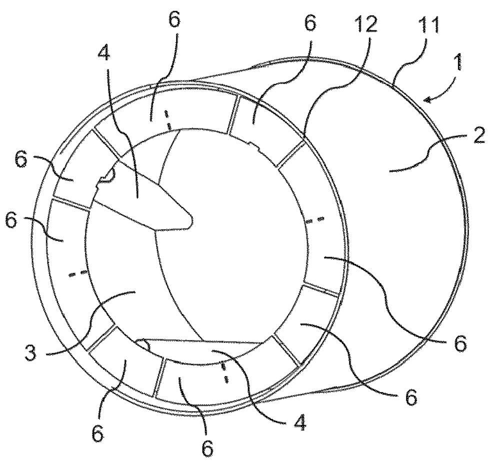

FIG. 3A

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Description

Technical Field

[0001] The present disclosure concerns a machine (or system) for textile processing and a related method of operation of the machine. Said method can also be considered as being a method for controlling a rotating unbalance (rotating imbalance) in the machine. The present disclosure further concerns a software for using in (with) such a machine or system, and a related computer readable medium.

Background

[0002] There are several known types of machines for textile processing, e.g. washing machines or dryers, comprising a rotatable tumbler in which there are placed the textiles for being processed. Commonly, in such a machine, upon rotation of the tumbler, especially at high speeds, the tumbler (which may also be called drum) may be or become imbalanced, i.e. exhibit rotating unbalance, due to an uneven distribution and/or movement of the textiles within the tumbler. The rotating unbalance may cause the vibration of the tumbler, the uncontrollable change of the tumbler's rotation speed, or even the damage of the machine, particularly the damage of the transmission means and/or of the motor which are commonly used for rotating the tumbler. Said imbalance, and any uncontrolled change of the rotation speed of the tumbler, may in turn affect the processing or finishing of the textiles in the tumbler, and cause the formation of undesired defects and inhomogeneities on said textiles.

[0003] Various attempts have been made to balance the rotating drums machines for processing textile products. However, these prior art solutions have encountered significant limitations that compromise their effectiveness and overall performance.

[0004] One conventional approach is the use of fixed counterweights attached to the drum or the appliance frame. While counterweights can partially reduce vibrations, they often fail to achieve optimal balance due to the inherent limitations of static weights. This can result in residual vibrations during operation, leading to excessive noise, wear and tear, and reduced washing or drying efficiency.

[0005] Another common technique involves the implementation of suspension springs to minimize drum imbalance. Although suspension springs provide some degree of dynamic balancing, they are unable to completely eliminate vibrations, particularly when confronted with unevenly distributed loads. As a consequence, washing machines or tumble dryers equipped with suspension springs may still exhibit substantial oscillations, affecting their stability and performance.

[0006] Certain prior art solutions propose the use of adjustable feet or levelling legs to compensate for an unbalanced drum. However, these mechanisms primarily address static imbalances and are not effective in dynamically balancing the drum during rotation. Consequently, the vibrations generated during operation remain largely unaddressed, leading to suboptimal performance and potential damage to the appliance or surrounding environment.

[0007] Some prior art designs utilize passive dampening systems, such as rubber or foam pads, to absorb vibrations. While these solutions can attenuate some degree of vibrations, they often fail to provide sufficient balance, especially when dealing with heavy or irregular loads. Moreover, passive dampening systems may deteriorate over time, resulting in reduced effectiveness and the need for frequent maintenance.

[0008] Overall, the aforementioned prior art solutions suffer from deficiencies in achieving effective dynamic balancing of the drum during rotation. Consequently, they exhibit limited success in reducing vibrations, optimizing performance, and ensuring the longevity of washing machines or tumble dryers.

[0009] The present invention aims to overcome these disadvantages and provide an improved balancing mechanism for the rotating drums of washing machines or tumble dryers. By addressing the deficiencies of the prior art, the invention seeks to enhance stability, minimize vibrations, and optimize the overall performance of these appliances.

[0010] It is therefore required to control the rotating unbalance. The present disclosure provides solutions to this problem.

Summary of the Invention

[0011] The present invention offers a solution to the problem of how to control rotating unbalance in a machine for textile processing. Some non-limiting examples of such a machine is a washing machine, a tumbler drier, a drier or a machine for finishing the textiles using a liquid, a chemical compound, a spray, a gas, a solid (e.g. stones), a compound or other medium. The tumbler may be a drum. The machine comprising the tumbler may be used for processing one or more textiles (i.e. textile products). Some non-limiting examples of textiles that may be processed with the machine are garments, clothes, cloths, towels, home textiles, leathers, fabrics, denims, articles of clothing, or others.

[0012] The tumbler may be a drum. The machine comprising the tumbler may be used for processing one or more textiles (i.e. textile products). Some non-limiting examples of textiles that may be processed with the machine are garments, clothes, cloths, towels, home textiles, leathers, fabrics, denims, articles of clothing, or others.

[0013] A first aspect of the invention refers to a machine for processing textile products, the machine comprising a drum, a plurality of contacting elements and a plurality of chambers (i.e. compartments). The drum comprises a surface which is configured to define (i.e. delimit) an inner compartment configured for receiving textile products. The surface comprises an inner/internal face (also called inner surface) and an outer/external face, wherein the inner face is the one facing the inner compartment for receiving textile products. The drum is configured to extend lengthwise along a longitudinal geometric axis between a first end portion and a second end portion of the drum, and being adapted to be rotated about said longitudinal geometrical axis. The drum may comprise or may be connected to a rotation means configured for causing the drum to rotate (e.g. a motor). Each end portion corresponds respectively either to a front part of the drum or to a rear part of the drum. For example, the first end potion may correspond to the front part of the drum, while the second end portion may correspond to the rear part, or vice versa.

[0014] The plurality of contacting elements (e.g. comprising 2 to 8 contacting elements, preferably 3 to 6, more preferably 4 or 5) are attached to the inner surface of the drum, wherein said contacting elements are configured to interact with the textile products to cause them to move along at least a part of the length of the drum when the drum rotates at a rotation speed being within a predetermined initial range, wherein the longitudinal direction of advance is dependent on the direction of rotation of the drum. In other words, the contacting elements may be configured such that, when the drum rotates at a rotation speed being within the predetermined initial range in a first rotation direction, the contacting elements cause the textile products to move within the drum along a longitudinal direction aligned with the longitudinal geometric axis towards the first end portion of the drum; and/or the contacting elements may be configured such that, when the drum rotates at a rotation speed being within the predetermined initial range in a second rotation direction being reverse to the first rotation direction, the contacting elements cause the textile products to move within the drum along the longitudinal direction aligned with the longitudinal geometric axis towards the second end portion of the drum.

[0015] Thus, the predetermined initial range comprises rotation speeds which are configured such that, when the drum rotate at said speeds, the textile products receive a centrifugal force causing them to shake within the tumbler and/or to be in contact with the inner surface of the tumbler with a contact force (e.g. a force normal to the surface of the drum extending substantially radially from the longitudinal central axis) allowing them to move relative to said inner surface due to the interaction with the contacting elements. Accordingly, the predetermined initial range is configured such that, when the drum rotates at a rotation speed being within said predetermined initial range, the contact force received by the textile products (i.e. the force with which the textile products are pressed against the inner surface of the drum and the contacting elements) is not high enough to cause them to be in a stable position inside the drum (i.e. to jam/stick against the inner surface).

[0016] In some embodiments, the predetermined initial range may comprise a plurality of pre-sets adapted to ensure that the textile products are permitted to move along the drum for different loads/weights (e.g. of textile products) introduced within the drum (i.e. within the inner compartment) of the machine. The diameter of the drum (which is a parameter of the design of the machine, having influence in the volume of the inner compartment) is also determinant to define the rotation speeds included within the predetermined initial range. According to some embodiments, the machine may be dimensioned/configured such that the predetermined initial range may comprise rotation speeds lower than 50 rpm, preferably lower than 40 rpm. In some embodiments the machine may further comprise means configured to detect/sense the load inserted into the compartment of the drum, so that the predetermined initial range may be adapted to the detected/sensed load.

[0017] The plurality of chambers are configured to be controllably and selectively filled with a liquid, preferably while the drum is rotating. In the context of the present invention, selectively filled means that each chamber (i.e. individually) is configured to be at least partially filled with an amount of liquid. Optionally, the plurality of chambers may be further configured to be selectively emptied (e.g. at least partially emptied) of liquid. Preferably, the liquid is water. The plurality of chambers are arranged such that, when the respective chamber is partially or totally filed with liquid, its centre of mass is radially separated from the longitudinal geometrical axis. Thus, each chamber is configured as a variable mass, which is arranged at a distance (i.e. at a radius distance) from the axis of rotation of the drum (i.e. the longitudinal geometrical axis) that can be selectively activated.

[0018] In preferred embodiments, the plurality of chambers may comprise: a first group of chambers arranged at the first end portion of the drum, preferably within the drum (e.g. arranged in contact with the inner surface of the drum); and/or a second group of chambers arranged at the second end portion of the drum, preferably within the drum. In preferred embodiments the plurality of chambers may comprise a group (first or second) arranged at the end portion of the drum corresponding to the rear portion of the drum, i.e. the portion being arranged opposite to the front end portion, which may comprise a door. In those embodiments for which a group (first or second) of chambers is arranged at the end portion where a door is arranged (this end portion being frequently the front end portion of the drum) to allow the introduction of textile products into the inner compartment of the drum, said group of chambers is configured to surround the door, thereby allowing a normal process of loading the inner compartment with textile products through the corresponding door. Preferably, the chambers of the first and/or of the second group of chambers may be configured such that at least a part of the chambers of (i.e. belonging to) a same group have an equivalent size and/or volume capacity.

[0019] The first group of chambers and/or the second group of chambers may comprise a number of chambers being in the range 3 to 40, preferably 6 to 20, more preferably 8 to 12.

[0020] Preferably, the chambers of the first and/or of the second group of chambers may be arranged to at least partially surround (i.e. to at least partially encircle) the longitudinal geometrical axis. Preferably, at least a part of the chambers may be in lateral contact to each other (i.e. adjacent to each other) such that, when all the chambers of a group are configured this way, they completely surround the longitudinal geometrical axis, e.g. the chambers of at least one of the groups may be configured as a disc-shaped volume comprising a plurality of chambers/compartments, said chambers being located adjacent to each other around the longitudinal geometrical axis about which the drum is configured to rotate. In some embodiments, at least a part of the chambers of the first and/or of the second group of chambers may be arranged around the longitudinal geometrical axis but being spaced apart to each other (i.e. having a lateral space of separation between each other), wherein preferably said spaces of separation may be arranged around the longitudinal geometrical axis describing/defining a regular pattern.

[0021] In preferred embodiments of the invention, the plurality of chambers may further comprise at least one auxiliary group of chambers comprising one or more chambers (e.g. 1 to 30 chambers, preferably 3 to 15, more preferably 5 to 10). Each auxiliary group of chambers may be arranged within one of the contacting elements, wherein preferably each contacting element comprising one of the auxiliary groups of chambers is configured as an elongated body, such as a paddle, extending longitudinally at least partially along the longitudinal direction aligned with the longitudinal geometric axis, such that, when said auxiliary group comprises a plurality of chambers, said chambers are arranged as a one or more sequences of chambers (e.g., arranged consecutively or spaced apart) along the respective elongated body.

[0022] It should be noted that the multiples configurations for the contacting elements are compatible with the functional definition of said elements provided in claim 1 and in the preceding disclosure. The invention cannot be defined more precisely without unduly restricting the scope of the claims and the interpretation of said contacting elements. Thus, the contacting elements may be configured as any type of protruding (i.e. configured to protrude from the inner surface of the drum) element arranged on the inner surface of the drum and having a geometry/shape configured to cause the textile products to move within the inner compartment of the drum (e.g. by pushing with a lateral contact force) along the longitudinal direction towards a predetermined end of the drum dependent on the rotation direction of the drum (provided that the rotation speed is not so high that the centrifugal force prevents any movement). In preferred embodiments, the contacting elements are configured as elongated elements/bodies (e.g. paddles), i.e. each elongated body may be configured to extend longitudinally at least a long a component being parallel to the longitudinal geometrical axis. The elongated bodies (e.g. paddles) may be configured to be straight or curved (e.g. helical), or a combination thereof.

[0023] The paddles attached to the interior surface of the drum are also commonly known as baffles. Optionally, the paddles are disposed in radially symmetrical positions across the circumference of said inner surface, for example, when there are three paddles and the inner surface is cylindrical, it is preferable that the central angle subtended by the arc across the circumference of the inner surface and between two paddles is 120 (degrees). Therefore, optionally the drum with the paddles presents rotational symmetry about the drum's longitudinal and rotational axis as this characteristic facilitates the rotation of the drum. It is clarified that the front mouth and/or the back mouth of the drum during the process may be close, or partially or completely open, therefore the term "inner/interior surface" mentioned herein, refers to the surface of the interior of the drum on which the paddles are disposed, i.e. excluding the surface of any caps arranged for covering any of the mouths of the drum, because any of said mouths may be partially or completely open/uncovered. Preferably though one mouth is sealed/closed and the other is open.

[0024] The paddles are essentially long bars attached to and lengthwise laying on the inner surface of the drum. In some examples, the shape of a paddle's cross section that is normal to the longitudinal axis of the paddle is triangular or tetragonal or orthogonal or circular or ellipsoidal or polygonal or more complex. In some other examples, the shape and dimension of the aforementioned cross section are the same across the length of the paddle, and in some further examples said shape and/or dimensions are not the shame and change across the length of the paddle. Another and preferential option is that the shape of the paddle is twisted across the paddle's longitudinal axis, because this modifies across said axis the force applied by the paddle to the cloths and the air in contact with the paddle, and said modification can offer an additional control of the motion of said cloths and air moved by the paddle when the drum is rotated. This is clarified further below.

[0025] In preferred embodiments, the contacting elements are configured as paddles having at least a part of their length extending longitudinally between two respective opposing end portions of the respective paddle being distally arranged with respect each other along a longitudinal axis, said longitudinal axis being configured to form an angle (e.g. a first angle) of between 5 degrees and 85 degrees with a geometrical orthogonal projection of said longitudinal axis of the paddles on a first geometrical plane which is normal to the longitudinal axis of the drum. More preferably, said angle formed between the longitudinal axis and the geometrical projection of said longitudinal axis of the paddles on the first geometrical plane which is normal to the longitudinal axis of the drum is of between 50 degrees and 80 degrees.

[0026] In some embodiments of the invention compatible with any of the previously described embodiments, the machine may comprise a liquid management system comprising means configured to selectively introduce liquid into each of the plurality of chambers, preferably while the drum is rotating. Optionally, the liquid management system may further comprise means configured to selectively remove amounts of liquid from each of the plurality of chambers, preferably while the drum is rotating; in the absence of said means configured for selectively remove liquid, the chambers may be partially or totally emptied by gravity, when the drum rotates at a low speed (i.e. a speed for which the centrifugal force received by the liquid in the chambers is not sufficiently high so as to avoid the water to leave the compartment by gravity through an outlet arranged in a lower position of the respective chamber when the chamber is located at the highest point of the rotation path). Additionally or alternatively, the machine may further comprise an imbalance measuring system configured to measure one or more characteristics (i.e. data) of the imbalance of the drum while rotating. The imbalance measuring system may be preferably a vibration measuring/detecting system for measuring a vibration of the drum while rotating. More preferably said one or more characteristic preferably comprise a vibration amplitude and/or vibration phase, such that the imbalance measurement system may comprise one or more devices (e.g. sensors) configured to monitor said characteristics.

[0027] In preferred embodiments, the machine may further comprise a controller configured to control the speed of rotation of the drum and/or the direction of rotation of the drum. Preferably, the controller may be further configured to control the liquid management system based on the characteristics (i.e. data) of the imbalance of the drum measured by the imbalance measuring system while the drum is rotating. Accordingly, the controller may determine what amount of liquid is required in each chamber and instruct the liquid management system to inject it in to the corresponding chamber, wherein for this technical purpose, the controller compares the measured imbalance data with a predetermined balance threshold (i.e. a predetermined balance condition to be met).

[0028] In preferred embodiments of the invention, the machine may be configured to monitor at least one parameter related to an energy being provided to the drum for rotating the drum at a speed of rotation (i.e. at any speed of rotation compatible with the machine). The machine may comprise a controller (the same that has been previously described or another one) configured to monitor said at least one parameter. Preferably, the one or more parameter may comprise a parameter configured as an indicator of a power (e.g. a parameter directly related to the power or a parameter related operating characteristics of the motor, such as the intensity, frequency or DC braking current of the motor) provided to the drum for rotating and/or a parameter configured as an indicator of a torque provided to the drum for rotating. The role and importance of this monitoring ability is further developed in relation to the method described below.

[0029] A second aspect of the invention refers to a method for balancing a machine according to the disclosure above. The method comprises the step of:

a) rotating the drum of the textile processing machine about its longitudinal geometric axis at a first rotation speed being within a predetermined main range being configured such that, when the drum rotates at a rotation speed being within said predetermined main range, the textile products that have been previously inserted into the drum are pressed against the inner surface of the drum with a force preventing the textile products from moving along the longitudinal direction;

b) obtaining/measuring imbalance data of the drum while the drum is rotating and comparing said data with a predetermined balance threshold, wherein preferably the obtained/measured imbalance data is an indicator of a vibration of the drum while rotating;

c) determining, while the drum is rotating, for each of the plurality of chambers, and based on the imbalance data, a quantity of liquid required in each of the plurality of chambers to meet the predetermined balance threshold; and

d) selectively filing each of the plurality of chambers according to the previously determined respective quantity of liquid while the drum is rotating.

[0030] The steps b), c) and d) are carried out during step a) (e.g. step a) is executed during a respective time period, so that steps b), c) and d) are carried out during said time period), preferably in the order provided.

[0031] The first rotation speed may be configured as a constant speed within the predetermined main range. The predetermined main range comprises a plurality of speeds being higher than those of the predetermined initial range previously disclosed. The predetermined main range is configured such that, when the drum rotates at a rotation speed being within said predetermined main range, the contact force received by the textile products (i.e. the force with which the textile products are pressed against the inner surface of the drum and the contacting elements) is high enough to cause them to be in a stable position inside the drum (i.e. to jam/stick against the inner surface), thereby preventing the textile products from moving along the longitudinal direction. In some embodiments, the machine conducting the method may be dimensioned/configured such that the predetermined main range may start (i.e. its minimum value may be) at a rotation speed in the range 30 to 50 rpm, preferably in the range 40 to 45 rpm. The first rotation speed may be configured as a rotation speed in the range 100 rpm to 200 rpm, preferably in the range 120 to 180 rpm.

[0032] In some embodiments, the predetermined balance threshold may be configured as a minimum value of imbalance or a percentage of improvement being tolerable/sufficient for the machine to operate with normality at a given rotation speed (e.g. without risk of suffering damage or reducing its reliability/service life), while in other embodiments the predetermined balance threshold may comprise more than one threshold (e.g. a set of thresholds) describing a progression (e.g. from an initial threshold representing a minimum imbalance target to an ultimate threshold representing a higher or maximum desirable balancing target) for a given rotation speed. Accordingly, when the predetermined balance threshold is configured as a set of thresholds, the method may further comprise executing one or more cycles comprising steps b), c) and d) (i.e. one or more times), wherein for each cycle the predetermined balance threshold is adapted to adopt a more restrictive threshold (i.e. a higher level of balance is required to meet the threshold). In addition, the predetermined balance threshold may comprise a respective threshold or a respective set of progressive thresholds for each rotation speed. These configuration of the method is broadly compatible with any of the embodiments disclosed for the method, because no substantial modification of the machine or of the rest of method steps are required. The predetermined balance threshold may be configured as one or more thresholds related to the vibration amplitude and/or vibration phase of the drum while rotating, preferably at a constant speed. Thus, the predetermined balance threshold may comprise different values for different rotations speeds.

[0033] In step b), obtaining/measuring imbalance data of the drum while the drum is rotating may be carried out by the imbalance measuring system previously described for the machine (e.g. a device measuring the vibration of the drum while rotating), while comparing said obtained/measured data with a predetermined balance threshold may be carried out by the controller previously described for the machine.

[0034] In step c), determining, while the drum is rotating, for each of the plurality of chambers, and based on the imbalance data, a quantity of liquid required in each of the plurality of chambers to meet the predetermined balance threshold may be carried out by the controller of the machine. It should be noted that in cases where the controller detects that the balance of the rotating drum meets the predetermined balance threshold, no amount of liquid may be injected to fill any chamber.

[0035] In preferred embodiments of the invention, before starting the method with step a), the method may further comprise:

e) rotating the drum of the textile processing machine about its longitudinal geometric axis at a rotation speed being within the predetermined initial range comprising lower speeds than the main predetermined range, said predetermined initial range being configured such that, when the drum rotates at a speed being within said predetermined initial range, the contacting elements cause the textile products to move within the drum along a longitudinal direction aligned with the longitudinal geometric axis towards the first end portion of the drum if the drum rotates in a first rotation direction or towards the second end portion of the drum if the drum rotates in a second direction reversed with respect to the first rotation direction.

[0036] The predetermined initial range described in step e) corresponds to the predetermined initial range previously described for the machine. Executing step e) allows an agitation (i.e. shaking) of the textile products within the drum as well as a movement of the textile products (caused by the interaction of the textile products with the contacting elements) along the length of the drum towards a predetermined end portion of the drum (which may be configured as the front end portion or the rear end portion), dependent on the direction of rotation of the drum. In preferred embodiments, when step e) is executed for the first time during the execution of the method, the rotation direction is selected such that the textile products are moved towards the rear end portion. However, as discussed below, the rotation direction may be reversed in some cases.

[0037] Thus, when step e) is executed, the textile products are moved and repositioned/relocated inside the drum.

[0038] Preferably, the method may further comprise carrying out, after step e) and before step a), the step:

f) accelerating the drum to rotate at a rotation speed (e.g. a constant speed) being within the predetermined main range during a time period, said rotation speed being lower than or equal to the first rotation speed;

> obtaining, during said time period, data related to an energy provided to the drum for rotating and comparing said data with a predetermined energy threshold, wherein preferably said data comprises at least one parameter being configured as an indicator of the power and/or of the torque being provided to the drum for rotating; and
>
> verifying if the data related to the energy provided to the drum for rotating previously obtained meets the predetermined energy threshold, and if the predetermined energy threshold is met then starting step a).

[0039] Step f) serves the technical purpose of detecting critical situations for which increasing the rotational speed to higher rotation speeds may be dangerous for the machine. Accordingly, the method may be configured such that the machine monitors (e.g. by means of the controller) at least one parameter related to an energy being provided to the drum for rotating the drum at a speed of rotation (i.e. at any speed of rotation -e.g. any constant rotation speed- compatible with the machine). Preferably, and accordingly to the description provided for this same feature for the machine, the one or more parameters may comprise a parameter configured as an indicator of a power (e.g. a parameter related to the power or to operating characteristics of the motor, such as the intensity, frequency or DC braking current of the motor) provided to the drum for rotating and/or a parameter configured as an indicator of a torque provided to the drum for rotating. Preferably, the predetermined energy threshold may comprise a plurality of thresholds for each parameter, each of these thresholds corresponding to a different rotation speed.

[0040] Preferably, the speed of rotation reached in step f), which is a rotation speed within the predetermined main range and which is lower than or equal to the first rotation speed, may be in the range 30 to 50 rpm, preferably in the range 35 to 40 rpm.

[0041] In preferred embodiments, the method may further comprise, if in step f) the data related to the energy provided to the drum for rotating previously obtained does not meet the predetermined energy threshold (wherein the predetermined energy threshold is configured as a predetermined energy condition to be met), then repeating a sequence comprising steps e) and f) one or more times until the data obtained in step f) meets the predetermined energy threshold or until a predetermined number of repetitions of the sequence has been conducted. Preferably, wherein, before carrying out step e) in at least one of the sequences comprising steps e) and f), the rotation direction of the drum is reversed and/or the rotation of the drum is paused/stopped (e.g. such that the drum stops for a period of time before start rotating again).

[0042] According to a preferred embodiment compatible with any of the above-above disclosed embodiments, the method may further comprise:

- if after executing steps c) and d) the predetermined balance threshold is met, then:
  g) accelerating the rotation of the drum from the first rotation speed of step a) to a second rotation speed, preferably a constant rotation speed, being within the predetermined main range and being higher than the first rotation speed of the step a), wherein preferably the second rotation speed resulting from the acceleration is configured as a speed of centrifugation for the textile products;

- if after executing steps c) and d) the predetermined balance threshold is met, then:
  h) carrying out step e) as an initial step for restarting the method of any of the preceding embodiments.

[0043] Accordingly, steps g) and h) may implicitly comprise verifying whether the predetermined balance threshold is met after executing steps c) and d) (e.g. any time that steps c) and d) are carried out).

[0044] In preferred embodiments, the method may be further configured such that, in step g), accelerating the rotation of the drum from the first rotation speed of step a) to the second rotation speed further comprises rotating the drum at one or more intermediate rotation speeds (e.g. one or more constant rotations speeds) for a respective period of time each and carrying out the steps b), c) and d) for each of the one or more intermediate rotation speeds during said respective period of time, wherein the one or more intermediate rotation speeds are between the first and the second rotation speeds. Preferably, if, after carrying out steps c) and d) for any of the intermediate rotations speeds, the predetermined balance threshold is not met, then carrying out carrying out step e) as an initial step for restarting the method; and/or if, after carrying out steps c) and d) for any of the intermediate rotations speeds, the predetermined balance threshold is met, the drum is accelerated to rotate at the second rotation speed or at an intermediate rotation speed being higher than a current intermediate rotation speed.

[0045] A third aspect of the invention refers to a computer program comprising instructions which, when the program is executed by a machine according to the present disclosure, causes the machine to carry out the method according to the invention. Further, a fourth aspect of the invention refers to a computer-readable medium data carrier having stored thereon the computer program above.

Brief Description of Drawings

[0046]

FIGS.1A to 1D show four different views of a first embodiment of the drum related to the first and second aspects of the invention.

FIGS. 2A to 2D show respective front views of a drum according to a second embodiment of the invention.

FIGS. 3A to 3D show respective rear views of the drum shown in FIGS. 2A to 2D.

FIG. 4 shows a perspective of a third embodiment of the drum related to the first and second aspects of the invention.

FIG. 5 shows a cross section of the drum related to the first and second aspects of the invention, wherein the cross section is normal to the longitudinal geometrical axis of the drum.

Fig. 6 shows a perspective of another embodiment of the drum of the first and second aspects of the invention, with only one of the paddles of the drum indicated therein for the purpose of illustrating how the angle 'a' is defined.

Fig. 7 shows a cross section of another embodiment of the drum of the first and second aspects of the invention, with only one of the paddles of the drum indicated therein for the purpose of illustrating how the angle 'b' is defined, and wherein the cross section is normal to the longitudinal axis of the paddle.

Fig. 8 shows a cross section of another embodiment of the drum of the first and second aspects of the invention, with only one of the paddles of the drum indicated therein for the purpose of illustrating how the angle b is defined, and wherein the cross section is normal to the longitudinal axis of the paddle.

FIG. 9 a flow diagram of an embodiment of a method according to the invention.

FIG. 10 a flow diagram of an embodiment of a method according to the invention.

Detailed Description of embodiments

[0047] A preferred embodiment of a drum 1 of a machine for processing textile products according to the invention is shown in FIGS. 1A-1D with each of these figures showing a different view/perspective of the drum 1. Fig. 1A is a back view of said drum 1 and shows that the rear end portion 12 (indicated in Fig. 1B) of the drum 1 is closed by a cap 13 (the cap 13 being an optional feature). As indicated, the drum 1 of this specific embodiment is lengthwise oriented parallel to the level of the ground and is supported by a supporting base 10, which also holds the rotation means 5 which are configured for rotating the drum. FIG. 1B, which is a side view, indicates the external surface 2 of the drum, and the front end portion 11 (i.e. the front part of the drum) and the rear end portion 12 of the drum 1. FIG. 1C, which is a perspective view of the drum 1, shows the inner surface 3 of the drum on which four contacting elements configured as respective paddles 4 are arranged (it is noted that the drum of FIGS. 1A-1D is also compatible with other configurations for the contacting elements according to the description above), wherein the longitudinal axis (not indicated) of one paddle forms an angle of 70 degrees (this angle is selected as an example, although this angle may be configured as an angle in the range in the range 5 to 85 degrees). A mouth (i.e. an opening for access to the inner compartment) is arranged at the front end portion 11 of the drum, which is normal to the longitudinal geometrical axis (not indicated) of the drum, therefore said angle of 70 degrees is the angle 'a'. It is noted that, since drum 1 as shown is cylindrical (optional feature, since the drum may be configured to have other geometries) and has a respective front circular mouth, a respective rear circular mouth (i.e. at the front end portion 11 and at the rear end portion 12, respectively) and a disc-shaped cap 13 covering the rear mouth, the longitudinal geometrical axis of the drum 1 about which the drum 1 rotates is normal to said cylindrical cap 13. It is also noted that the cross section of each of the paddles 4 shown has a triangular shape and does not change along the length of the paddle. The exterior surface 2 of the drum 1 is also indicated in FIG. 1C. FIG. 1D is the front view of the drum and shows that the four paddles 4 of the drum 1 are positioned in symmetric positions around the circumference of the inner surface 3 of the drum 1 so that the drum 1 has a rotational symmetry. In this case, the central angle (not shown) subtended by the arc across the circumference of the inner surface 3 and between every two neighbouring paddles is 90 degrees (however this angle may be different for a different number of contacting elements). Although the embodiment of FIG. 1C-1D does not explicitly depict any plurality of chambers, it should be noted that the drum is configured to have a plurality of chambers configured to be controllably and selectively filled with a liquid, preferably while the drum 1 is rotating. The plurality of chambers are arranged such that, when the respective chamber is partially or totally filed with liquid, its centre of mass is radially separated from the longitudinal geometrical axis. In some embodiments of the invention compatible with the drum 1 shown in FIGS. 1C-1D the plurality of chambers may be configured as one or more of:

- a (first/front) group of chambers being arranged at the first end portion 11 (i.e. at the front portion 11) of the drum 1, preferably within the drum 1; and/or
- a (second/rear) group of chambers 6 being arranged at the second end portion 12 (i.e. at the rear end portion 12) of the drum 1, preferably within the drum 1; and/or
- at least one auxiliary group of chambers comprising one or more chambers 7, each auxiliary group of chambers being arranged within one of the contacting elements 4.

[0048] FIGS. 2A-2C show three different front views of a drum 1 according to the invention (compatible with the embodiment of FIGS. 1A-1D), while FIGS. 3A-3C show three different rear views of the same drum of FIGS. 2A-2C. The drum 1 of FIGS. 2A-2C and FIGS. 3A-3C comprises a (second) group of chambers 6 arranged at the second/rear end portion of the drum 1 and an auxiliary group of chambers arranged within one of the paddles 4, said auxiliary group of chambers comprising three chambers arranged in a sequence. It is noted that the number of chambers 7 of the auxiliary group is merely exemplary, but in other embodiments may be adapted to be less (e.g. 1 or 2) or more (e.g. 1 to 20). The same applies to the arrangement of said chambers, which may be arranged according to the description provided in the summary of the invention.

[0049] The (second) group of chambers 6 is shown as comprising eight chambers, wherein a respective chamber having a first size is arranged to be aligned with the respective longitudinal axis of a respective contacting element configured as a paddle (such that there are four respective smaller chambers), and wherein a respective chamber having a second size (the second size being bigger than the first size, wherein size refers to volume capacity - the second size may be 1.5 to 3 times the first size, preferably 2 times) is arranged at the space between two respective paddles consecutively arranged within the drum 1. The drum 1 depicted in FIGS. 2A-2C and FIGS. 3A-3C is however compatible with other configurations (e.g. number, sizes, arrangements, etc) for the chambers of the one or more auxiliary groups of chambers and for the chambers of the first and/or of second group of chambers.

[0050] Further, for simplicity, the embodiment of FIGS. 2A-2C and FIGS. 3A-3C are shown as not comprising any (first/front) group of chambers arranged at the first/front end portion 11 of the drum 1. However, it should be noted that the embodiment is compatible with this feature.

[0051] The chambers 6 of the (second/rear) group of chambers are shown with the optional features of being arranged to totally surround/encircle the longitudinal geometrical axis (not shown) about which the drum 1 is configured to rotate, and of being configured to be consecutively arranged (e.g. in lateral contact to each other). However, in other embodiments of the invention said chambers 6 may be configured to be laterally spaced apart to each other.

[0052] FIG. 4 shows a similar, yet different embodiment of the drum 1, wherein the shape of each paddle 4 is twisted across the longitudinal axis of the paddle 4 (not shown). This configuration is compatible with any angle of inclination for the paddle described above. This feature modifies across said axis the force applied by the paddle to the textile products, offering an additional control of the motion of said textile products when being moved by the paddle when the drum rotates.

[0053] FIG. 5 shows an embodiment of the drum 1 having three paddles 4 attached to its interior surface, wherein the shape of each paddle 4 as viewed on the plane of the figure is triangular, and wherein as indicated the drum has a rotational symmetry because the central angle subtended by the arc across the circumference of the inner surface 3 and between every two paddles is 120 degrees.

[0054] FIG. 6 shows how the angle 'a', related to the orientation of the longitudinal axis LP of a paddle, is defined. It is noted that for clarity of presentation, only one of the paddles 4 is shown in FIG. 6. The shown paddle 4 is attached to the inner surface 3 of the drum 1, and the part of the paddle which is behind the external surface 2 of the drum 1 is drawn using dash-dotted lines, wherein the rest of the paddle 4 is drawn using solid lines. The longitudinal geometrical axis LD of the drum 1 (i.e. the axis about which the drum 1 is configured to rotate) and a plane N which is normal to said longitudinal geometrical axis LD of the drum 1 are also shown. The orthogonal projection OP of the longitudinal axis LP of the paddle 4 on said plane N is indicated by the respective dash-dotted line. The angle 'a' is the angle formed between the longitudinal axis LP of the paddle and said orthogonal projection OP.

[0055] FIG. 7 shows how the angle 'b', related to the orientation of an exterior surface 8 of the paddle according to another embodiment of the drum 1 (wherein this feature is broadly compatible with the features previously defined for the preceding embodiments), is defined. As shown in FIG. 7, the paddle 4 is attached to the inner surface 3 of the drum 1, and the exterior surface 2 of the drum 1 is also indicated. The longitudinal axis LP (not shown) of the paddle 4 is perpendicular to the indicated plane NB which is parallel to the plane of FIG. 7. Said exterior surface 8 of the paddle 4 has a linear segment defined by two extreme points S, D. Said extreme points S, D are connectable by straight line SD which in between said extreme points S, D does not pass though the external surface 8 of the paddle 4. There is also shown the central point B of the interface between the paddle 4 and the interior surface 3 of the drum 1, and the plane T which is tangent to said interior surface 3 and at said central point B. The tangent plane T is perpendicular to the normal plane NB and for this reason in FIG. 7 the tangent plane T is indicated by a dashed line which is defined by the intersection of the tangent plane T and the normal plane NB. In FIG. 7 there is also indicated the orthogonal projection SD' of line SD on the tangent plane T. The angle 'b' is the angle formed between the straight line SD and its orthogonal projection SD'.

[0056] Similarly to FIG. 7, FIG. 8 also shows how angle 'b' is defined, wherein the main difference between the two figures is that in FIG. 8 the shape of the shown cross section of the paddle is orthogonal, while in FIG. 7 the corresponding shape is triangular.

[0057] Although the embodiments shown in the figures only depict the drum 1 and the plurality of chambers, it is noted that a machine for processing textile products according to the invention may further comprise a liquid management system (not shown) comprising means configured to selectively introduce liquid into each of the plurality of chambers, preferably while the drum 1 is rotating; and/or an imbalance measuring system (not shown in the figures) configured to measure one or more characteristics of the imbalance of the drum 1 while rotating, said imbalance measuring system being preferably a vibration measuring/detecting system for measuring a vibration of the drum while rotating, wherein more preferably said one or more characteristic preferably comprise a vibration amplitude and/or a vibration phase.

[0058] Additionally, a machine for processing textile products comprising a drum according to any of the preceding figures may further comprise a controller configured to control the speed of rotation of the drum and the direction of rotation of the drum, wherein the controller is preferably further configured to control the liquid management system based on the characteristics of the imbalance of the drum measured by the imbalance measuring system while the drum is rotating. The controller the controller may be further configured to monitor at least one parameter related to an energy provided to the drum for rotating the drum at a speed of rotation, wherein preferably said at least one parameter is configured: as an indicator of a power provided to the drum to rotate at a constant or variable speed of rotation; and/or as an indicator of a torque provided to the drum for rotating the drum at a constant or variable speed of rotation.

[0059] FIG. 9 shows a flow diagram comprising a plurality of blocks of a preferred embodiment of a for balancing a textile processing machine according to the invention. It is noted that some of the blocks represent optional features of the method.

[0060] The basic part of the method is represented by block 101. Block 101 comprises the method steps:

a) rotating the drum of the textile processing machine about its longitudinal geometric axis at a first rotation speed being within a predetermined main range being configured such that, when the drum rotates at a rotation speed being within said predetermined main range, the textile products that have been previously inserted into the drum are pressed against the inner surface of the drum with a force preventing the textile products from moving along the longitudinal direction;

b) obtaining/measuring imbalance data of the drum while the drum is rotating and comparing said data with a predetermined balance threshold, wherein preferably the obtained/measured imbalance data is an indicator of a vibration of the drum while rotating;

c) determining, while the drum is rotating, for each of the plurality of chambers, and based on the imbalance data, a quantity of liquid required in each of the plurality of chambers to meet the predetermined balance threshold; and

d) selectively filing each of the plurality of chambers according to the previously determined respective quantity of liquid while the drum is rotating.

[0061] The steps b), c) and d) are carried out during step a) (e.g. step a) is executed during a respective time period, so that steps b), c) and d) are carried out during said time period), preferably in the order provided. In some embodiments for which the predetermined balance threshold is configured as a set of thresholds, the method may further comprise executing one or more cycles comprising steps b), c) and d), wherein for each cycle the predetermined balance threshold is adapted to adopt a more restrictive threshold (i.e. a higher level of balance is required to meet the threshold).

[0062] The method represented in block 101 provides an improvement of the balance (e.g. the dynamic balance) of the drum of the machine when rotating for processing textile products, so that it can be executed in an isolated manner for achieving an improvement.

[0063] Before executing the method steps of block 101, the method optionally comprises executing the instructions of block 104, wherein block 104 comprises the step of:

e) rotating the drum of the textile processing machine about its longitudinal geometric axis at a rotation speed being within the predetermined initial range comprising lower speeds than the main predetermined range, said predetermined initial range being configured such that, when the drum rotates at a speed being within said predetermined initial range, the contacting elements cause the textile products to move within the drum along a longitudinal direction aligned with the longitudinal geometric axis towards the first end portion of the drum if the drum rotates in a first rotation direction or towards the second end portion of the drum if the drum rotates in a second direction reversed with respect to the first rotation direction.

[0064] Accordingly, in some embodiments block 104 may be an initial block which is followed by block 101, such that step e) is carried out initially and then step a) is carried out (together with steps b), c) and d)).

[0065] In preferred embodiments, blocks 105 and 106 are executed in between the initial execution of block 104 and the subsequent execution of block 101.

[0066] Blocks 105 and 106 comprise the step of:

f) accelerating the drum to rotate at a rotation speed (e.g. a constant speed) being within the predetermined main range during a time period, said rotation speed being lower than or equal to the first rotation speed;

obtaining, during said time period, data related to an energy provided to the drum for rotating and comparing said data with a predetermined energy threshold, wherein preferably said data comprises at least one parameter being configured as an indicator of the power and/or of the torque being provided to the drum for rotating; and

verifying if the data related to the energy provided to the drum for rotating previously obtained meets the predetermined energy threshold, and if the predetermined energy threshold is met then starting step a).

[0067] It is noted that the second half of the second paragraph of step f) (namely, "comparing said data with a predetermined energy threshold") and the third paragraph of step f) (namely, "verifying if the data related to the energy provided to the drum for rotating previously obtained meets the predetermined energy threshold, and if the predetermined energy threshold is met then starting step a)") are represented by block 106, which has been placed independently on behalf of comprehensibility.

[0068] Optionally, the method may further comprise that, if the data related to the energy provided to the drum for rotating previously obtained does not meet the predetermined energy threshold, then proceeding to repeat a sequence comprising steps e) and f) (i.e. a sequence of blocks 104, 105 and 106) one or more times until the data obtained in step f) meets the predetermined energy threshold or until a predetermined number of repetitions of the sequence has been conducted. Preferably, before carrying out step e) in at least one of the sequences comprising steps e) and f), the rotation direction of the drum is reversed and/or the rotation of the drum is stopped.

[0069] Accordingly, block 106 represents that, upon a negative determination of compliance with the predetermined energy threshold (i.e. energy condition), then block 106 leads to block 107, wherein it is verified if the number of times NS (Number of Sequences) that the sequence comprising steps e) and f) has been repeated is higher than a predetermined number (i.e. "Limit") of repetitions (e.g. 1 to 20). If the number of repetitions is higher than the predetermined number, then the method may further comprise stopping the drum and/or triggering an alarm.

[0070] Although FIG. 9 does not show any counter or any countering step, the method may further comprise counting each repetition of the sequence after the execution of block 105. Preferably, the counter of the number of repetitions (which may be carried out by a controller) may be reset to zero if the predetermined energy threshold is eventually met in block 106.

[0071] So far, different optional combinations of block 101 with blocks 104 to 108 has been disclosed as part of the method according to the invention. Now different combinations of block 101 with blocks 102 and 103 are to be described, such that these additional combinations may be considered in combinations with any of the optional combinations of block 101 with blocks 104 to 108 previously described.

[0072] In preferred embodiments, after executing block 101, the method optionally comprises executing block 103, wherein block 103 comprises the step of:
g) accelerating the rotation of the drum from the first rotation speed of step a) to a second rotation speed, preferably a constant rotation speed, being within the predetermined main range and being higher than the first rotation speed of the step a), wherein preferably the second rotation speed resulting from the acceleration is configured as a speed of centrifugation for the textile products;

[0073] It should be noted that, although block 101 may comprise an implicit verification of whether or not the predetermined balance threshold is met, in order to improve the comprehensibility of the diagram, this verification has been included as an independent block in block 102. Therefore, the execution of block 103 is carried out if, after executing steps c) and d) in block 101, it is verified that the predetermined balance threshold is met.

[0074] In those rare cases in which the predetermined balance threshold is not met (i.e. after executing steps c) and d) in block 101), then block 102 leads to executing block 104 for carrying out step e) as an initial step for restarting the method of any of the preceding embodiments.

[0075] Finally, FIG. 10 depicts an optional configuration for block 103, in which step g) is configured for accelerating the rotation of the drum from the first rotation speed of step a) to the second rotation speed in step g) by rotating the drum at one or more intermediate rotation speeds for a respective period of time each and carrying out the steps b), c) and d) for each of the one or more intermediate rotation speeds during said respective period of time, wherein the one or more intermediate rotation speeds are between the first and the second rotation speeds.

[0076] It should be noted that, when the method comprises a plurality of intermediate rotation speeds, said speeds are configured to define a progression from a lower speed to a higher speed, wherein for each intermediate rotation speed a corresponding cycle of steps b), c) and d) is carried out during the respective period of time that the drum is configured to rotate at the respective intermediate rotation speed. For each intermediate speed, FIG. 10 shows a corresponding pair of blocks 103ax (wherein ’x’ represents one of the intermediate rotation speeds) and 102 (this block 102 being configured identically to the block 102 of FIG. 9). Accordingly, for a first intermediate rotation speed a pair of blocks 103a1 and 102 is provided, for a second intermediate rotation speed a pair of blocks 103a2 and 102 is provided, and for a n^{th} intermediate rotation speed a pair of blocks 103an and 102 is provided.

[0077] As shown in FIG. 10, if while the drum is rotating at any of the intermediate rotation speeds (i.e. in any of blocks 103ax), it is verified in a corresponding block 102 that the predetermined balance threshold/condition is not met, then the method may further comprise executing block 104 of FIG. 9 for restarting the method (i.e. carrying out step e) as an initial step). The predetermined balance threshold may be configured according any of the embodiments described in the description, namely as it may be configured as a minimum value of imbalance or a percentage of improvement being tolerable/sufficient for the machine to operate with normality at a given rotation speed (e.g. without risk of suffering damage or reducing its reliability/service life), while in other embodiments the predetermined balance threshold may comprise more than one threshold (e.g. a set of thresholds) describing a progression (e.g. from an initial threshold representing a minimum imbalance target to an ultimate threshold representing a higher or maximum desirable balancing target) for a given rotation speed. Thus, the predetermined balance threshold may comprise different values for different rotations speeds.

[0078] Further, if while the drum is rotating at any of the intermediate rotation speeds (i.e. in any of blocks 103ax), it is verified in a corresponding block 102 that the predetermined balance condition is met, then the method may further comprise executing the next block 103a to accelerate the drum to rotate at a subsequent intermediate rotation speed (the subsequent intermediate rotation speed being higher than the current intermediate rotation speed). In the particular case of the last intermediate rotation speed, if it is verified in the corresponding block 102 that the predetermined balance condition is met, then the method may further comprise executing the block 103b to accelerate the drum to rotate at the second rotation speed.

Claims

1. A machine for processing textile products, the machine comprising:

- a drum (1) comprising an inner surface (3) defining an inner compartment configured for receiving textile products, the drum (1) extending lengthwise along a longitudinal geometric axis (LD) between a first end portion (11) and a second end portion (12) of the drum (1), and being adapted to be rotated about said longitudinal geometrical axis (LD);
- a plurality of contacting elements (4) attached to the inner surface (3) of the drum (1), the contacting elements (4) being configured such that:

  when the drum (1) rotates at a rotation speed being within a predetermined initial range in a first rotation direction, the contacting elements (4) cause the textile products to move within the drum (1) along a longitudinal direction aligned with the longitudinal geometric axis (LD) towards the first end portion (11) of the drum (1); and/or
  when the drum (1) rotates at a rotation speed being within the predetermined initial range in a second rotation direction being reverse to the first rotation direction, the contacting elements (4) cause the textile products to move within the drum (1) along the longitudinal direction aligned with the longitudinal geometric axis (LD) towards the second end portion (12) of the drum (1); and

- a plurality of chambers (6, 7) configured to be controllably and selectively filled with a liquid while the drum (1) is rotating, the liquid being preferably water, each chamber (6, 7) being arranged such that, when the respective chamber (6, 7) is partially or totally filed with liquid, its centre of mass is radially separated from the longitudinal geometrical axis (LD).

2. The machine of claim 1, wherein the plurality of chambers (6, 7) comprises:

a first group of chambers (6) being arranged at the first end portion (11) of the drum (1), preferably within the drum (1); and/or
a second group of chambers (6) being arranged at the second end portion (12) of the drum (1), preferably within the drum (1);
wherein preferably the chambers (6) of the first and/or of the second group of chambers are configured such that at least a part of the chambers belonging to a same group have an equivalent size and/or volume capacity.

3. The machine of claim 2, wherein the chambers of the first and/or of the second group of chambers are arranged to at least partially surround/encircle the longitudinal geometrical axis (LD);
wherein preferably at least a part of said chambers are in lateral contact to each other and/or at least a part of said chambers are space apart around the longitudinal central axis (LD).

4. The machine of any of the preceding claims, wherein the plurality of chambers further comprises at least one auxiliary group of chambers comprising one or more chambers, each auxiliary group of chambers being arranged within one of the contacting elements (4);
wherein preferably the contacting element comprising one of the auxiliary groups of chambers are respectively configured as an elongated body, such as a paddle, extending longitudinally at least partially along the longitudinal direction aligned with the longitudinal geometric axis (LD), such that, when said auxiliary group comprises a plurality of chambers, said chambers are arranged as a sequence of chambers along the respective elongated body.

5. The machine of any of the preceding claims, wherein the contacting elements (5) are configured as respective paddles (4);

wherein preferably each paddle (4) is configured to have a length extending longitudinally between two respective opposing end portions being distally arranged with respect each other along a longitudinal axis (LP), said longitudinal axis (LP) being configured to form an angle (a) of between 5 degrees and 85 degrees with a geometrical orthogonal projection (OP) of said longitudinal axis (LP) of the paddles on a first geometrical plane (N) which is normal to the longitudinal axis (LD) of the drum (1);
wherein more preferably said angle (a) formed between the longitudinal axis (LP) and the geometrical projection (OP) of said longitudinal axis (LP) of the paddles on the first geometrical plane (N) which is normal to the longitudinal axis (LD) of the drum (1) is of between 50 degrees and 80 degrees.

6. The machine of claim 5, wherein an external surface (8) of at least one paddle (4) has a linear segment which has two extreme points (S, D) that belong to a second geometrical plane (NB) which is normal to the longitudinal axis of the respective paddle (LP), wherein the two extreme points (S, D) are connectable to each other by a straight line (SD), wherein in between said extreme points (S, D) the straight line (SD) does not pass through the external surface (8), and wherein said straight line (S, D) forms an angle (b) of between 5 degrees and 85 degrees with a line being an orthogonal projection (SD') on a third geometrical plane (T) being tangent to the inner surface (3) of the drum (1) at a middle point of an interface between the drum (1) and the paddle (4) belonging to said second geometrical plane (NB).

7. The machine of any of the preceding claims, further comprising:

a liquid management system comprising means configured to selectively introduce liquid into each of the plurality of chambers, preferably while the drum (1) is rotating; and/or
an imbalance measuring system configured to measure one or more characteristics of the imbalance of the drum while rotating, said imbalance measuring system being preferably a vibration measuring/detecting system for measuring a vibration of the drum (1) while rotating, wherein more preferably said one or more characteristic preferably comprise a vibration amplitude and/or a vibration phase.

8. The machine of any of the preceding claims, further comprising a controller configured to control the speed of rotation of the drum and the direction of rotation of the drum, wherein the controller is preferably further configured to control the liquid management system based on the characteristics of the imbalance of the drum measured by the imbalance measuring system while the drum is rotating.

9. The machine of any of claim 8, wherein the controller is further configured to monitor at least one parameter related to an energy provided to the drum for rotating the drum at a speed of rotation, wherein preferably said at least one parameter:

is configured as an indicator of a power provided to the drum to rotate at a constant or variable speed of rotation; and/or
is configured as an indicator of a torque provided to the drum for rotating the drum at a constant or variable speed of rotation.

10. A method for balancing a textile processing machine according to any of the preceding claims, the method comprising the step of:

a) rotating the drum of the textile processing machine about its longitudinal geometric axis at a first rotation speed being within a predetermined main range being configured such that, when the drum rotates at a rotation speed being within said predetermined main range, the textile products that have been previously inserted into the drum are pressed against the inner surface of the drum with a force preventing the textile products from moving along the longitudinal direction;
wherein the method further comprises carrying out each of the following steps during step a), preferably in the order provided:
b) obtaining/measuring imbalance data of the drum while the drum is rotating and comparing said data with a predetermined balance threshold, wherein preferably the obtained/measured imbalance data is an indicator of a vibration of the drum while rotating;
c) determining, while the drum is rotating, for each of the plurality of chambers, and based on the imbalance data, a quantity of liquid required in each of the plurality of chambers to meet the predetermined balance threshold; and
d) selectively filing each of the plurality of chambers according to the previously determined respective quantity of liquid while the drum is rotating.

11. The method of any of claim 10, further comprising as an initial step before step a):
e) rotating the drum of the textile processing machine about its longitudinal geometric axis at a rotation speed being within a predetermined initial range comprising lower speeds than the main predetermined range, said predetermined initial range being configured such that, when the drum rotates at a speed being within said predetermined initial range, the contacting elements cause the textile products to move within the drum along a longitudinal direction aligned with the longitudinal geometric axis towards the first end portion of the drum if the drum rotates in a first rotation direction or towards the second end portion of the drum if the drum rotates in a second direction reversed with respect to the first rotation direction.

12. The method of claims 10 or 11, further comprising after step e) and before step a):
f) accelerating the drum to rotate at a rotation speed being within the predetermined main range during a time period, said rotation speed being lower than or equal to the first rotation speed;
obtaining, during said time period, data related to an energy provided to the drum for rotating and com-

paring said data with a predetermined energy threshold, wherein preferably said data comprises at least one parameter being configured as an indicator of the power and/or of the torque being provided to the drum for rotating; and verifying if the data related to the energy provided to the drum for rotating previously obtained meets the predetermined energy threshold, and if the predetermined energy threshold is met then starting step a).

13. The method of claims 12, further comprising, if the data related to the energy provided to the drum for rotating previously obtained does not meet the predetermined energy threshold, repeating a sequence comprising steps e) and f) one or more times until the data obtained in step f) meets the predetermined energy threshold or until a predetermined number of repetitions of the sequence has been conducted;. wherein preferably, before carrying out step e) in at least one of the sequences comprising steps e) and f), the rotation direction of the drum is reversed and/or the rotation of the drum is stopped.

14. The method of any of claims 10 to 13, the method further comprising:

if after executing steps c) and d) the predetermined balance threshold is met, then:
g) accelerating the rotation of the drum from the first rotation speed of step a) to a second rotation speed being within the predetermined main range and being higher than the first rotation speed of the step a), wherein preferably the second rotation speed is configured as a speed of centrifugation for the textile products; and
if after executing steps c) and d) the predetermined balance threshold is met, then:
h) carrying out step e) as an initial step for restarting the method of any of claims 10 to 13.

15. The method of claim 14, wherein accelerating the rotation of the drum from the first rotation speed of step a) to the second rotation speed in step g) further comprises rotating the drum at one or more intermediate rotation speeds for a respective period of time each and carrying out the steps b), c) and d) for each of the one or more intermediate rotation speeds during said respective period of time, wherein the one or more intermediate rotation speeds are between the first and the second rotation speeds;
wherein preferably:

if, after carrying out steps c) and d) for any of the intermediate rotations speeds, the predetermined balance threshold is not met, then carrying out step e) as an initial step for restarting the method; and/or
if, after carrying out steps c) and d) for any of the intermediate rotation speeds, the predetermined balance threshold is met, the drum is accelerated to rotate at the second rotation speed or at an intermediate rotation speed being higher than a current intermediate rotation speed.

16. A computer program comprising instructions which, when the program is executed by the machine (1) according to any of claims 1 to 9, causes the machine (1) to carry out the method of any of claims 10 to 14.

17. A computer-readable medium data carrier having stored thereon the computer program of claim 15

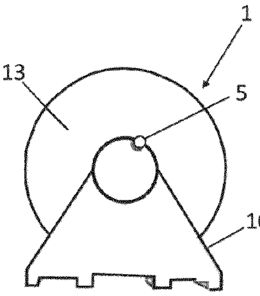

FIG. 1A

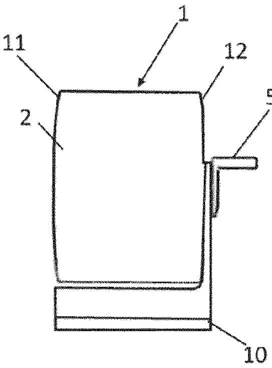

FIG. 1B

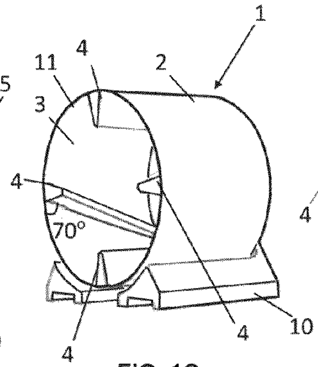

FIG. 1C

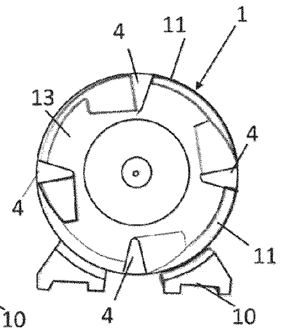

FIG. 1D

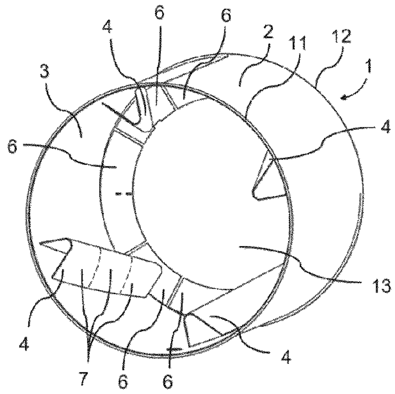

FIG. 2A

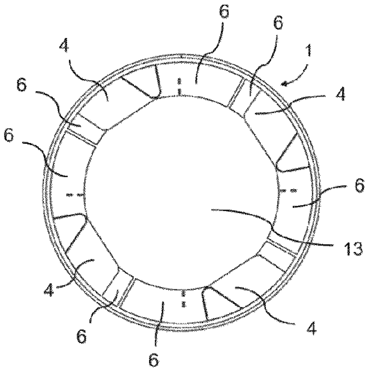

FIG. 2B

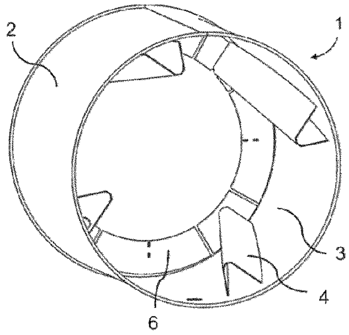

FIG. 2C

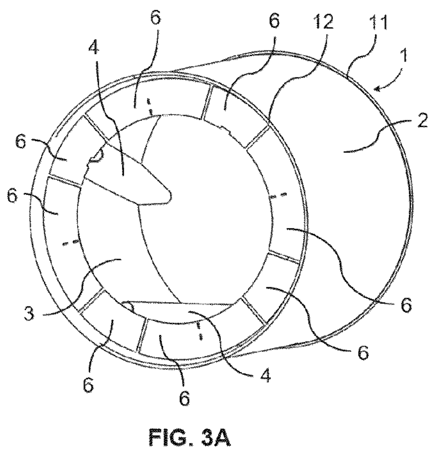

FIG. 3A

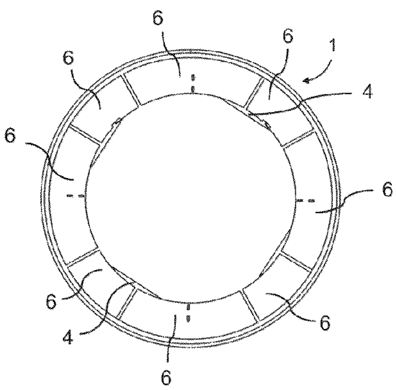

FIG. 3B

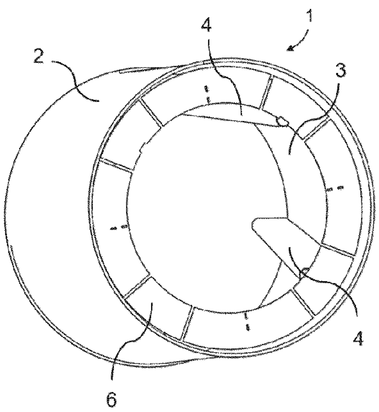

FIG. 3C

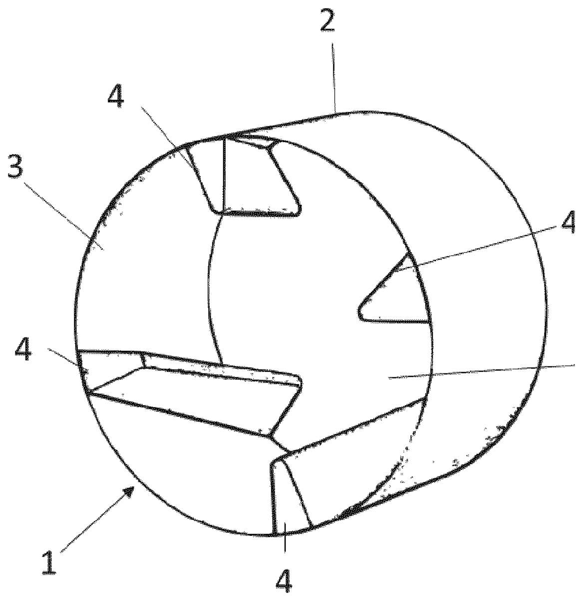

FIG. 4

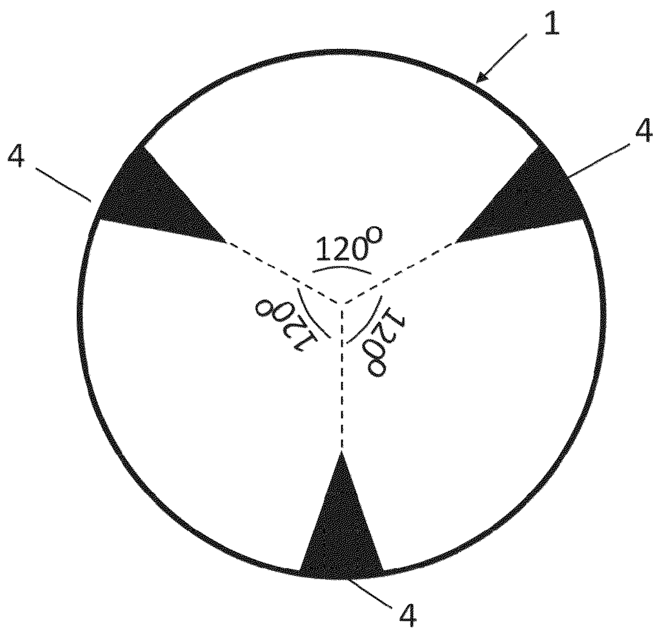

FIG. 5

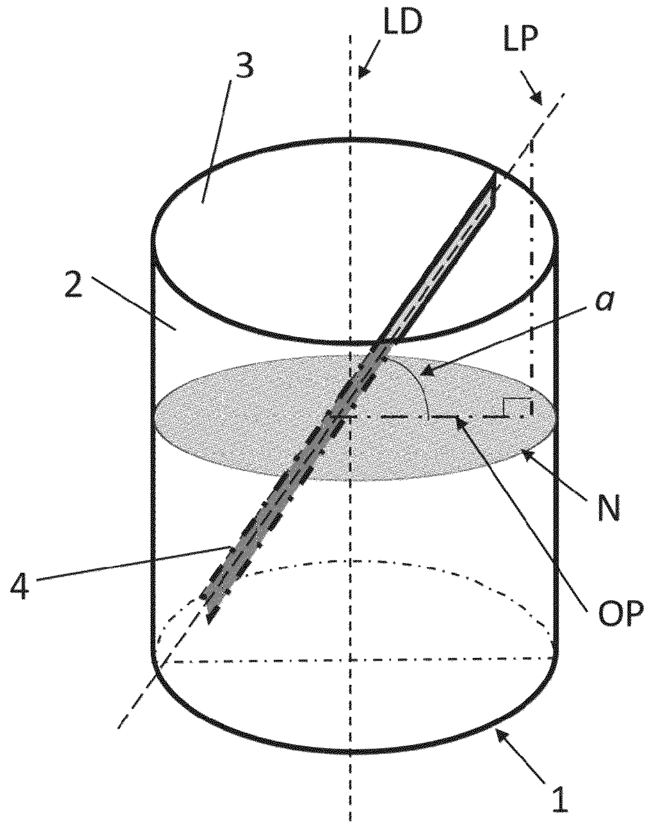

FIG. 6

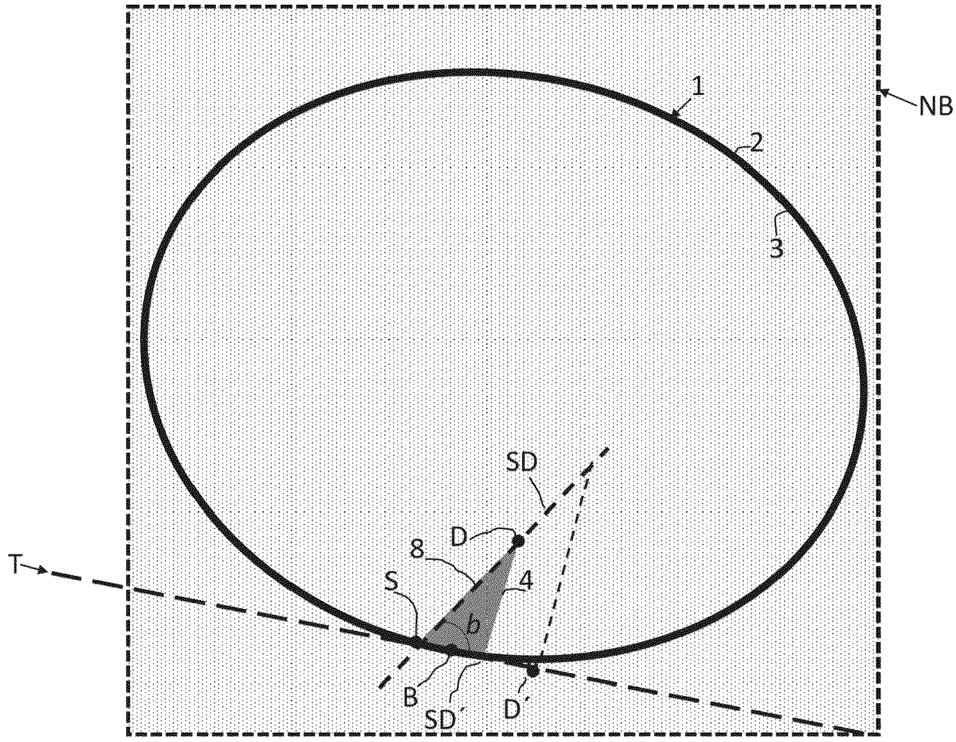

FIG. 7

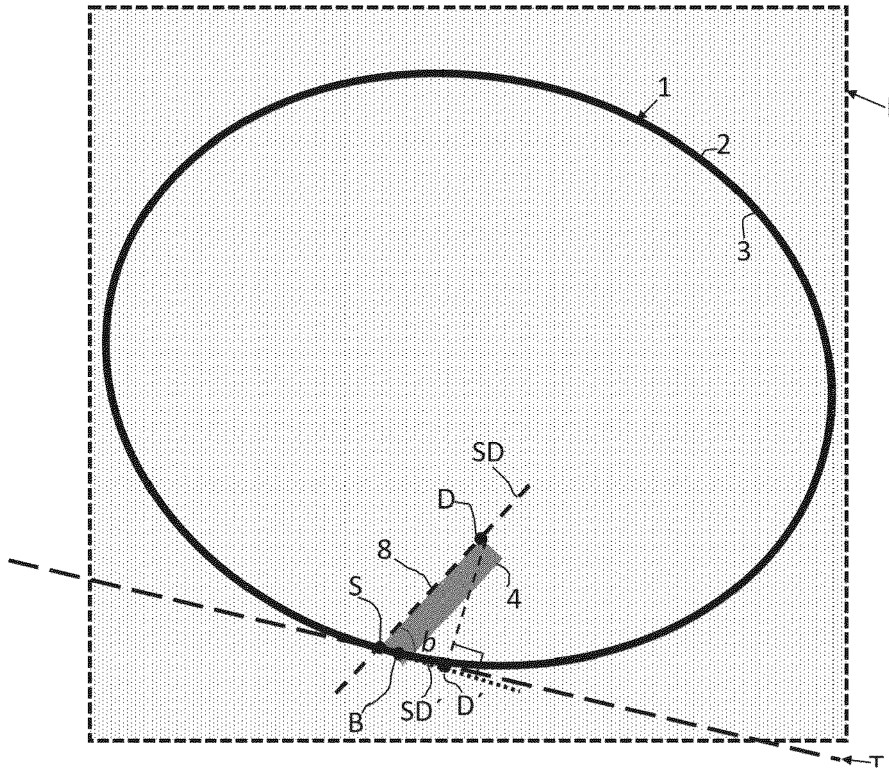

FIG. 8

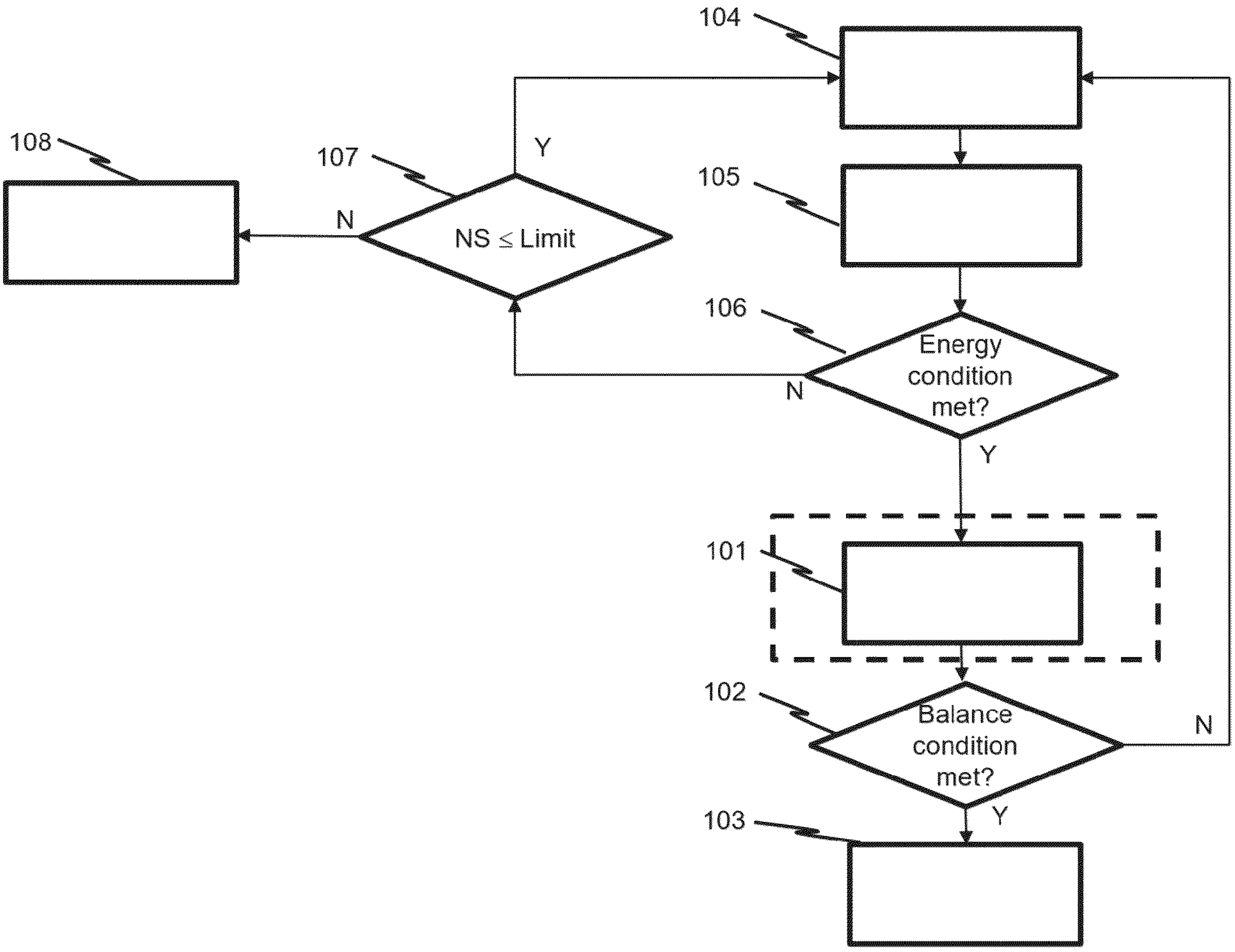
104
105
106
Energy condition met?
101
102
Balance condition met?
103
107
NS ≤ Limit
108
Y
N
Y
N
N
Y

FIG. 9

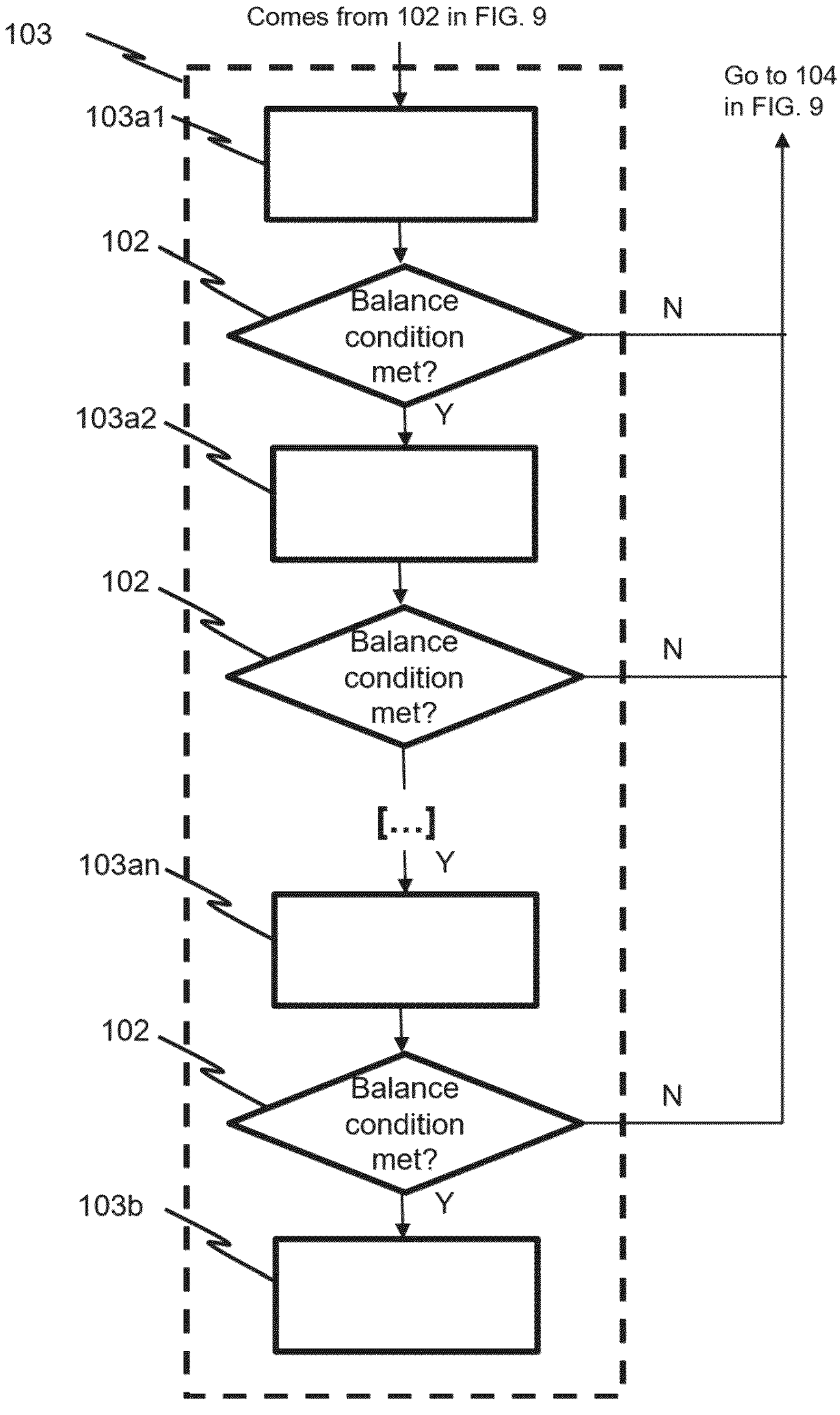
Comes from 102 in FIG. 9
103
103a1
Go to 104
in FIG. 9
102
Balance
condition
met?
N
Y
103a2
102
Balance
condition
met?
N
[…]
Y
103an
102
Balance
condition
met?
N
Y
103b

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 23 38 2561

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X	US 5 280 660 A (PELLERIN JAMES W [US] ET AL) 25 January 1994 (1994-01-25) * figures 5, 9 * * column 1, line 5 - column 10 * * column 5, line 52 - line 66 * * column 10, line 3 - line 9 * -----	10-17	
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			D06F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	10 November 2023	Werner, Christopher

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10-11-2023

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