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(54) **SYSTEMS AND METHODS FOR BALANCING AN OBJECT ROTATING ABOUT AN AXIS**

SYSTEME UND VERFAHREN ZUM AUSWUCHTEN EINES SICH UM EINE ACHSE DREHENDEN TEILS

SYSTEMES ET PROCEDES PERMETTANT D'EQUILIBRER UN OBJET EN ROTATION AUTOUR D'UN AXE

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a washing machine having a rotating container and a method of balancing the container, which turns around an axis and which is provided with balancing chambers which can be selectively filled with a balancing liquid supplied by an appropriate number of liquid feed devices, e.g. a liquid flow controlled by solenoid valves. The liquid feed devices are operated when the out-of-balance operation of the rotating container exceeds a certain maximum limit and the balancing is continued until the movement is again under this pre-set limit. In particular the present invention relates to a machine containing a drum for extracting liquid out of liquid absorbent goods like a washing or drying machine whose drum rotates about a horizontal or vertical axis and more particularly to the prevention or reduction of vibration due to imbalanced forces caused by an unequal dividing of the absorbent goods about the inner periphery of the drum during the intermediate or final spin stage.

TECHNICAL BACKGROUND

[0002] US 4,991,247 describes a method of balancing a washing machine whose drum rotates about a horizontal axis. Cavities are provided evenly distributed along the periphery of the drum and these having openings via which liquid can be selectively introduced into a cavity. A sensor is provided for sensing vibrations caused by imbalanced forces resulting from unequally divided linen in the drum. The output signal of the sensor is a measure of the current out-of-balance operation of the drum. The drum is brought to a first rotational speed and the sensor signal is read. A predetermined amount of liquid is introduced into a randomly selected cavity along the periphery of the drum. The sensor signal is again read and the value is compared with the preceding sensed value. If the value is lower than the preceding one, a predetermined amount of water is introduced into the selected cavity while if the value is equal to or greater than the preceding one, the predetermined amount is introduced into the immediate following cavity along the periphery. This sequence is repeated until the sensor signal is lower than a predetermined, permissible value at which the container is brought to rotate at a second rotational speed, higher than the first one. The sequence described is repeated for different rotational speeds until the desired rotational speed has been reached and the sensor signal is lower than the predetermined value.

[0003] US 5,280,660 describes a method of balancing a washing machine whose drum rotates about a horizontal axis and is provided with cavities evenly distributed along the periphery thereof and having openings via which liquid can be selectively introduced into a cavity. The magnitude of the out-of-balance is determined by means of an accelerometer mounted on the housing between drum and housing. The location of the out-of-balance is determined by measuring the time that has lapsed between the passage of a target mounted on the rotatable drum and the moment when the accelerometer generates a signal above a certain threshold. The passage of the target is sensed by means of an inductive sensor. By comparing this lapsed time, knowing the speed of the drum, with values stored in a memory element the injector to be activated is determined. The injector stays activated as long as the magnitude of the imbalance exceeds the threshold value. In the preferred embodiment, a single stage cavity injection process is implemented. If time t indicates the imbalance is located directly across from a cavity, that cavity is injected with water until the magnitude of the imbalance falls below an acceptable level. If time t indicates the imbalance is not located directly across from a cavity, then two predetermined cavities are injected simultaneously, at the same rate, to effectively move the location of the imbalance directly to be across from another cavity, at which time that new cavity is injected to counterbalance the imbalance.

[0004] EP 0 856 604 describes a method for balancing the drum of a washing machine equipped with three or more hollow water chambers distributed along the internal periphery of the drum. The imbalance is compensated while the drum accelerates from a low initial speed to a high final maximum spinning speed. Water is injected into a selected water chamber which is situated diametrically opposite the imbalance position. The addition of compensating water is continuous, by means of a predetermined flow, during continuous and gradual acceleration, while vibrations are measured continuously, and only the rate of acceleration is dependent upon the result of the vibration measurement. With this known method, smooth rotation is achieved without exceeding an admissible washing machine vibration value by means of drum acceleration at a gradual rate until reaching a maximum speed. It is alleged that the imbalance of the clothes is compensated for in a shorter total process time.

[0005] US 2,791,917 describes a two-drum washing machine with a balancing system. Each of a plurality of balancing chambers has an inlet for balancing liquid and also an outlet for discharge of the liquid from the chamber during operation. It is admitted that there is no known system for guaranteeing that the liquid is injected into the correct chamber. This results in augmentation of imbalance instead of reducing it. The ability to discharge liquid from each chamber allows corrections to be made but this reduces the speed at which balance can be reached.

[0006] In known methods the balancing chambers or cavities come into contact with soapy water from the drum which can reach a temperature of 90° C. This can cause the openings of the balancing chambers or the

injectors of the injection system to be blocked by chalk residue or other contamination. Regularly cleaning of those elements is required which leads to high maintenance costs and can also lead to higher water consumption because of residue liquids in the balancing chambers caused by above mentioned items.

[0007] FR-A-986.259 describes a method of balancing a washing machine. In this machine the arrangement of chambers and feed and discharge pipes is made such that there is a reduced chance that dirty liquid from the drum of the washing machine enters the balancing chambers. However, a guarantee of elimination of entry is not provided.

[0008] Another problem exists if Approval Bodies in some countries forbid that a water supply is in direct connection with a space that can be contaminated and can be placed under pressure so that contaminated water is pushed back in the public water system. Thus open systems may require water supply by means of water pumped out of a separate container. Because of the direct connection between housing and the balancing chambers, the water used to perform the balancing operation is lost after balancing which leads to about 5 to 10 % higher water consumption. Additionally, the balancing chambers may be filled with water during the prewash, main-wash and rinse operation which leads to a higher water consumption of between 20 and 30 %. Not only is there a higher water consumption but also the amount of energy needed to heat the water during a prewash or wash cycle increases by the same amount. One way of reducing loss of balancing water is to use a sealed liquid balancing system. This may include a simple sealed balancing ring which contains liquid. Due to out-of-balance motion of an unbalanced drum, the free liquid is thrown in a direction which compensates for the movement. Such a simple system can still have serious out-of-balance vibration. More sophisticated designs as disclosed in US 5,913,951 include a motor and pump mounted on the rotating drum to pump liquid between balancing cavities arranged around the periphery of the drum. This increases the complexity and cost of the design and places larger loads on the drive shaft.

[0009] With the above known methods a synchronisation between the maximum amplitude of the imbalance signal and the rotation of the drum is often required. This may be achieved by a target on the drum, e.g. an encoder, combined with a very accurate measurement of the maximum displacement caused by the imbalance or the maximum out-of-balance force. This measurement of the maximum imbalance requires an accurate sensing device with appropriate filtering of its output signal in order to prevent noise fluctuations from disguising the true maximum. Many years ago Leo Kahn proposed a solution to this problem in US 3,330,168 in which chambers are provided around the circumference of the drum and water is injected into a chamber opposite to the imbalance. It is the imbalanced movement of the drum which activates a microswitch which in turn activates water supply to one of the chambers.

[0010] With the known methods it is difficult to empty the balancing containers completely because the opening to let the balancing liquid out of the balancing cavities is at a radius smaller then the maximum radius of the balancing chamber. This means that water can be passed from an instantaneously higher chamber to a lower chamber or that liquid in the base of the machine may flow into the lower chambers. To obtain perfect evacuation of the water from the balancing chambers a dehydration cycle is required which is, however, usually not 100% effective.

[0011] It is an object of the present invention to provide an apparatus with a rotating component and a method of operating the apparatus for balancing the rotation of the component which is more effective and/or economical than known apparatus and methods.

[0012] It is a further object of the present invention to provide an apparatus for extracting a liquid from a solid using a rotating hollow drum and a method of operating the apparatus which has a lower liquid consumption than conventional apparatus and methods of this kind.

[0013] It is still a further object of the present invention to provide an apparatus for extracting a liquid from a solid using a rotating hollow drum with balancing cavities for filling with a balancing liquid and a method of operating the apparatus, with which the cavities may be more effectively drained after a high-speed rotation cycle.

[0014] It is still a further object of the present invention to provide an apparatus for extracting a liquid from a solid using a rotating hollow drum with balancing cavities for filling with a balancing liquid and a method of operating the apparatus, with which contamination of the cavities may be prevented.

DISCLOSURE OF THE INVENTION

[0015] The present invention provides a method of operating a washing machine having a rotating container as well as at least one balancing chamber on the periphery of the rotating container, said at least one balancing chamber being fillable with clean water for correcting out-of-balance rotational operation of said container, and an operation cycle of said washing machine which uses washing water. The method comprises the steps of balancing said rotating container by introducing clean water into said at least one balancing chamber during a first operation cycle; draining clean water from said balancing chamber into a dehydration unit at the end of said first operation cycle; storing excess drained clean water in a water container; using said excess stored clean water in washing water of a subsequent operation cycle; and discarding said washing water at the end of said subsequent operation cycle.

[0016] A method according to the present invention may include draining said clean water gravimetrically.

[0017] A method according to the present invention

may include catching said excess drained clean water from said balancing chamber in said water container after a predetermined quantity thereof has been drained into a housing of said washing machine.

[0018] A method according to the present invention may include releasing said stored clean water from said water container for a subsequent operation cycle when said washing machine requires water for at least one of a pre-wash, main-wash or rinsing operation.

[0019] A method according to the present invention may include controlling the capture and/or release of said excess drained clean water by means of a valve positioned between said water container and the housing of said washing machine.

[0020] In a method according to the present invention, wherein said rotating container comprises a drum of said washing machine, the method may include segregating said balancing chamber from said drum by means of a seal, whereby dirty water from said drum is prevented from entering said balancing chamber.

[0021] A method according to the present invention may include correcting said out-of-balance operation of said rotating container by two-plane compensation using at least two said balancing chambers. One of said balancing chambers may be placed closer to a side from which said machine is loaded than the other.

[0022] A method according to the present invention may further comprise the steps of sensing said out-of-balance rotational operation of said container and introducing said clean water into said at least one balancing chamber in accordance with said sensed out-of-balance operation.

[0023] A method according to the present invention, wherein said container is cylindrical and rotates about its cylindrical axis and at least two balancing chambers are provided, a first said balancing chamber lying substantially in a first plane perpendicular to said cylindrical axis and a second said balancing chamber lying in a second plane perpendicular to said cylindrical axis, may include the steps of: sensing said out-of-balance rotational operation of said container in two planes perpendicular to said cylindrical axis; and controlling the introduction of clean water into said first balancing chamber based on the results of said sensing in said first plane and controlling the introduction of clean water into said second balancing chamber based on the results of said sensing in said second plane. The method may further comprise the step of draining said clean water from said first balancing chamber after a balancing step through a first drainage channel in a direction parallel to said cylindrical axis into a second pipe common to both said first and second balancing chambers.

[0024] The present invention also provides a washing machine having a rotating container as well as at least one balancing chamber on the periphery of the rotating container, said at least one balancing chamber being fillable with clean water for correcting out-of-balance rotational operation of said container, and an operation cycle of said washing machine which uses washing water. Said machine is adapted to balance said rotating container by introduction of said clean water into said at least one balancing chamber during a first operation cycle; to drain clean water from said balancing chamber into a dehydration unit at the end of said first operation cycle; to store excess drained clean water in a water container; to use said excess stored clean water from said water container in a subsequent operation cycle; and to discard said washing water at the end of said subsequent cycle. Said clean water may be drained gravimetrically.

[0025] Said excess drained clean water from said balancing chamber may be caught in said water container after a predetermined quantity thereof has been drained into a housing of said washing machine.

[0026] In a machine according to the present invention, said stored clean water is released from said water container for use in a subsequent operation cycle when said machine requires water for at least one of a prewash, main wash or rinsing operation.

[0027] The capture and/or release of said excess drained clean water may be controlled by means of a valve positioned between said water container and the housing of said washing machine.

[0028] In a machine according to the present invention, said rotating container may comprise a drum of said washing machine and said balancing chamber may be segregated from said drum by means of a seal, whereby dirty water from said drum is prevented from entering said balancing chamber.

[0029] The out-of-balance operation of said rotating container may be corrected by two-plane compensation using at least two balancing chambers. One of said balancing chambers may be placed closer to a side from which said machine is loaded than the other.

[0030] A machine according to the present invention may further comprise a sensor for sensing said out-of-balance rotational operation of said container; and a control unit for introducing said clean water into said at least one chamber in accordance with an output of said sensor.

[0031] A machine according to the present invention, wherein said container is cylindrical and rotates about its cylindrical axis and has at least two balancing chambers, a first balancing chamber lying substantially in a first plane perpendicular to said cylindrical axis and a second balancing chamber lying in a second plane perpendicular to said cylindrical axis, may further comprise a first sensor for sensing said out-of-balance rotational operation of said container in said first plane; a second sensor for sensing said out-of-balance rotational operation of said container in said second plane; and a control unit being adapted to control the introduction of clean water into said first balancing chamber based on an output of said first sensor and to control the introduction of clean water into said second balancing chamber based on the output of said second sensor.

[0032] A machine according to the present invention, wherein said container is cylindrical and rotates about its cylindrical axis and has at least two balancing chambers, a first balancing chamber lying substantially in a first plane perpendicular to the cylindrical axis and a second balancing chamber lying in a second plane perpendicular to the cylindrical axis; may further comprise a first drainage channel running in a direction parallel to said cylindrical axis for draining said clean water from said first balancing chamber into a second pipe common to both said first and second balancing chambers.

[0033] The invention will now be described with reference to the following drawings.

DESCRIPTION OF THE DRAWINGS

[0034]

Fig. 1A is a schematic diagram of a washing machine.

Fig. 1 B is a schematic diagram of the force diagram acting upon a rotating drum of a washing machine.

Fig. 2 is a schematic representation of a washing machine in accordance with an embodiment of the present invention having two plane balancing and six balancing chambers in the front, six balancing chambers in the rear side each over an angle of 60°.

Fig 3 is a view D-D of Fig. 2 showing the front chambers and the housing mounted on spring or rubber block and the placement of a microswitch.

Fig. 4 is a view C-C of Fig. 2 showing the water injection system.

Fig. 5 is a view B-B of Fig. 2 showing a section view of the rear balancing chambers Fig. 6 is a view A-A of Fig. 2 showing a section view of the dehydration unit.

Fig. 7 is a graph showing the imbalance signal (D), the activation signal from the out-of-balance sensor (A) and operating times for the water injection, firstly when the injectors are placed in a positive sense of the activation of the sensor (B) and in the negative sense (C).

Fig. 8 is a schematic representation of a washing machine in accordance with another embodiment of the present invention having one plane balancing and three longitudinal chambers in the inner periphery of the drum having a width of e.g. 20°.

Fig. 9 is a view C-C of Fig. 8 showing the water injection system.

Fig. 10 is a view B-B of Fig. 8 showing the water supply to the balancing chambers Fig. 11 is a view A-A of Fig. 8 showing a section view of the dehydration unit.

Fig 12. is a schematic representation of a washing machine in accordance with an embodiment of the present invention having two plane balancing and six chambers in the inner periphery of the drum in line.

Fig 13 is a view A-A of Fig. 12 showing a section view of the draining chambers of a first dehydration unit.

Fig. 14 is a view B-B of Fig. 12 showing a section view showing the water supply to the chambers

Fig. 15 is a view C-C of Fig. 12 showing the water injection system.

Fig. 16 is a view D-D of Fig. 12 showing the draining chambers of a second dehydration unit.

Fig. 17 is a schematic cross-sectional representation of a washing machine in accordance with another embodiment of the present invention.

Fig. 18 shows a cross-section along the line 18-18 of the washing machine of Fig. 17.

DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

[0035] The present invention will be described with reference to certain drawings and certain embodiments but the present invention is not limited thereto but only by the claims. The present invention will mainly be described with reference to front-loaded washing machines in which the shaft of the drum is horizontal and cantilevered from a bearing but the present invention is not limited thereto. For instance, the present invention may be applied advantageously to top-loading washing machines in which the shaft of the drum is vertical as shown, for example and merely for explanatory purposes, in US 5,269,159 and US 5,829,084 or in International Patent Application WO 97/00349. In addition the skilled person will appreciate that the methods and apparatus of the present invention may find advantageous use outside washing machines as exemplified by the applications described in US 4,688,355 and US 5,561,993.

[0036] In the following words such as front, back, top, bottom, upper, lower etc. relate to a front loading washing machine in its usual operational position, i.e. the washing is loaded through a door at the front into a drum which is rotatably mounted in a cantilever fashion at the back of the machine.

[0037] The present invention may be applied to a washing machine 1 as shown schematically in Fig. 1A. Machine 1 includes a housing 2 on suspension units, e. g. rubber blocks 3, and mounted in a frame 4 and a rotatable drum 5 within the housing which is cantilevered from a bearing 32. The housing has a front door 38 for loading washing into the drum 5. A motor 13 is provided for driving the drum, e.g. through a belt and pulley system. A water supply 30, a drain valve 34 for waste water and a pump 36 for pumping out the waste water are also provided. It is well known that the damping support for a machine should ideally have a low elastic modulus, i. e. be very "soft", with viscous damping to reduce oscillations. Ideally, the system should be designed so that 1.414 times the natural resonant frequency of the system should lie well below the operating frequency of the system. This approach has been used extensively for

automobile suspensions and requires an expensive, bulky and sophisticated damper arrangement. Such a suspension system is not very suitable for a washing machine which has to work at low frequencies during washing cycles and higher frequencies during drying cycles. The present invention starts from the use of a simple suspension such as provided by rubber blocks, while actively reducing the out-of-balance forces and movements to a minimum or even to a negligible amount. In such a case the rubber blocks do not absorb significant motions or energies but rather are only provided to suppress noise. To reduce the out-of-balance forces at least one balancing chamber is provided which may be filled with water to provide the balancing. The water used for balancing is re-used in the next cycle. The chamber is segregated from the drum by means of a seal. A seal also prevents dirty water from the drum entering the balancing chamber. The out-of-balance operation of the drum is preferably corrected by two-plane compensation using at least two balancing chambers one of which is placed closer to the front of the machine 1 than the other.

[0038] A first embodiment will be described with reference to Figs. 2 to 7. A washing machine 1 to be balanced comprises a housing 2 fixed on suspension units such as rubber blocks 3 or springs which themselves are connected to a frame 4 (frame 4 is not shown in Fig. 2 for clarity purposes). A drum 5 for holding the washing rotates about a horizontal shaft 3a. The drum 5 has a plurality of circumferentially and preferably contiguously distributed and preferably equally spaced balancing chambers 6a, 6b, 6c, 6d, 6e, 6f on the front vertical surface of drum 5 and a plurality of circumferentially and preferably contiguously distributed and preferably equally spaced chambers 7a, 7b, 7c, 7d, 7e, 7f on the rear vertical surface of the drum 5. For example, 6 balancing chambers 6, 7 are particularly preferred. A casing 2a holding bearings for the shaft 3a is fixed to the rear of the housing 2. Injection pipes 8a, 8b supply water from a water source, e.g. a water main, to the front balancing chambers 6a, 6b, 6c, 6d, 6e, 6f via cylindrical space 35 and through connection pipes 5a, 5b, 5c, 5d, 5e, 5f respectively and to rear balancing chambers 7a, 7b, 7c, 7d, 7e, 7f via cylindrical space 37. The water supply is regulated by controllable water valves 13a, b which are under the control of a controller 17. Controller 17 receives as an input the output from at least one out-of-balance sensor 18. The out-of balance sensor 18 may be a microswitch, a strain gauge an accelerometer or similar. Preferably, there are two out-of balance sensors 18, a first sensor 18-1 which senses the out-of-balance operation of the front of the drum 5 and a second out-of-balance sensor 18-2 which senses the out-of-balance operation of the rear of the drum 5. Where microswitches are used, these may be activated by the movements of an upper frame 21 which is part of or attached to the housing 2 (see Fig. 3). Alternatively, the outer surface of drum 5 may be used to activate the microswitches 18 but this is less preferred as the movement of drum 5 will cause wear of the microswitch contact surfaces.

[0039] In addition, a dehydration unit 9 is provided which may comprise a plurality of circumferentially and contiguously arranged draining chambers. The dehydration unit 9 is preferably divided into the same number of chambers as the number of balancing chambers, e. g. six chambers 9a, 9b, 9c, 9d, 9e, 9f connected with the front chambers 6a, 6b ,6c ,6d ,6e, respectively through dehydration tubes 10a, 10b; 10c, 10d; 10e, 10f; 10g, 10h; 10i, 10j; 10k, 101. Preferably, each front chamber 6 is connected to a pair of dehydration tubes 10. One of the pair can drain water while the other allows entry of air. Otherwise the front chambers 6 are closed so that water ingress and extraction is only by the connections described above.

[0040] A mechanical seal 12 is preferably provided at the centre of the dehydration unit 9 to prevent soapy water from the drum 5 entering into any of the balancing chambers 7. The balancing chambers 6, 7 are connected with the housing 2 through cylindrical spaces 35, 37 and pipes 14b, 14c which can be isolated from each other by means of a valve 15. A water container 14 is provided to catch surplus balancing water which is recovered from the dehydration unit 9 and/or the rear chambers 7. 14a represents a connection to the open air which is an overflow when container 14 is full. Item 16 is a seal which prevents water entering into the bearings.

[0041] An AC motor 19 may be controlled by a frequency converter 20 so that the drum 5 can be rotated with speeds between 10 rpm and 1000 rpm or higher. For spin drying the speed may be gradually increased according to any one of the following non-limiting speed series :

	Series 1	Series 2	Series 3
n_1	100 rpm	125 rpm	100 rpm
n_2	200 rpm	250 rpm	150 rpm
n_3	400 rpm	500 rpm	300 rpm
n_4	800 rpm	1000 rpm	400 rpm
n_5	1000 rpm		550 rpm
n_6	1200 rpm		800 rpm
n_7			1000 rpm

It is clear that any other sequence can be chosen according the construction parameters of the machine.

[0042] The controller 17 may be a microcontroller or a programmable microcontroller and may include some local intelligence, i.e. a microprocessor or programmable gate for controlling the operation of the water values as well as the motor 19. The local intelligence, e.g. microprocessor or programmable gate array, is preferably programmed to carry out any of the control algorithms

of the present invention as explained below.

[0043] At each pre-determined speed step a drum balancing operation may be performed by injecting balancing liquid independently into any one or both sets of balancing chambers 6 and/or 7 if drum 5 is out-of-balance, e.g. because the washing inside the drum 5 is located all at one spot the drum has an out-of-balance motion to be corrected. A microswitch 18 is activated when the movement of the flexible frame 21 which is mounted on the housing 2 exceeds a certain limit caused by the out-of-balance operation of the drum 5. The skilled person will appreciate that out-of-balance movements of forces on the housing 2 can be detected in different ways such as with a magnetic switch, an inductive sensor or strain-gauge or a piezo-electrical element or any other suitable proximity or force sensor. In particular, physical movement of housing 2 or frame 21 is not necessary for balancing in accordance with the present invention. For rigidly journalled drums 5 there may be little movement but significant forces which may be detected by strain gauges placed in appropriate positions, e.g. on the bearings within casing 2A.

[0044] The balancing step in accordance with the present invention will be described with reference to Fig. 7. In Fig. 7 curve D shows the out-of-balance displacement of drum 5. In a first balancing step a checking cycle or parameter cycle is performed in which a time T 1 which elapses between when a signal of the microswitch 18 becomes high and low is measured (A) as well as a time T2 between when the signal of a microswitch 18 becomes low and then high again. T1 + T2 is a measure of the period time or cycle time T of one rotation of the drum 5. In the next step balancing cycles are performed, which are based on the moment at which a microswitch 18 switches from on position to off position. Ideally, water is injected into the balancing chambers 6, 7 either side of the middle point of time period T1 (see B and C) into those chambers 6, 7 which lie opposite the out-of-balance load in the drum 5. By doing this it can be guaranteed that the balancing chambers 6, 7 are filled which are opposite the out-of-balance load in drum 5. It is preferred in accordance with the present invention if water is injected into a sufficient number of contiguous balancing chambers 6, 7 which together make up a certain angle α of the circumference of drum 5. Preferably, this angle is about 120°, e.g. 120° ± 30°, or more preferably 120° ± 15°. This may be achieved by 6 equally spaced balancing chambers 6, 7 which each have an included angle of 60°. Water should be injected in such a way that 2 chambers are filled with balancing water thus making up 120° of the circumference of the drum 5. It has been found that introducing water into one narrow chamber 6, 7 is not as efficient as into a chamber or chambers having a total angle of about 120°C. The narrower the chamber, the less water it can hold and the smaller the correction effect. On the other hand chambers close to ± 90 from the position opposite the out-of-balance load have little balancing effect as the balancing force is in a direction 90° to the direction of the out-of-balance load so that it has no correction effect. Some included angle between the extremes of 180° and about 10° is therefore optimum and about 120° as been found to be suitable. This is achieved most easily by 3, 6, 9 or 12 equally distributed balancing chambers. To ensure that only 120° of chambers are filled with water during balancing, the water injection must only be continued for a time equal to or less than T/3. Therefore, the water injection time T/3 must be located within the time T1 if this time T1 is greater than T/3 - see Fig. 7. In this case the water injection is started at a time T6 after the microswitch 18 activates. However, if time T1 is less than T/3 then water may be injected for the time T1 or the time T/3 whichever is preferred. As a small time T1 indicates a position close to balance it is preferred if the water injection is only over time T1 if T1 is less than T/3 as usually in this condition less water is necessary to achieve balancing. Depending upon the position of the microswitch the injection may be necessary in phase with the operation of the microswitch (B in Fig. 7) or in counter-phase (C in Fig. 7).

[0045] In addition a further phase correction is preferably applied for determining when water should be introduced into the balancing chambers 6, 7. This phase correction value is an experimentally determined value which takes into account the phase angle deviation between the movement of the drum 5 and the out-of-balance load in the drum 5. As is well known, there is a phase difference between the force and the movement in a forced viscously damped vibration or oscillation. The phase correction changes as the operation becomes closer to or further away from the natural resonant frequency of the rotating system and it is within the scope of the present invention that the water injection control includes corrections which take into account the frequency of rotation of drum 5. This phase correction is of importance especially close to resonance as the phase correction angle ρ becomes a large value, e.g. 180° in the extreme case. This means that, without correction, balancing liquid would be injected into the chamber which is diametrically opposite to the one which would improve balancing. Such an injection will make the out-of-balance operation worse resulting in a further attempt by the balancing system to correct. This further attempt also injects liquid into the wrong chamber resulting in ever increasing out-of-balance. To try and correct this control instability it is possible to arrange that balancing liquid can not only be injected into a chamber but also extracted therefrom during rotation. This may be done by pumping liquid between chambers or by discarding the liquid. However, these solutions are costly and difficult to implement. It is preferred in accordance with the present invention if there is no discarding of the liquid from the chambers or pumping of liquid between chambers during balancing cycles. Another method is to design the suspension system for the drum so that the phase correction is roughly constant over the

frequency range 100 to 1000 rpm so that a fixed correction may be applied to obtain sufficient accuracy. This may, however, place severe limitations on the kind of suspension which can be used in practical designs of washing machines.

[0046] Accordingly, in accordance with a preferred embodiment of the present invention a correction angle p is applied dependent upon the rotational frequency of the drum so that during a balancing step, liquid is injected into the correct chamber and the balancing system does not increasingly spiral out of control. The first step is to determine the phase correction angle p versus rotational speed characteristic for the washing machine. This may be done experimentally on each machine or, if the mechanical design is independent of manufacturing tolerances, on one machine for all. The phase deviation can be determined by measuring the time shift between the signal from a fixed target on the drum and the sinusoidal signal from a proximity sensor. This characteristic is then stored in the form of an equation or as discrete values, e.g. in a look-up table (LUT). This data may be stored in non-volatile memory of the controller 17. During operation of the machine, the rotational speed is first calculated from the cycle time T by the controller 17, the inverse of which gives the rotational speed. Once the rotational speed is known, the correction angle p can be determined either from the stored function or from the LUT. Where values between stored values in the LUT are required these can be determined by conventional interpolation routines. The phase correction time T4 is calculated as $T4 = T\rho/2\pi$ when ρ is in radians. The time point of injection is then defined by:

$$(T1\text{-}T/3)/2 — T4 — T5$$

where T5 is a correction constant relating to delays in the system, e.g. the time delay between applying the current to an electrically operated valve and the release of the liquid into a balancing chamber.

[0047] The output of microswitches 18-1 at the front of the washing machine 1 and the other microswitch 18-2 at the rear is used to control the water injected into the front and rear balancing chambers 6, 7, respectively. The control procedures for the front and rear chambers 6, 7 can be carried out so that complex gyratory motions of the drum 5 may be balanced automatically. The advantage of balancing in two planes is that the centre of gravity point of the combined balancing liquid amounts in the front or rear chambers 6, 7 can be exactly aligned with the imbalance forces generated by imbalanced loads of washing in drum 5. This leads to reduced shear forces on the main shaft which carries drum 5. Fig. 1B shows the force diagram on a rotating drum where:

F_{front} = the reaction force on the front suspension (measured)

F_{rear} = the reaction force on the rear suspension (measured)

F_u = periodic unbalanced force on the suspension (unknown)

L_{fu} = distance between front suspension and centre of gravity of imbalance (unknown)

Lru = distance between rear suspension and centre of gravity of imbalance (unknown)

L = fixed distance between front and rear suspension.

From the requirement that $\Sigma F = 0$ and $\Sigma M = 0$ for stability to be maintained the following equation can be derived:

$$F_{front}/F_{rear} = L/L_{fu} - 1$$

This can be solved for L_{fu} by various methods of which only one will be described below. The time that a microswitch is on, which equals T1, is determined by the excentricity of the motion of the drum. The greater the excentricity, the longer the microswitch will stay on. However, the excentricity is also a measure of the force generating that excentricity so an approximation may be made that F_{front} is proportional to $T1_{front}$ and that F_{rear} is proportional to $T1_{rear}$, where $T1_{front}$ is the time that the front microswitch 18-1 is on and $T1_{rear}$ is the time the rear microswitch 18-2 is on (see Fig. 7 for an explanation of T1). After substituting these values in the above equation one arrives at:

$$T1_{front}/T1_{rear} = L/L_{fu} - 1$$

from which L_{fu} can be obtained.

[0048] Instead of using T1, the difference of T and T2 (T-T2) can be used. This can be an advantage when the drum is close to being balanced as then T1 is very small and T2 is large. Hence, it is easier to measure T2. A practical control algorithm can be made which relies only on keeping the value of $T1_{front}/T1_{rear}$ close to 1. At start up it is assumed that the drum is balanced and the value of $T1_{front}/T1_{rear}$ is equal to 1. If as the speed increases, the value of $T1_{front}/T1_{rear}$ increases then it means that the centre of balance of the drum and the clothes therein has moved towards the back of the drum and balancing liquid must be introduced into the rear chambers. If it decreases, liquid must be injected into the front chambers. By this means the drum may be kept equally balanced throughout its the speed range. The necessary calculations and valve control can be carried out by programming the controller 17 appropriately.

[0049] The effect of the balancing step will be to reduce movement of drum 5 and at some time both microswitches 18 are no longer activated in any rotation cycle, or, alternatively $T1_{front}$ and $T1_{rear}$ become less than a certain value in relation to the speed of the drum 5. At this point the drum has reached a satisfactory level of balance the current balancing step is completed. The

drum 5 may then be safely accelerated until the next pre-determined speed is reached at which there is performed a further balancing operation. If $T1_{front}$ or $T1_{rear}$ or both of them already exceeds a certain maximum value during the acceleration phase then the acceleration can be stopped early and a balancing operation can be performed at a speed between two predetermined values. Control of the balancing operation is done by controller 17 programmed to carry out the control actions described above.

[0050] The balancing operations are repeated until the final spinning speed is reached. The washing machine 1 is held at maximum speed by controller 17 until enough water has been extracted from the washing load in accordance with the machine design specification. Before deceleration of the drum 5, the drain valve 34 of the washing machine 1 is closed and the water valve 15 opened. All water that is in the balancing chambers 6, 7 and is submitted to a centrifugal force of less then 1 G will be drained into the bottom of housing 2. This draining occurs as the drum 5 turns slowly and is without pumping, i.e. the drainage is gravimetric. This clean water is used in the next cycle for washing purposes. Thus, no clean water is lost in accordance with the present invention. The balancing liquid in the front balancing chambers 6 is drained in the following way. In the upper position of a front balancing chamber 6 the water is drained through the pipes 5a-5f and 14b-14c to the housing 2. In this case the tubes 10 act as an air inlet. When the balancing chamber 6 is in the lower position the water is drained from the front balancing chambers 6 into the specially constructed drain chamber 9 through pipes 10. In this case the pipes 5a-5f act as an air inlet. The water is taken up to higher position through the shutters 33 in the draining chamber (see Fig. 6) so that the balancing liquid is drained to the central cylindrical space 39 and from there into the housing 2 through the pipe 14b-14c. A water level sensor (not shown) is provided to detect when a certain pre-determined level of water is in the housing 2 and when this level is reached, the water valve 15 is closed and the rest of the balancing liquid is caught in the container 14. Balancing water from the rear chamber 7 drains down through pipe 14b into housing 2. Any excess water drained after the water level indicator has been activated is drained into container 14. Water in container 14 is released later into the housing 2 at the moment when the washing machine 1 requires water for pre-, main-wash or rinsing operations by opening valve 15. Not only fresh water is saved but also energy is conserved. When the balancing water is in the balancing chambers 6, 7 is absorbs heat from the drum 5 remaining after the washing cycle. Thus, when this water is re-used in the next cycle less heat energy is required to heat up the water.

[0051] In the above embodiment of the present invention only the rear chambers 7 or the front chambers 6 may be provided. All other aspects of conservation of water are maintained.

[0052] Another embodiment of the present invention is shown in Figs. 8 to 11 in which three longitudinal discrete balancing chambers 7a, 7b, 7c are provided which are drained by dehydration unit 9. Reference numbers in the drawings which are the same as the numbers in Figs. 1 to 6 refer to the same items. The chambers are located in a longitudinal direction on the outer rim of drum 5. All other aspects of collecting and re-using water are as described above. As only one set of chambers 7 is provided, only one out-of-balance sensor 18 is required. Dehydration unit 9 may be provided by narrow channels 9a, 9b, 9c as shown in Fig. 11. The number of discrete chambers 7 may be increased to 6 or 12 for instance.

[0053] Yet another embodiment will be described with reference to Figs. 12 to 16. Reference numbers in the drawings which are the same as the numbers in Figs. 1 to 6 refer to the same items. In this embodiment two sets of discrete balancing chambers 6, 7, one at the front (6) and one at the back (7), are provided on the rim of drum 5. Each set of chambers 6, 7 has its own dehydration unit 9, 11 respectively for draining balancing water from the front chambers 6 and rear chambers 7. Each dehydration unit is similar to the dehydration unit of the first embodiment. All other aspects of water and energy conservation are maintained.

[0054] Yet another embodiment will be described with reference to Figs. 17 and 18. Reference numbers in the drawings which are the same as the numbers in Figs. 1 to 6 refer to the same items. In this embodiment one set of discrete balancing chambers 6a to f at the front are provided on the rim of drum 5. A further set of balancing chambers 7a to f is provided at the back. The balancing chambers 6a to f are connected with draining chambers 9a to f of a dehydration unit 9 for draining balancing water from the front chambers 6a to f. Supply of liquid to front chambers 6a to f as well as draining of liquid to the rehydration unit 9 is done through pipes 10a to 1. Liquid is supplied to these tubes 10 from liquid supply tube 8 via the draining chambers 9a to f. Rear balancing chambers 7a to f are filled directly from tube 8.

[0055] Certain aspects of the present invention will be understood from the above description. A balancing method of an object such as a container or hollow drum is described which turns around a horizontal or vertical axis and which is provided with balancing chambers. These chambers may be combined in various ways, e. g. at least three chambers evenly distributed in the inner or outer periphery of the drum or with at least 6 chambers (preferably, is 12 chambers) in the front and/or rear side of the drum. The chambers on the outer or. inner periphery of the drum may be further divided into two; a front and rear set. Each of the distributed chambers is connected with a cylindrical shaped volume 35, 37 so that balancing liquid can be supplied continuously. Alternatively, the water may be supplied from one cylindrical shaped volume having tubes likes spokes of a wheel leading to the chambers. In this case it is sufficient to

have only one water valve for each balancing plane.

[0056] Filling of the axial chambers is done continuously by means of connecting each separate chamber to a respective cylindrical shaped volume 35, 37 or discontinuously by means of connecting each chamber in a direct or indirect way to the respective part of a cylindrical shaped volume 35, 37 divided in an equal number of chambers like the number of balancing chambers in the front respective the rear side of the drum.

[0057] Further, a flexibly mounted rotating machine has been described whose out-of-balance movement is detected by means of a suitable sensor, such as a microswitch, a strain gauge, the plunger of the water valve, inductive -, optical sensor or any other means that can directly or indirectly detect a movement. This can be done in a simple way by a simple device such as a microswitch so that this invention makes it possible to implement the system on a small washing machine. The microswitch is mounted so that the direction of its movement is perpendicular to the movement that is caused by the imbalance To enable this the machine may also be mounted on rubber blocks or springs with a high k factor so that there is no or negligible movement in vertical direction to be expected. Having it mounted on rubber blocks has the consequence that the spring constant k is high resulting in a resonant frequency of the system which is also high. Thus resonance at low frequencies can be avoided.

[0058] In the machine in accordance with the present invention the balancing chambers are sealed from the housing by means of a mechanical seal. An injection collector volume is provided with a small diameter which is connected through pipes with the balancing chambers. A means is provided for quick draining of the balancing chambers. Two or more tubes connect each front chamber for draining towards the back. One tube is situated on the maximum radius of the chamber. The other tube is situated on the smallest radius of the chamber. Those tubes are situated in the spare space formed between the outer periphery of the drum and the rib of the washing drum. The tubes on the outer periphery are all connected with a cylindrical chamber at the rear side of the drum also divided in an equal number of chambers as there are at the front side of the drum. The outer radius of this cylindrical chamber is bigger then the radius of the front balancing chambers and the width of it as small as possible. In this way a quick draining of the front chambers is achieved.

[0059] Acceleration may be provided by predetermined steps of increasing speed. Each increment of speed is followed by a balancing operation until the measured time of microswitch operation, T I, falls under a certain limit according the speed of the drum. Further, a balancing cycle may consist out of determining the respective microswitch operating times $T1_{Front}$ and $T1_{Rear}$ during which the microswitch in the front respectively in the rear, is activated and time $T2_{Front}$ and $T2_{rear}$ during which the microswitches, in the front, respectively in the rear, are not activated.

[0060] Depending on the position of the out-of-balance sensors 18 with respect to the water injection points, different delays may be required between the operation of a sensor 18 and the water injection time. For example, if the sensor 18 is at the bottom of the housing 2 and the water injection is into chambers 6, 7 at the top of the machine 1, then a delay of T/6 may be appropriate (see Fig. 7). On the other hand if the injection point and the sensors 18 are located at about the same place then it is necessary to wait until the next half cycle, that is a time T4 (Fig. 7). $T4_{Rear}$ or $T4_{Front}$ may be determined independently which is the delay time before activating the injection water valve after detecting the rising edge of the microswitch. The water valve is generally activated for a period T/3.

[0061] A balancing system is provided for a washing machine which is sealed from the housing of the washing machine so that there are no problems to comply with water approval authority regulations and with which no problems are to be expected due to contamination in the balancing chambers.

[0062] Recycling the balancing liquid is provided without any need of extra pumps so that there is no additional water consumption compared to a conventional washing machine. To achieve this, the housing drain valve is closed before decelerating the drum. The water valve 15 is opened during deceleration so that the balancing water drains to the housing. Water valve 15 is closed if a water level sensor senses that the water has reached almost the outer diameter of the drum so that the rest of the balancing water is collected in a container 14. The moment that there is a request for water for washing or rinsing the valve 15 is opened until water is drained out of the container 14 towards the drum 5 and then closed again. For this the bottom of the container 14 is higher then the highest water level to be expected in the housing 2 when receiving the maximum to be expected balancing liquid. The volume of the container 14 is preferably equal to the maximum to be expected imbalance liquid minus the volume of water that can be contained in the housing before the water touches the drum.

[0063] The dehydration unit may be divided in an equal number of chambers as there are balancing chambers in the respective balancing plane. These draining chambers have a radius bigger then the one of the balancing chamber and are connected to each other with at least one pipe at the maximum radius of the balancing chamber. This assures a complete dehydration of the balancing chambers and makes it also possible by this to make a closed system without any mechanical or electrical dehydration valves.

[0064] DC operated water valves may be used which are opened with a positive voltage impulse to achieve short opening times and are closed by a normal negative voltage to have a small closing time.

Claims

1. A method of operating a washing machine (1) having a rotating container (5) as well as at least one balancing chamber (6a to f, 7a to f) on the periphery of the rotating container (5), said at least one balancing chamber (6a to f, 7a to f) being fillable with clean water for correcting out-of-balance rotational operation of said container, and an operation cycle of said washing machine which uses washing water; comprising the steps of:

   balancing said rotating container by introducing clean water into said at least one balancing chamber during a first operation cycle;
   draining clean water from said balancing chamber into a dehydration unit (9a to f) at the end of said first operation cycle;
   storing excess drained clean water in a water container (14);

   characterised in that the method further comprises
   using said excess stored clean water in washing water of a subsequent operation cycle; and discarding said washing water at the end of said subsequent operation cycle.

2. A method according to claim 1, including draining said clean water gravimetrically.

3. A method according to claim 1 or claim 2, including catching said excess drained clean water from said balancing chamber (6a to f, 7a to f) in said water container (14) after a predetermined quantity thereof has been drained into a housing (2) of said washing machine (1).

4. A method according to any preceding claim, including releasing said stored clean water from said water container (14) for a subsequent operation cycle when said washing machine (1) requires water for at least one of a pre-wash, main-wash or rinsing operation.

5. A method according to claim 3 or claim 4, including controlling the capture and/or release of said excess drained clean water by means of a valve (15) positioned between said water container (14) and the housing (2) of said washing machine (1).

6. A method according to any preceding claim, said rotating container comprising a drum (5) of said washing machine (1) and the method including segregating said balancing chamber (6a to f, 7a to f) from said drum by means of a seal (12), whereby dirty water from said drum is prevented from entering said balancing chamber.

7. A method according to any preceding claim, including correcting said out-of-balance operation of said rotating container (5) by two-plane compensation using at least two said balancing chambers (6a to f, 7a to f).

8. A method according to claim 7, including placing one of said balancing chambers (6a to f) closer to a side from which said machine (1) is loaded than the other (7a to f).

9. A method according to any preceding claim, further comprising the steps of sensing said out-of-balance rotational operation of said container (5) and introducing said clean water into said at least one balancing chamber (6a to f, 7a to f) in accordance with said sensed out-of-balance operation.

10. A method according to any of claims 1 to 6, wherein said container (5) is cylindrical and rotates about its cylindrical axis (3a) and at least two balancing chambers (6a to f, 7a to f) are provided, a first said balancing chamber (6a to f) lying substantially in a first plane perpendicular to said cylindrical axis and a second said balancing chamber (7a to f) lying in a second plane perpendicular to said cylindrical axis, the method including the steps of:

    sensing said out-of-balance rotational operation of said container in two planes perpendicular to said cylindrical axis; and
    controlling the introduction of clean water into said first balancing chamber (6a to f) based on the results of said sensing in said first plane and controlling the introduction of clean water into said second balancing chamber (7a to f) based on the results of said sensing in said second plane.

11. A method according to claim 10, further comprising the step of draining said clean water from said first balancing chamber after a balancing step through a first drainage channel (5a to f, 10a to f) in a direction parallel to said cylindrical axis into a second pipe (14b-c) common to both said first and second balancing chambers.

12. A washing machine (1) having a rotating container (5) as well as at least one balancing chamber (6a to 6f, 7a to f) on the periphery of the rotating container (5), said at least one balancing chamber (6a to f, 7a to f) being fillable with clean water for correcting out-of-balance rotational operation of said container, and an operation cycle of said washing machine which uses washing water, said machine being adapted to: balance said rotating container by introduction of said clean water into said at least one balancing chamber during a first operation cy-

cle: drain clean water from said balancing chamber into a dehydration unit (9a to f) at the end of said first operation cycle; store excess drained clean water in a water container (14);

characterised in that said washing machine (1) is further adapted to use said excess stored clean water from said water container (14) in a subsequent operation cycle; and to discard said washing water at the end of said subsequent cycle.

13. A machine according to claim 12, wherein said clean water is drained gravimetrically.

14. A machine according to claim 12 or claim 13, wherein said excess drained clean water from said balancing chamber (6a to f, 7a to f) is caught in said water container (14) after a predetermined quantity thereof has been drained into a housing (2) of said washing machine (1).

15. A machine according to any one of claims 12 to 14, wherein said stored clean water is released from said water container (14) for use in a subsequent operation cycle when said machine (1) requires water for at least one of a pre-wash, main wash or rinsing operation.

16. A machine according to claim 14 or claim 15, wherein the capture and/or release of said excess drained clean water is controlled by means of a valve (15) positioned between said water container (14) and the housing (2) of said washing machine (1).

17. A machine according to any one of claims 12 to 16, wherein said rotating container comprises a drum (5) of said washing machine (1) and said balancing chamber (6a to f, 7a to f) is segregated from said drum by means of a seal (12), whereby dirty water from said drum is prevented from entering said balancing chamber.

18. A machine according to any one of claims 12 to 17, wherein said out-of-balance operation of said rotating container (5) is corrected by two-plane compensation using at least two balancing chambers (6a to f, 7a to f).

19. A machine according to claim 18, wherein one of said balancing chambers (6a to f) is placed closer to a side from which said machine (1) is loaded than the other (7a to f).

20. A machine (1) according to any one of claims 12 to 19, further comprising:

a sensor (18-1, 18-2) for sensing said out-of-balance rotational operation of said container (5); and

a control unit (17) for introducing said clean water into said at least one chamber (6a to f, 7a to f) in accordance with an output of said sensor.

21. A machine (1) according to any one of claims 12 to 17, wherein said container (5) is cylindrical and rotates about its cylindrical axis (3a) and has at least two balancing chambers (6a to f, 7a to f), a first balancing chamber (6a to f) lying substantially in a first plane perpendicular to said cylindrical axis and a second balancing chamber (7a to f) lying in a second plane perpendicular to said cylindrical axis, further comprising:

a first sensor (18-1) for sensing said out-of-balance rotational operation of said container in said first plane;
a second sensor (18-2) for sensing said out-of-balance rotational operation of said container in said second plane; and
a control unit (17) being adapted to control the introduction of clean water into said first balancing chamber (6a to f) based on an output of said first sensor and to control the introduction of clean water into said second balancing chamber (7a to f) based on the output of said second sensor.

22. A machine according to any one of claims 12 to 20, wherein said container (5) is cylindrical and rotates about its cylindrical axis and has at least two balancing chambers (6a to f, 7a to f), a first balancing chamber (6a to f) lying substantially in a first plane perpendicular to the cylindrical axis (3a) and a second balancing chamber (7a to f) lying in a second plane perpendicular to the cylindrical axis; further comprising a first drainage channel (5a to f, 10a to l) running in a direction parallel to said cylindrical axis for draining said clean water from said first balancing chamber (6a to f) into a second pipe (14b-c) common to both said first and second balancing chambers.

Patentansprüche

1. Verfahren zum Betreiben einer Waschmaschine (1), welche einen Drehbehälter (5) sowie mindestens eine Auswuchtkammer (6a-f, 7a-f) an der Außenfläche des Drehbehälters (5) aufweist, wobei mindestens eine Auswuchtkammer (6a-f, 7a-f) zum Beseitigen eines unwuchtigen Drehbetriebs des Drehbehälters (5) mit sauberem Wasser füllbar ist, und einer Betriebsphase der Waschmaschine (1), welche Waschwasser nützt, mit den Schritten:

Auswuchten des Drehbehälters (5) durch Ein-

füllen von sauberem Wasser in mindestens eine Auswuchtkammer (6a-f, 7a-f) während einer ersten Betriebsphase;

Ablassen von sauberem Wasser aus der Auswuchtkammer (6a-f, 7a-f) in eine Entwässerungseinrichtung (9a-f) am Ende der ersten Betriebsphase;

Speichern von überschüssigem abgelassenem sauberem Wasser in einem Wasserbehälter (14);

dadurch gekennzeichnet, dass das Verfahren weiter aufweist:

Verwenden des überschüssigen gespeicherten sauberen Wassers in einer nachfolgenden Betriebsphase;

Entfernen des Waschwassers am Ende der nachfolgenden Betriebsphase.

2. Verfahren gemäß Anspruch 1, welches das gravimetrisches Ablassen des sauberen Wassers beinhaltet.

3. Verfahren gemäß dem Anspruch 1 oder 2, welches ein Auffangen des überschüssigen abgelassenen sauberen Wassers von der Auswuchtkammer (6a-f, 7a-f) in den Wasserbehälter (14), nachdem eine vorbestimmte Menge indes in ein Gehäuse (2) der Waschmaschine (1) abgelassen wurde, aufweist.

4. Verfahren gemäß einem der vorhergehenden Ansprüche, welches aufweist: Ablaufenlassen des sauberen gespeicherten Wassers aus dem Wasserbehälter (14) für eine nachfolgende Betriebsphase, wenn die Waschmaschine (1) Wasser für einen Vorwasch-, Hauptwasch- und/oder Spülbetrieb benötigt.

5. Verfahren gemäß dem Anspruch 3 oder 4, welches aufweist: Steuern des Auffangens und/oder des Ablaufenlassens des überschüssigen abgelassenen sauberen Wassers mittels eines Ventils (15), welches zwischen dem Wasserbehälter (14) und dem Gehäuse (2) der Waschmaschine (1) angeordnet ist.

6. Verfahren gemäß einem der vorhergehenden Ansprüche, wobei der Drehbehälter (5) eine Trommel (5) der Waschmaschine (1) aufweist und das Verfahren ein Trennen der Auswuchtkammer (6a-f, 7a-f) von der Trommel (5) mittels einer Dichtung (12) aufweist, wodurch schmutziges Wasser von der Trommel (5) daran gehindert wird in die Auswuchtkammer einzudringen.

7. Verfahren gemäß einem der vorhergehenden Ansprüche, welches aufweist: Beseitigen des unwuchtigen Betriebs des Drehbehälters (5) durch eine Zweiflächenkompensation, welche mindestens zwei der Auswuchtkammern (6a-f, 7a-f) nützt.

8. Verfahren gemäß Anspruch 7, welches aufweist: Anordnen einer der Auswuchtkammern (6a-f) näher an eine Seite, von welcher die Waschmaschine (1) beladen wird, als an die andere (7a-f).

9. Verfahren gemäß einem der vorhergehenden Ansprüche mit den weiteren Schritten: Erfassen des unwuchtigen Drehbetriebs des Drehbehälters (5) und Einbringen von sauberem Wasser in mindestens eine Auswuchtkammer (6a-f, 7a-f) entsprechend dem erfassten unwuchtigen Betrieb.

10. Verfahren gemäß einem der Ansprüche 1-6, wobei der Drehbehälter (5) zylindrisch ist und sich um seine axiale Achse (32) dreht und mindestens zwei Auswuchtkammern (6a-f, 7a-f) bereitgestellt sind, wobei eine erste Auswuchtkammer (6a-f, 7a-f) im Wesentlichen in einer ersten Ebene liegt, welche senkrecht zu der axialen Achse (32) ist und eine zweite Unwuchtkammer (7a-f) in einer zweiten Ebene liegt, welche senkrecht zur axialen Achse ist, wobei das Verfahren die Schritte aufweist:

Erfassen des unwuchtigen Drehbetriebs des Drehbehälters (5) in zwei Ebenen senkrecht zur axialen Achse;

Steuern des Einfüllens von sauberem Wasser in die erste Auswuchtkammer (6a-f) basierend auf den Ergebnissen des Erfassens in der ersten Ebene und Steuern des Einfüllens von sauberem Wasser in die zweite Auswuchtkammer (7a-f) basierend auf den Ergebnissen des Erfassens in der zweiten Ebene.

11. Verfahren gemäß Anspruch 10, welches des weiteren die Schritte aufweist:

Ablassen des sauberen Wassers aus der ersten Auswuchtkammer (6a-f) nach einem Auswuchtschritt durch einen ersten Entwasserungskanal (5a-f, 10a-l) in eine zu der axialen Achse (32) parallele Richtung in eine zweite Röhre (14b-c), welche der ersten und zweiten Auswuchtkammer (6a-f, 7a-f) gemein ist.

12. Waschmaschine (1), welche einen Drehbehälter (5) und ebenso mindestens eine Auswuchtkammer (6a-f, 7a-f) auf der Außenfläche des Drehbehälters (5) aufweist, wobei mindestens eine Auswuchtkammer (6a-f, 7a-f) mit Wasser füllbar ist, um einen unwuchtigen Drehbetrieb des Drehbehälters (5) zu

beseitigen und eine Betriebsphase der Waschmaschine (1), welche Waschwasser nutzt, aufweist, wobei die Waschmaschine (1) angepasst ist, um den Drehbehälter (5) auszuwuchten, durch: Einbringen von frischem Wasser in mindestens eine Auswuchtkammer (6a-f, 7a-f) während einer ersten Betriebsphase; Ablassen von Wasser aus der Ausgleichskammer (6a-f, 7a-f) in eine Entwässerungseinrichtung (9a-f) am Ende der ersten Betriebsphase; Speichern von überschüssigem abgelassenem Wasser in einem Wasserbehälter (14);
dadurch gekennzeichnet, dass die Waschmaschine (1) des Weiteren angepasst ist, überschüssiges gespeichertes Wasser aus dem Wasserbehälter (14) in einer nachfolgenden Betriebsphase zu nützen und das Wasser in einer nachfolgenden Betriebsphase zu entfernen.

13. Waschmaschine (1) gemäß dem Anspruch 12, wobei das Wasser gravimetrisch abgelassen wird.

14. Waschmaschine (1) gemäß den Ansprüchen 12 oder 13, wobei das überschüssige abgelassene saubere Wasser von der Auswuchtkammer (6a-f, 7a-f) im Wasserbehälter (14) aufgefangen wird, nachdem eine vorbestimmte Menge davon in ein Gehäuse (2) der Waschmaschine (1) abgelassen wurde.

15. Waschmaschine (1) gemäß einem der Ansprüche 12-14, wobei das gespeicherte saubere Wasser aus dem Wasserbehälter (14) zur Benutzung in einer nachfolgenden Betriebsphase abgelassen wird, wenn die Waschmaschine (1) Wasser für einen Vorwasch-, Hauptwasch- und/oder Spülbetrieb benötigt.

16. Waschmaschine (1) gemäß dem Anspruch 14 oder 15, wobei das Auffangen und/oder das Ablaufenlassen des überschüssigen abgelassenen sauberen Wassers mittels eines Ventils(15) gesteuert wird, welches zwischen dem Wasserbehälters (14) und dem Gehäuse (2) der Waschmaschine (1) angeordnet ist.

17. Waschmaschine (1) gemäß einem der Ansprüche 12-16, wobei der Drehbehälter (5) der Waschmaschine (1) eine Trommel aufweist und die Auswuchtkammer (6a-f, 7a-f) von der Trommel mittels einer Dichtung (12) getrennt ist, wodurch schmutziges Wasser der Trommel am Eindringen in die Auswuchtkammer (6a-f, 7a-f) gehindert wird.

18. Waschmaschine (1) gemäß einem der Ansprüche 12-17, wobei der unwuchtige Betrieb des Drehbehälters (5) durch eine Zweiflächenkompensation beseitigt wird, wobei mindestens zwei Auswuchtkammern (6a-f, 7a-f) verwendet werden.

19. Waschmaschine (1) gemäß dem Anspruch 18, wobei eine der Auswuchtkammern (6a-f, 7a-f) näher an einer Seite angeordnet ist, über welche die Waschmaschine (1) beladen wird, als die andere (7a-f).

20. Waschmaschine (1) gemäß einem der Ansprüchen 12-19 mit:

einem Sensor (18-1, 18-2) zum Erfassen des unwuchtigen Drehbetriebs des Drehbehälters (5); und
einer Steuereinrichtung (17) zum Einfüllen von sauberem Wasser in mindestens eine Auswuchtkammer (6a-f, 7a-f) entsprechend dem Ausgabewert des Sensors (18-1, 18-2).

21. Waschmaschine (1) gemäß einem der Ansprüchen 12-17, wobei der Drehbehälter (5) zylindrisch ist und sich um seine axiale Achse (3a) dreht und mindestens zwei Auswuchtkammern (6a-f, 7a-f) aufweist, wobei eine erste Ausgleichskammer (6a-f) im Wesentlichen in einer ersten Ebene liegt, welche senkrecht zu der axialen Achse (3a) ist und eine zweite Auswuchtkammer (7a-f), welche in einer zweiten Ebene liegt, welche senkrecht zu der axialen Achse (3a) ist, welche des Weiteren aufweist:

einen ersten Sensor (18-1) zum Erfassen des unwuchtigen Drehbetriebs des Drehbehälters (5) in der ersten Ebene;

einen zweiten Sensor (18-2) zum Erfassen des unwuchtigen Drehbetriebs des Drehbehälters (5) in der zweiten Ebene;

und eine Steuereinrichtung (17), welche angepasst ist, das Einfüllen von sauberem Wasser in die erste Auswuchtkammer (6a-f) basierend auf dem ersten Ausgabewert des ersten Sensors (18-1) zu steuern und das Einbringen von sauberem Wasser in die zweite Auswuchtkammer (7a-f) basierend auf dem Ausgabewert des zweiten Sensors (18-2) zu steuern.

22. Waschmaschine (1) gemäß einem der Ansprüchen 12-20, wobei der Drehbehälter (5) zylindrisch ist und um seine axiale Achse rotiert und mindestens zwei Auswuchtkammern (6a-f, 7a-f) aufweist, wobei eine erste Auswuchtkammer (6a-f) im Wesentlichen in einer ersten Ebene liegt, welche senkrecht zu der axialen Achse ist und eine zweite Auswuchtkammer (7a-f) in einer zweiten Ebene liegt, welche senkrecht zu der axialen Achse (3a) ist; welche des Weiteren einen ersten Entwässerungskanal (5a-f, 10a-l) aufweist, welcher in einer zu der axialen Achse parallelen Richtung verläuft, um das saubere Wasser von der ersten Auswuchtkammer (6a-f) in

eine zweite Röhre (14b-c) abzulassen, welche der ersten und zweiten Auswuchtkammer (6a-f, 7a-f) gemein ist.

Revendications

1. Procédé de mise en oeuvre d'une machine à laver (1) ayant un conteneur rotatif (5) aussi bien qu'au moins une chambre d'équilibrage (6a à f, 7a à f) sur la périphérie du conteneur rotatif (5), ladite au moins une chambre d'équilibrage (6a à f, 7a à f) pouvant être remplie avec de l'eau propre pour corriger un fonctionnement rotatif déséquilibré dudit conteneur, et un cycle de mise en oeuvre de ladite machine à laver qui utilise de l'eau de lavage ; comprenant les étapes consistant à :

équilibrer ledit conteneur rotatif en introduisant de l'eau propre dans ladite au moins une chambre d'équilibrage pendant un premier cycle de mise en oeuvre ;
vider l'eau propre de ladite chambre d'équilibrage dans une unité de déshydratation (9a à f) à la fin dudit premier cycle de mise en oeuvre ;
stocker l'eau propre en excès vidée dans un conteneur d'eau (14) ;

caractérisé en ce que le procédé comprend de plus :

l'utilisation de ladite eau propre en excès stockée comme eau de lavage lors d'un cycle de mise en oeuvre suivant ; et
le rejet de ladite eau de lavage à la fin dudit cycle de mise en oeuvre suivant.

2. Procédé selon la revendication 1, incluant le vidage de ladite eau propre par gravité.

3. Procédé selon la revendication 1 ou la revendication 2, comprenant la récupération de ladite eau propre en excès vidée en provenance de ladite chambre d'équilibrage (6a à f, 7a à f) dans ledit conteneur d'eau (14) après qu'une quantité prédéterminée de cette dernière s'est écoulée dans un logement (2) de ladite machine à laver (1).

4. Procédé selon l'une quelconque des revendications précédentes, comprenant la libération de ladite eau propre stockée depuis ledit conteneur d'eau (14) pour un cycle de mise en oeuvre suivant quand ladite machine à laver (1) a besoin d'eau pour au moins une opération de prélavage, de lavage principal ou de rinçage.

5. Procédé selon la revendication 3 ou la revendication 4, comprenant la commande de la récupération et/ou de la libération de ladite eau propre en excès vidée au moyen d'une vanne (15) positionnée entre ledit conteneur d'eau (14) et le logement (2) de ladite machine à laver (1).

6. Procédé selon l'une quelconque des revendications précédentes, ledit conteneur rotatif comprenant un tambour (5) de ladite machine à laver (1) et le procédé comprenant la séparation de ladite chambre d'équilibrage (6a à f, 7a à f) dudit tambour au moyen d'un joint (12), de sorte que l'eau sale provenant dudit tambour est empêchée de pénétrer dans ladite chambre d'équilibrage.

7. Procédé selon l'une quelconque des revendications précédentes, comprenant la correction dudit fonctionnement déséquilibré dudit conteneur rotatif (5) par une compensation en deux plans en utilisant au moins deux dites chambres d'équilibrage (6a à f, 7a à f).

8. Procédé selon la revendication 7, comprenant le placement d'une desdites chambres d'équilibrage (6a à f) plus près d'un côté par lequel ladite machine (1) est chargée que l'autre (7a à f).

9. Procédé selon l'une quelconque des revendications précédentes, comprenant de plus les étapes consistant à détecter ledit fonctionnement rotatif déséquilibré dudit conteneur (5) et à introduire ladite eau propre dans ladite au moins une chambre d'équilibrage (6a à f, 7a à f) selon ledit fonctionnement déséquilibré détecté.

10. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel ledit conteneur (5) est cylindrique et tourne autour de son axe cylindrique (3a) et au moins deux chambres d'équilibrage (6a à f, 7a à f) sont prévues, une première dite chambre d'équilibrage (6a à f) se situant sensiblement dans un premier plan perpendiculaire audit axe cylindrique et une seconde dite chambre d'équilibrage (7a à f) se situant dans un second plan perpendiculaire audit axe cylindrique, le procédé comprenant les étapes consistant à :

détecter ledit fonctionnement rotatif déséquilibré dudit conteneur dans deux plans perpendiculaires audit axe cylindrique ; et
commander l'introduction d'eau propre dans ladite première chambre d'équilibrage (6a à f) sur la base des résultats de ladite détection dans ledit premier plan et commander l'introduction d'eau propre dans ladite seconde chambre d'équilibrage (7a à f) sur la base des résultats de ladite détection dans ledit second plan.

11. Procédé selon la revendication 10, comprenant de

plus l'étape de vidage de ladite eau propre depuis ladite première chambre d'équilibrage après une étape d'équilibrage par l'intermédiaire d'un premier conduit de vidage (5a à f, 10a à 1) dans une direction parallèle audit axe cylindrique dans un second tuyau (14b et c) commun aux deux première et seconde chambres d'équilibrage.

12. Machine à laver (1) ayant un conteneur rotatif (5) aussi bien qu'au moins une chambre d'équilibrage (6a à 6f, 7a à f) sur la périphérie du conteneur rotatif (5), ladite au moins une chambre d'équilibrage (6a à f, 7a à f) pouvant être remplie avec de l'eau propre pour corriger un fonctionnement rotatif déséquilibré dudit conteneur, et un cycle de mise en oeuvre de ladite machine à laver qui utilise de l'eau de lavage, ladite machine étant conçue pour : équilibrer ledit conteneur rotatif par l'introduction de ladite eau propre dans ladite au moins une chambre d'équilibrage pendant un premier cycle de mise en oeuvre ; vider de l'eau propre depuis ladite chambre d'équilibrage dans une unité de déshydratation (9a à f) à la fin dudit premier cycle de mise en oeuvre ; stocker l'eau propre en excès vidée dans un conteneur d'eau (14) ;

caractérisée en ce que ladite machine à laver (1) est de plus conçue pour utiliser ladite eau propre en excès stockée provenant dudit conteneur d'eau (14) dans un cycle de mise en oeuvre suivant ; et pour rejeter ladite eau de lavage à la fin dudit cycle suivant.

13. Machine selon la revendication 12, dans laquelle ladite eau propre est vidée par gravité.

14. Machine selon la revendication 12 ou la revendication 13, dans laquelle ladite eau propre en excès vidée provenant de ladite chambre d'équilibrage (6a à f, 7a à f) est récupérée dans ledit conteneur d'eau (14) après qu'une quantité prédéterminée de cette dernière s'est écoulée dans un logement (2) de ladite machine à laver (1).

15. Machine selon l'une quelconque des revendications 12 à 14, dans laquelle ladite eau propre stockée est libérée dudit conteneur d'eau (14) pour une utilisation dans un cycle de mise en oeuvre suivant quand ladite machine (1) a besoin d'eau pour au moins une opération de prélavage, de lavage ou de rinçage.

16. Machine selon la revendication 14 ou la revendication 15, dans laquelle la récupération et/ou la libération de ladite eau propre en excès vidée est commandée au moyen d'une vanne (15) positionnée entre ledit conteneur d'eau (14) et le logement (2) de ladite machine à laver (1).

17. Machine selon l'une quelconque des revendications 12 à 16, dans laquelle ledit conteneur rotatif constitue le tambour (5) de ladite machine à laver (1) et ladite chambre d'équilibrage (6a à f, 7a à f) est isolée dudit tambour au moyen d'un joint (12), de sorte que l'eau sale provenant dudit tambour est empêchée de pénétrer dans ladite chambre d'équilibrage.

18. Machine selon l'une quelconque des revendications 12 à 17, dans laquelle ledit fonctionnement déséquilibré dudit conteneur rotatif (5) est corrigé par une compensation en deux plans en utilisant au moins deux chambres d'équilibrage (6a à f, 7a à f).

19. Machine selon la revendication 18, dans laquelle l'une desdites chambres d'équilibrage (6a à f) est placée plus près d'un côté par lequel ladite machine (1) est chargée que l'autre (7a à f).

20. Machine (1) selon l'une quelconque des revendications 12 à 19, comprenant de plus :

un capteur (18-1, 18-2) pour détecter ledit fonctionnement rotatif déséquilibré dudit conteneur (5) ; et
une unité de commande (17) pour introduire ladite eau propre dans ladite au moins une chambre (6a à f, 7a à f) selon une sortie dudit capteur.

21. Machine (1) selon l'une quelconque des revendications 12 à 17, dans laquelle ledit conteneur (5) est cylindrique et tourne autour de son axe cylindrique (3a) et comporte au moins deux chambres d'équilibrage (6a à f ; 7a à f), une première chambre d'équilibrage (6a à f) se situant sensiblement dans un premier plan perpendiculaire audit axe cylindrique et une seconde chambre d'équilibrage (7a à f) se situant dans un second plan perpendiculaire audit axe cylindrique, comprenant de plus :

un premier capteur (18-1) pour détecter ledit fonctionnement rotatif déséquilibré dudit conteneur dans ledit premier plan ;
un second capteur (18-2) pour détecter ledit fonctionnement rotatif déséquilibré dudit conteneur dans ledit second plan ; et
une unité de commande (17) conçue pour commander l'introduction d'eau propre dans ladite première chambre d'équilibrage (6a à f) sur la base d'une sortie dudit premier capteur et pour commander l'introduction d'eau propre dans ladite seconde chambre d'équilibrage (7a à f) sur la base de la sortie dudit second capteur.

22. Machine selon l'une quelconque des revendications 12 à 20, dans laquelle ledit conteneur (5) est cylindrique et tourne autour de son axe cylindrique

et comporte au moins deux chambres d'équilibrage (6a à f, 7a à f), une première chambre d'équilibrage (6a à f) se situant sensiblement dans un premier plan perpendiculaire à l'axe cylindrique (3a) et une seconde chambre d'équilibrage (7a à f) se situant dans un second plan perpendiculaire à l'axe cylindrique ; comprenant de plus un premier conduit de vidage (5a à f, 10a à 1) courant dans une direction parallèle audit axe cylindrique pour vider ladite eau propre provenant de ladite première chambre d'équilibrage (6a à f) dans un second tuyau (14b et c) commun aux deux dites première et seconde chambres d'équilibrage.

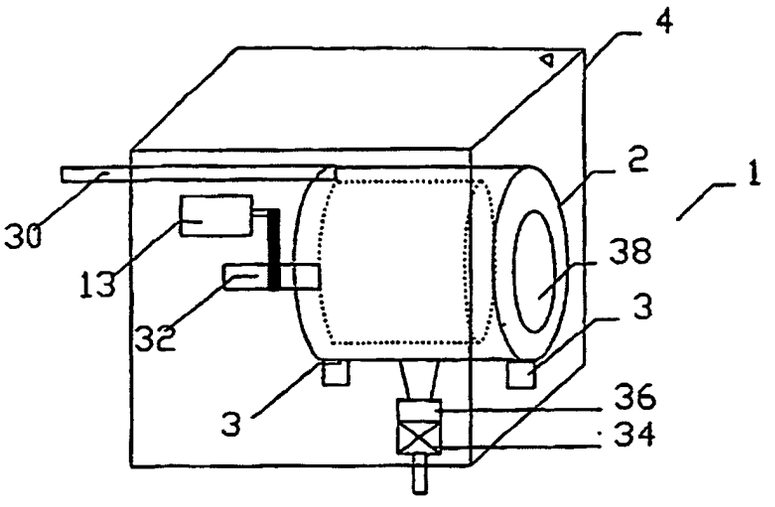


Fig. 1A

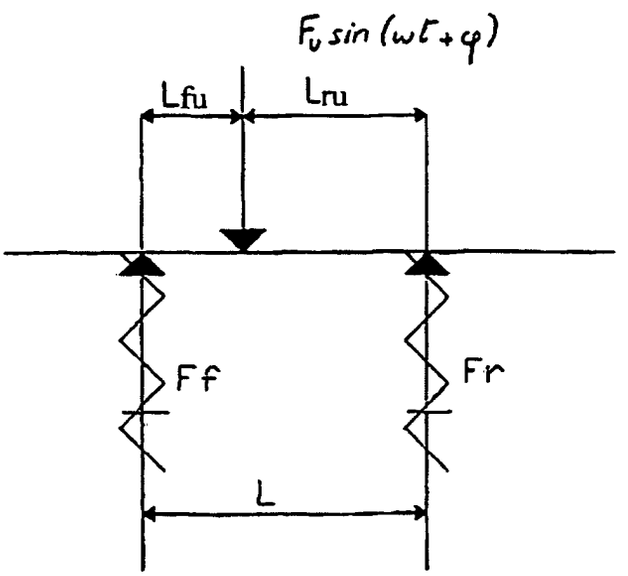


Fig. 1B

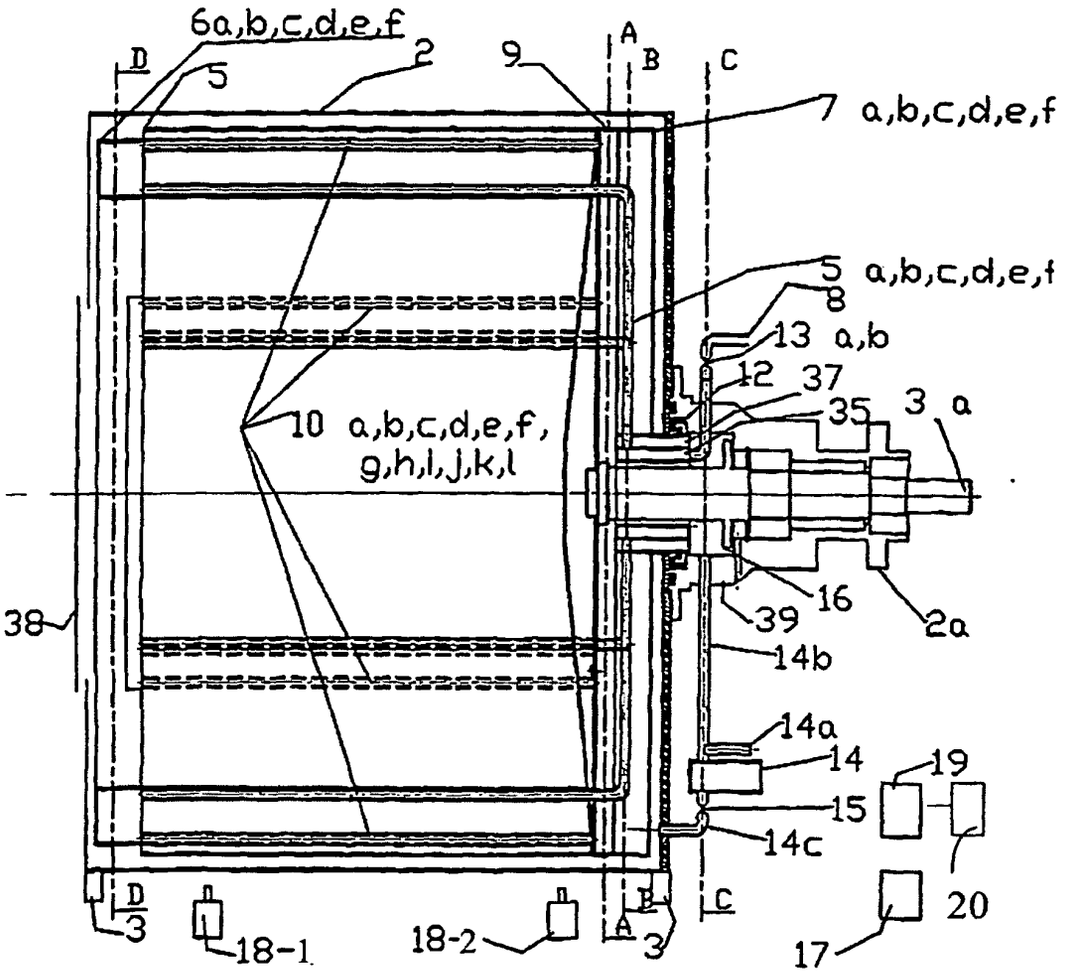

6a,b,c,d,e,f
D
5
2
9
A
B
C
7 a,b,c,d,e,f
5 a,b,c,d,e,f
8
13 a,b
12
37
35
3 a
10 a,b,c,d,e,f,
g,h,l,j,k,l
38
16
39
2a
14b
14a
14
19
15
14c
20
17
D
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18-1
18-2
A
B
C
3

Fig. 2

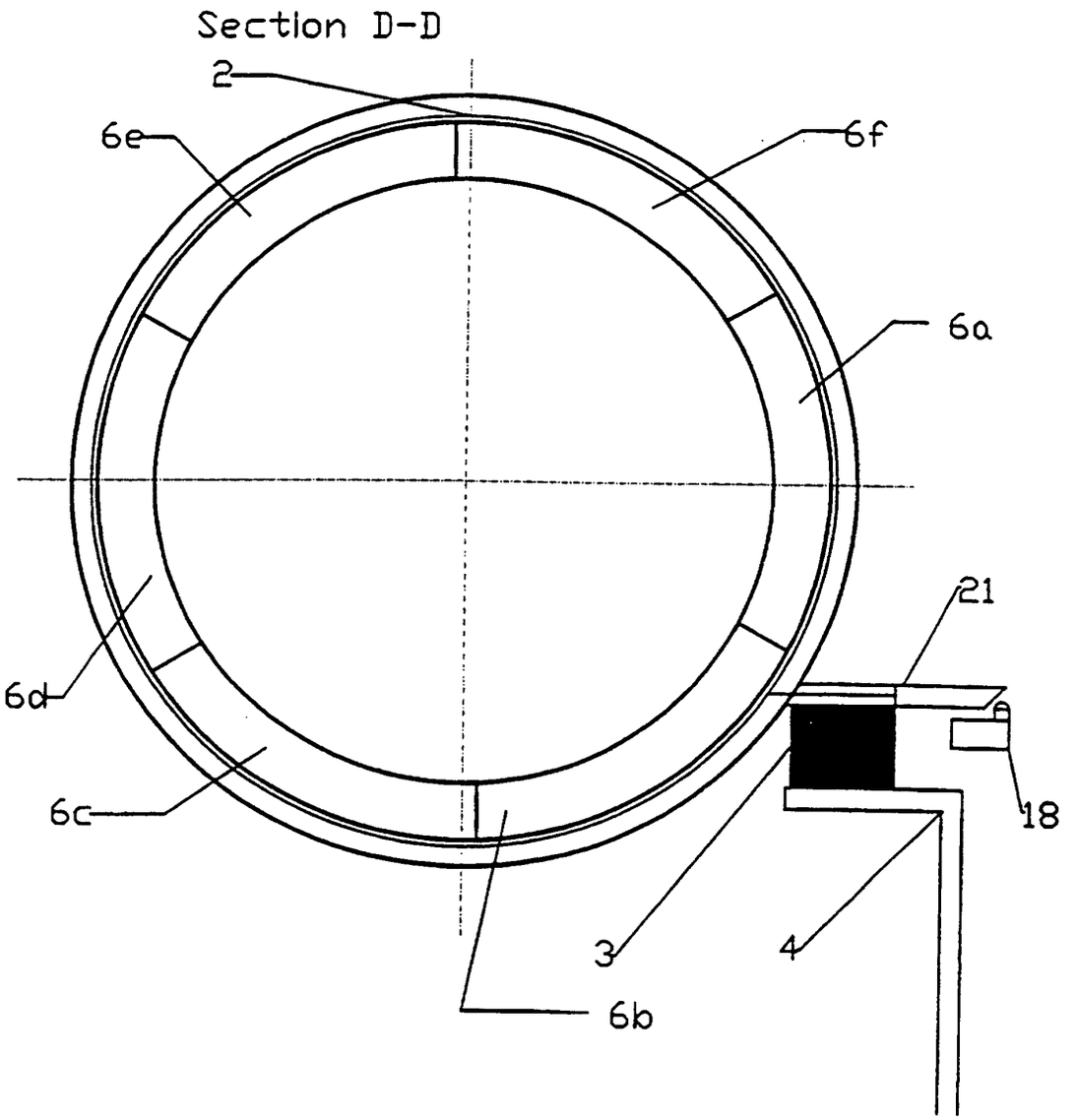


Fig 3.

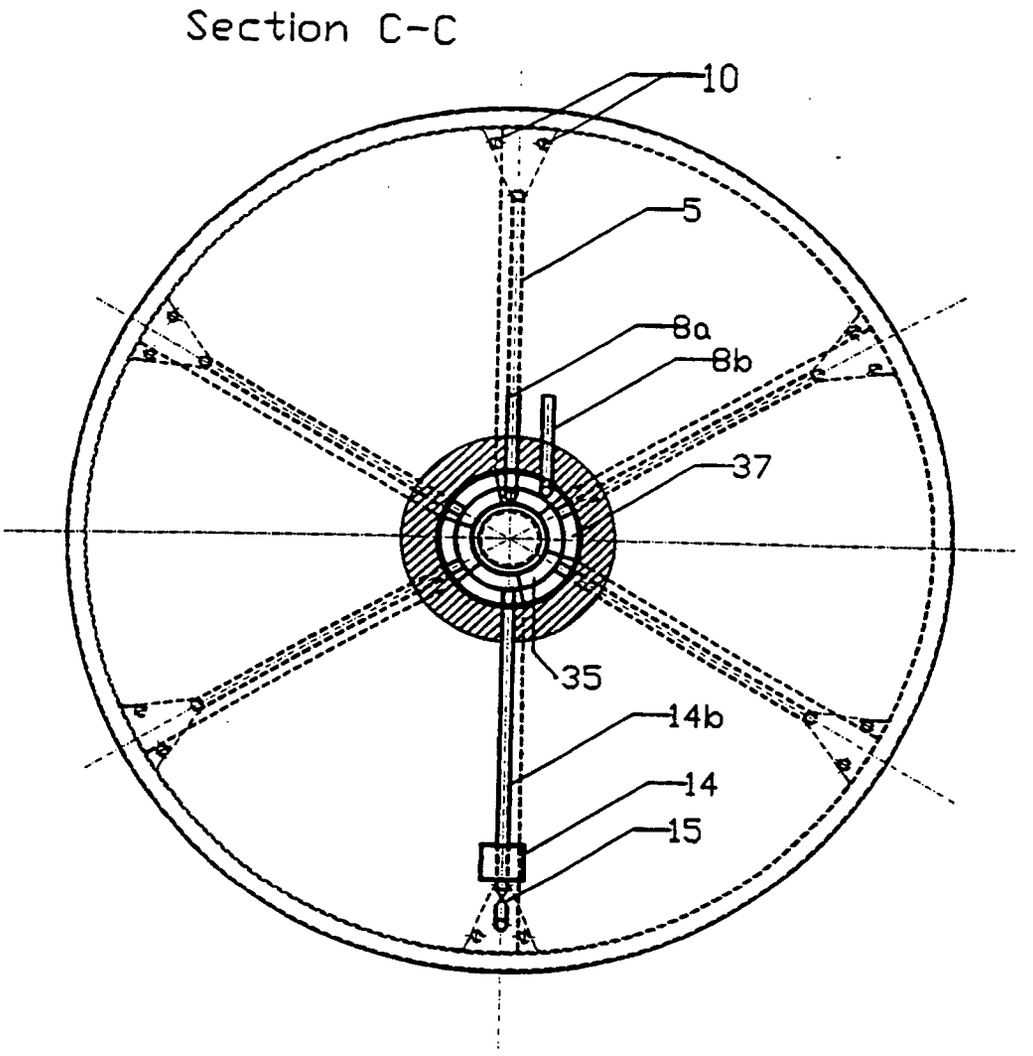


Fig 4.

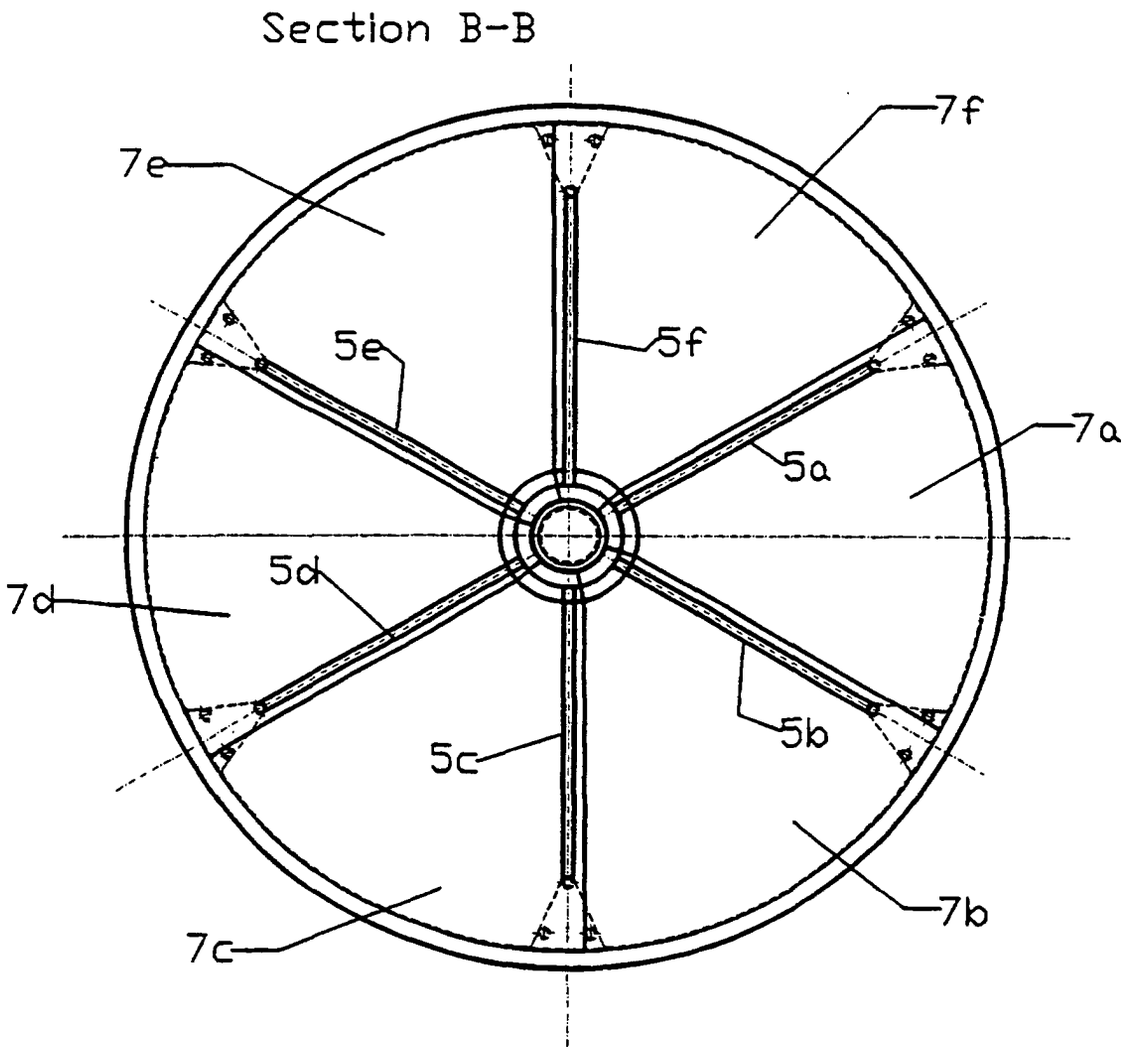


Fig 5.

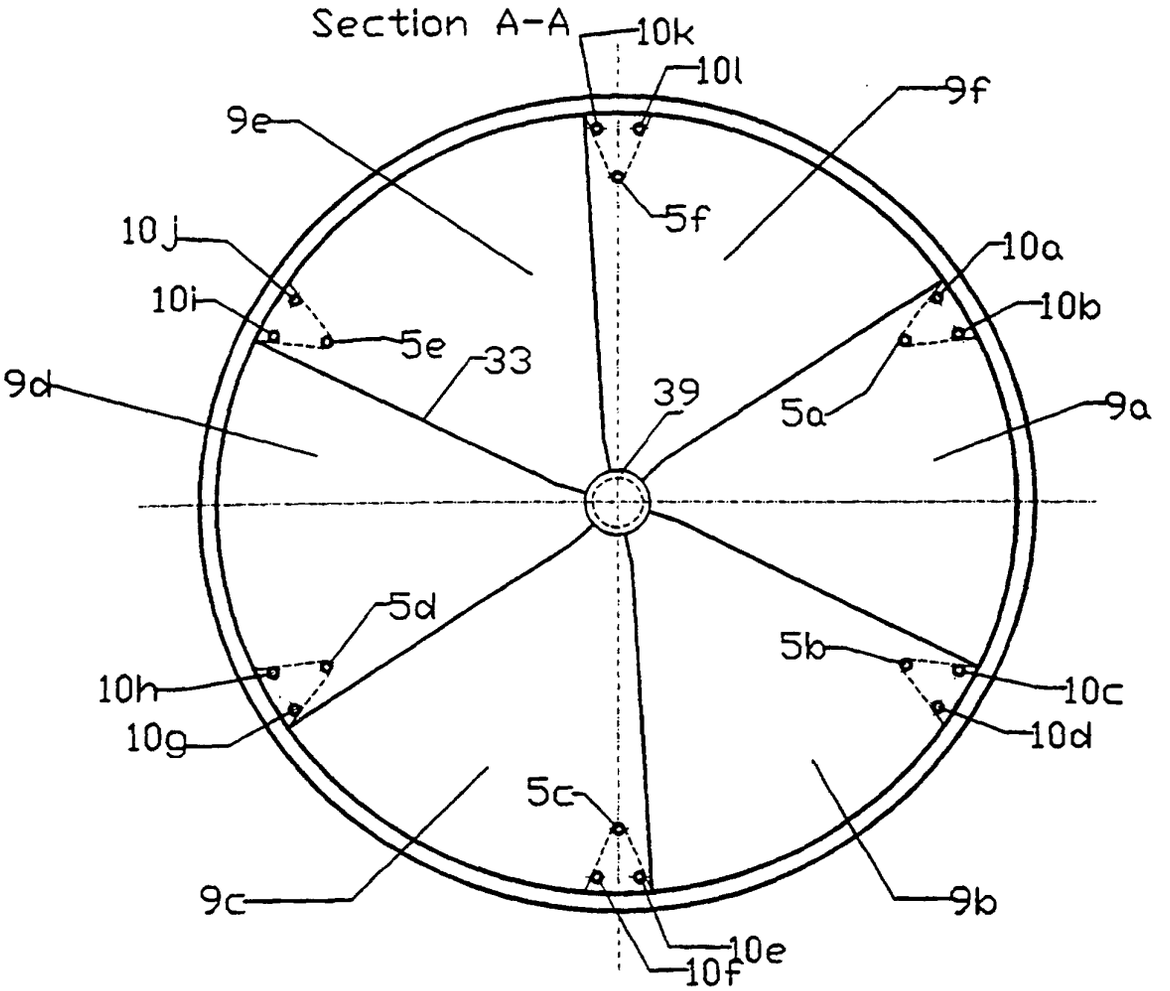

Section A-A
10k
10l
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5f
10j
10a
10i
10b
5e
33
39
9d
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5b
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10c
10g
10d
5c
9c
9b
10e
10f

Fig 6.

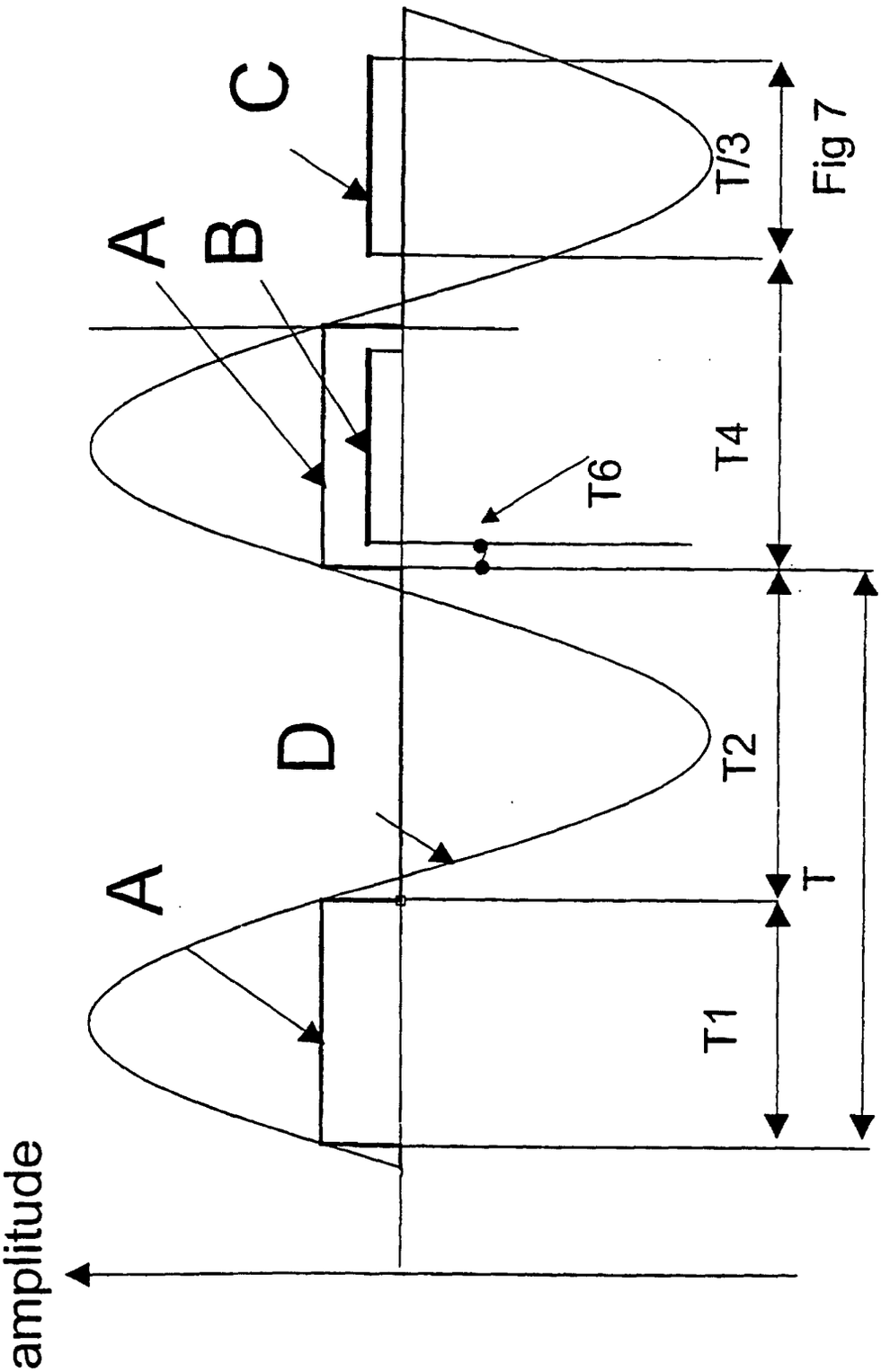


Fig 7

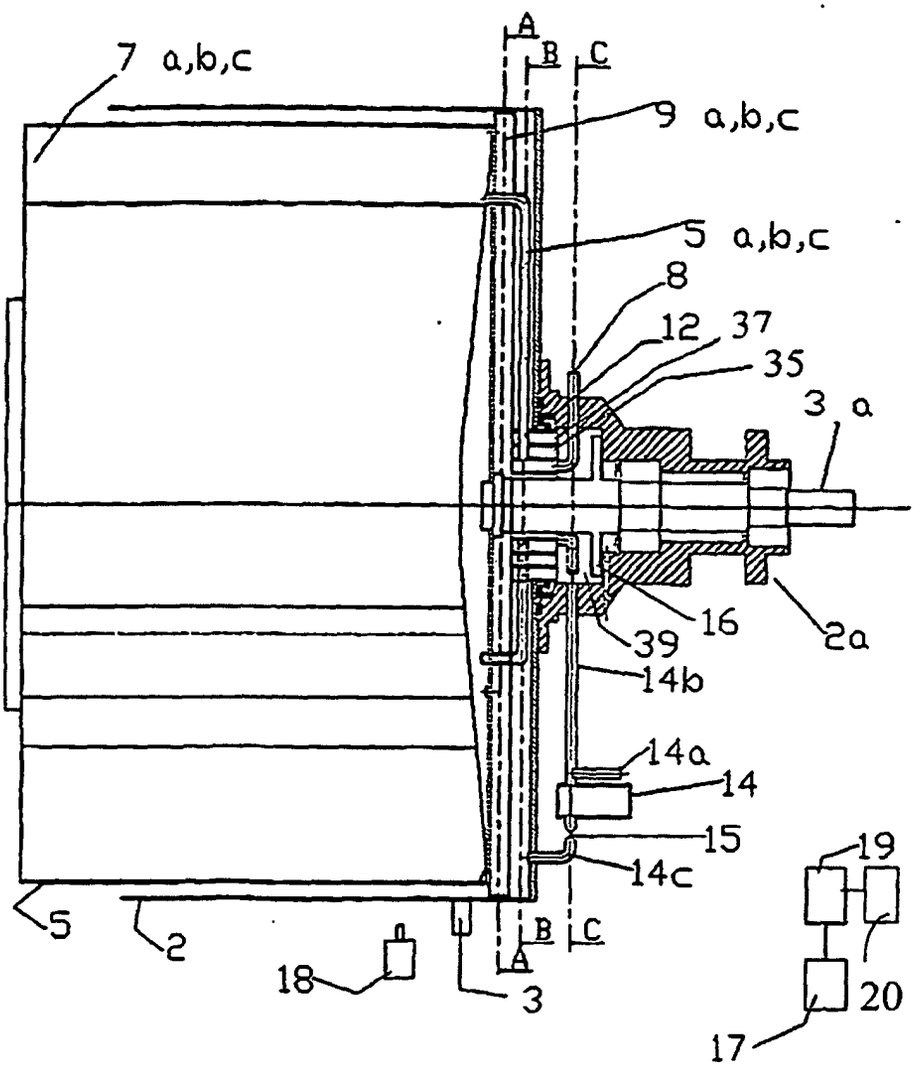

A
B
C
7 a,b,c
9 a,b,c
5 a,b,c
8
12
37
35
3 a
16
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14b
14a
14
15
14c
19
20
17
5
2
18
3
B
C
A

Fig. 8

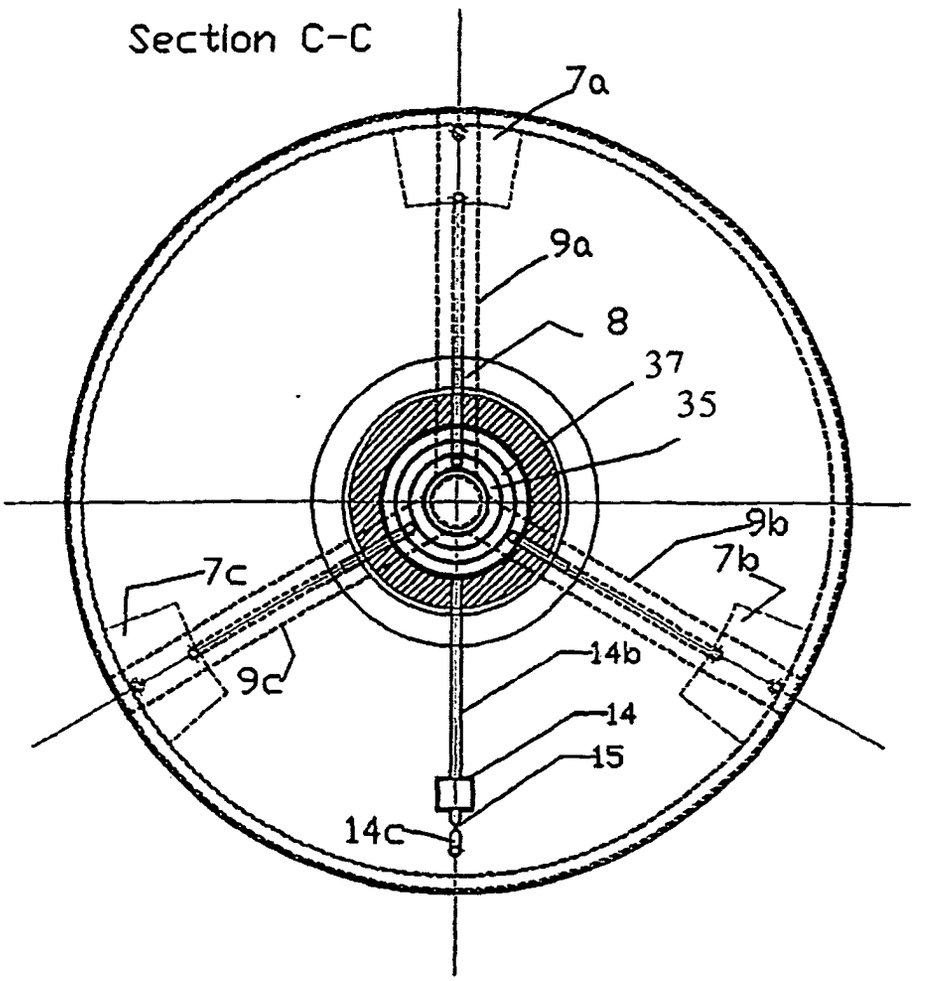


Fig. 9

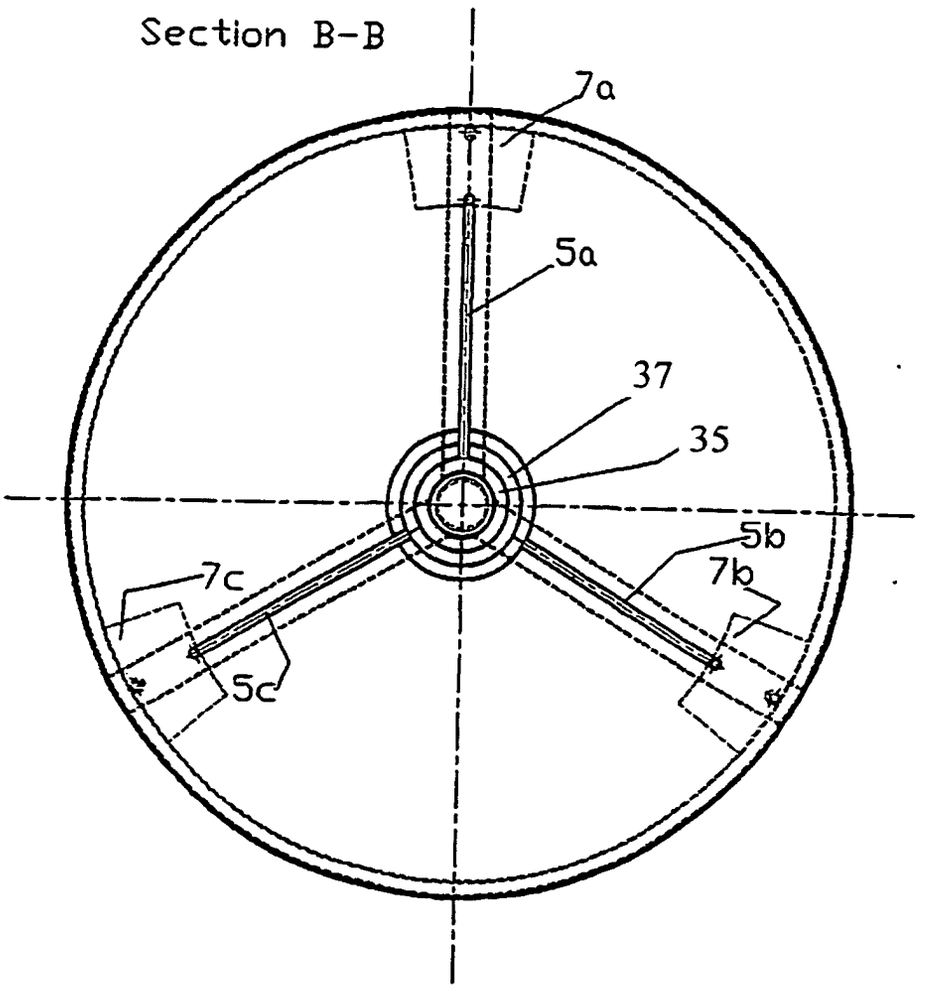


Fig. 10

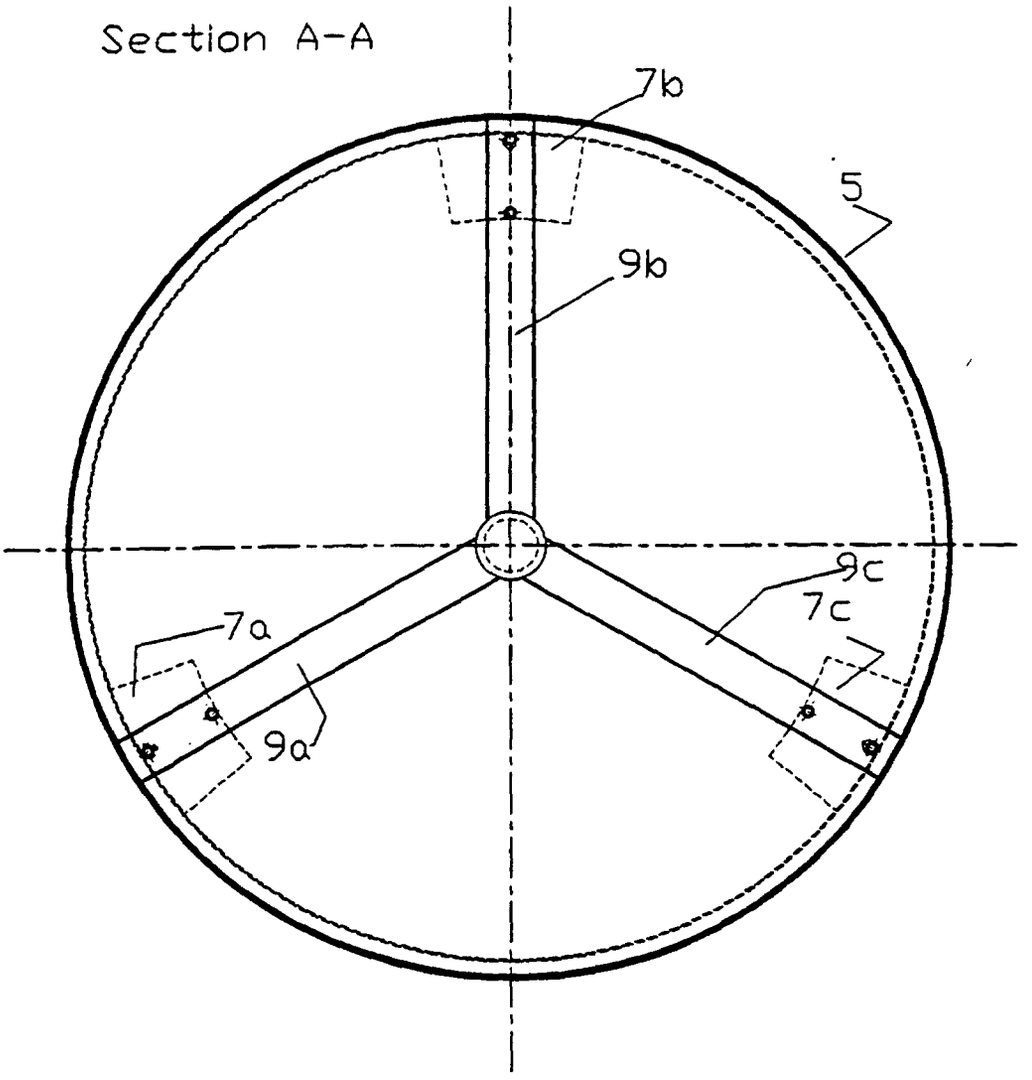


Fig 11

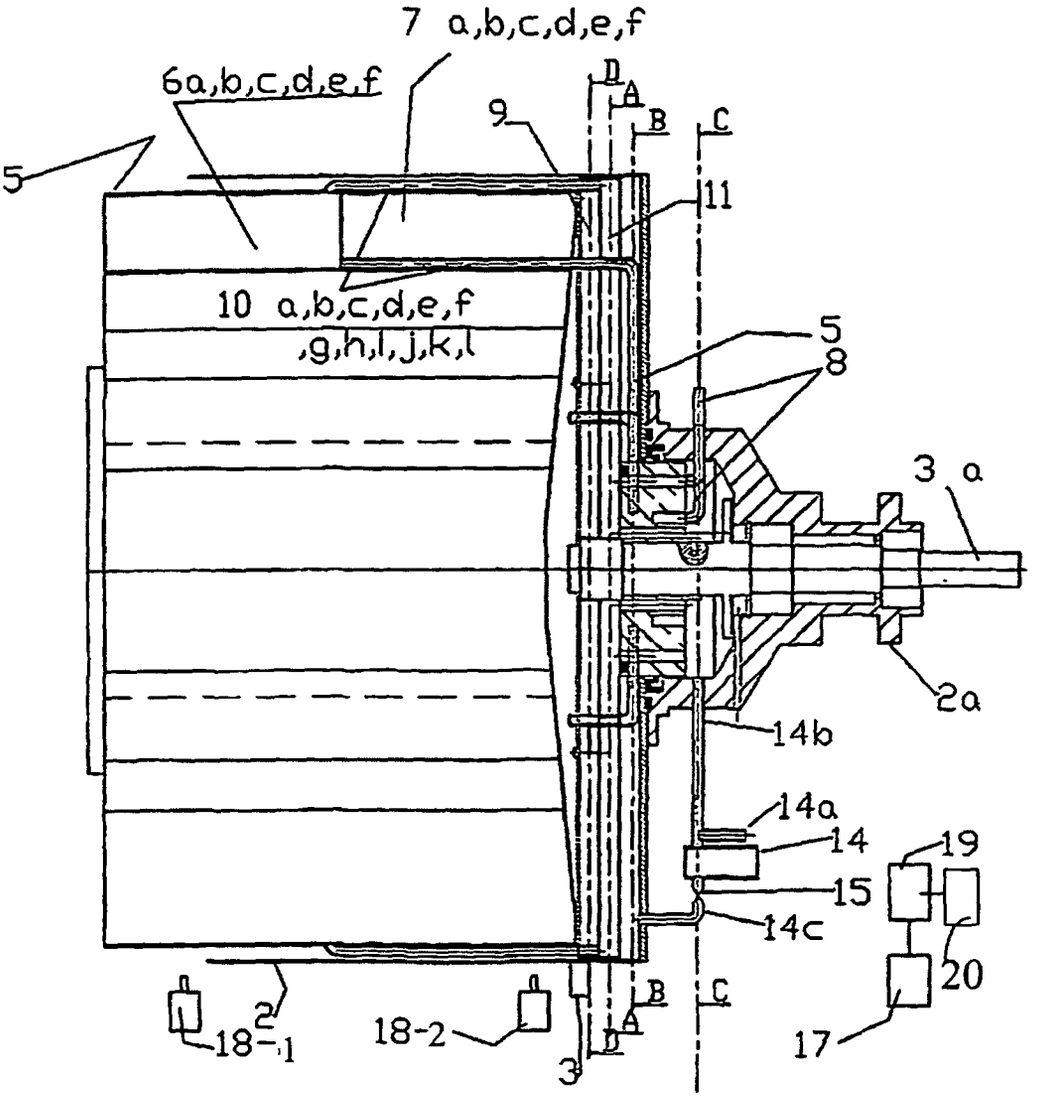

7 a,b,c,d,e,f
6a,b,c,d,e,f
9
D
A
B
C
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11
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,g,h,l,j,k,l
5
8
3 a
2a
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14c
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17
18-1
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18-2
3
B
C
A
D

Fig. 12

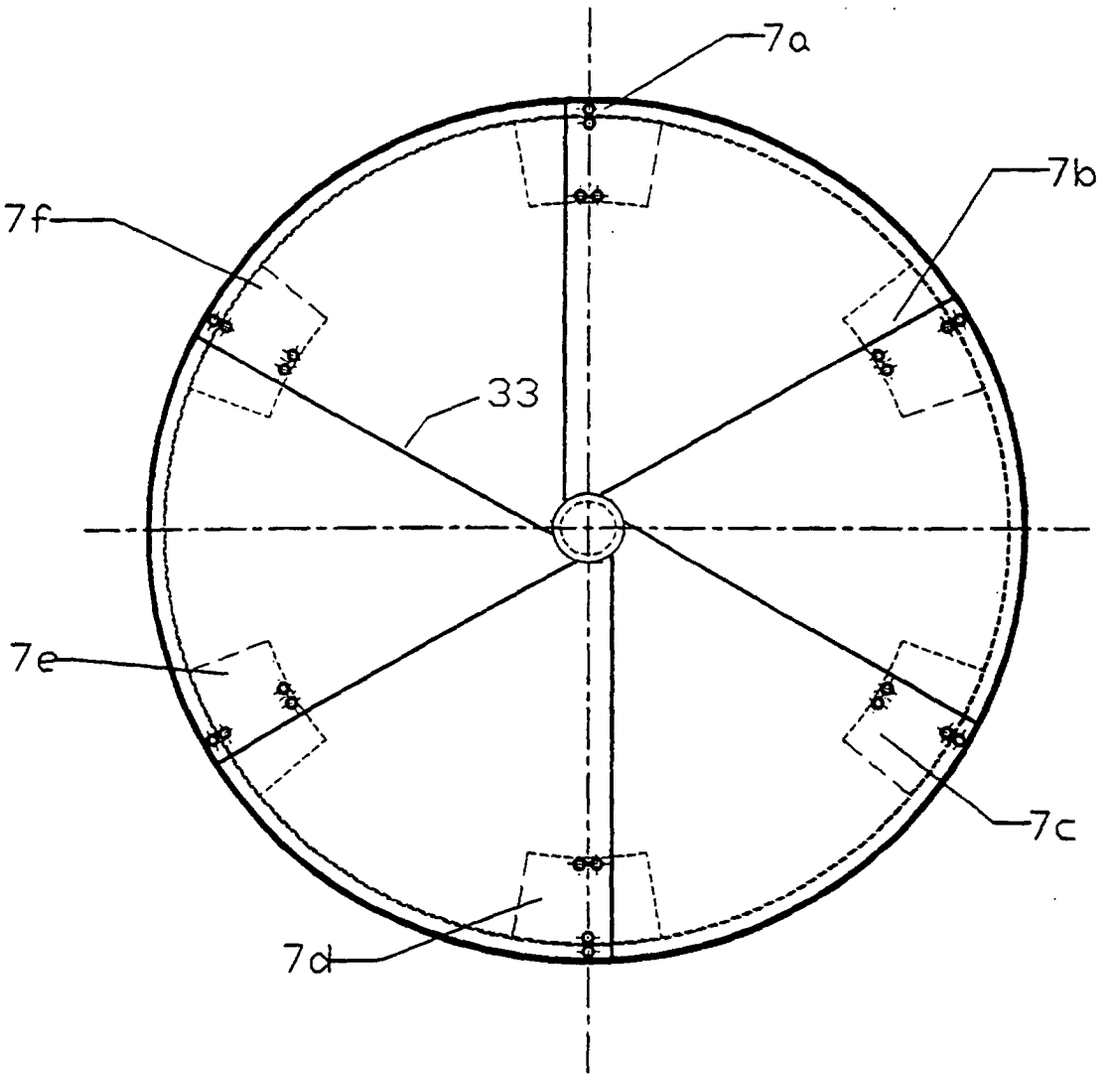


Fig 13

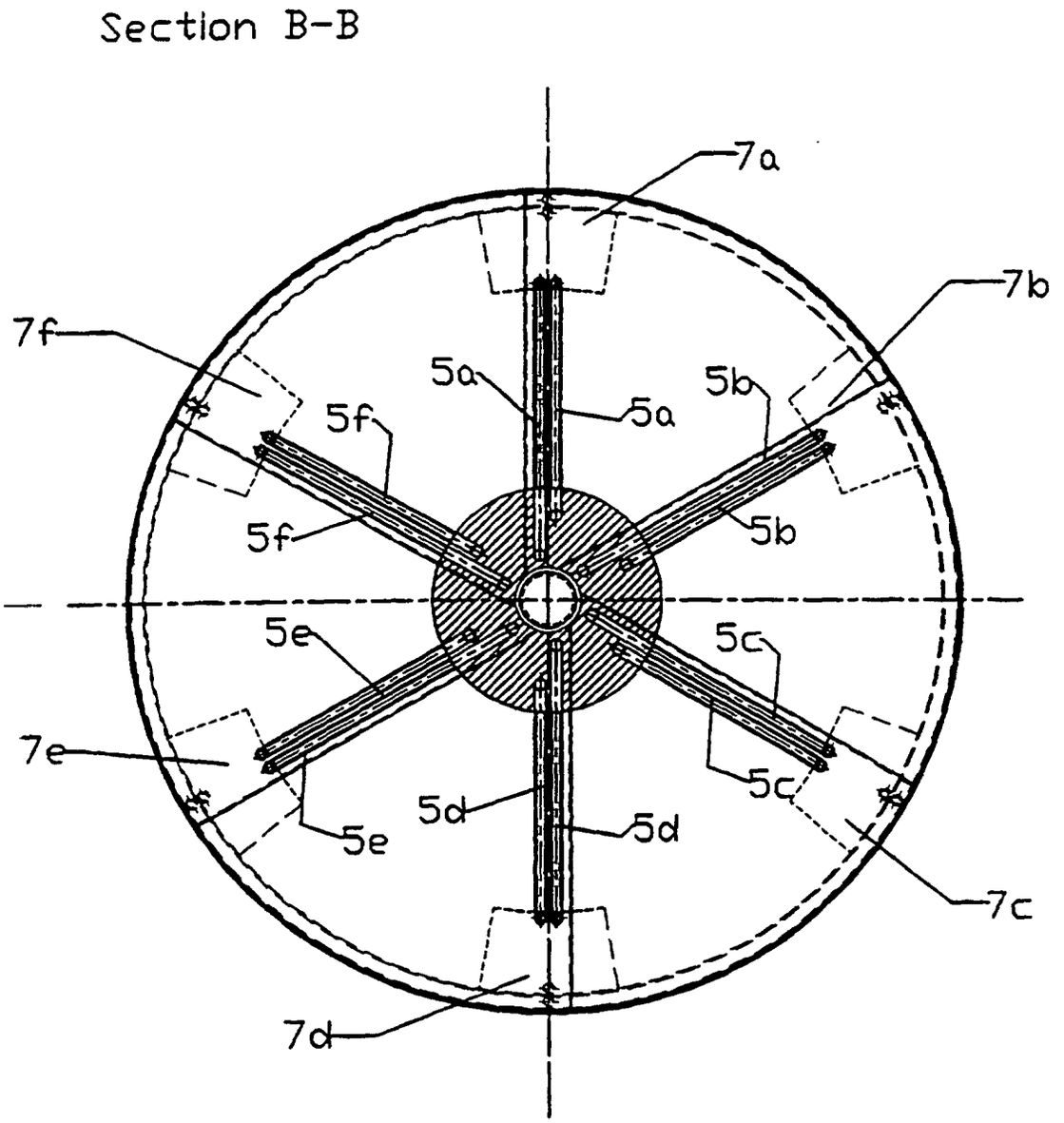


Fig 14

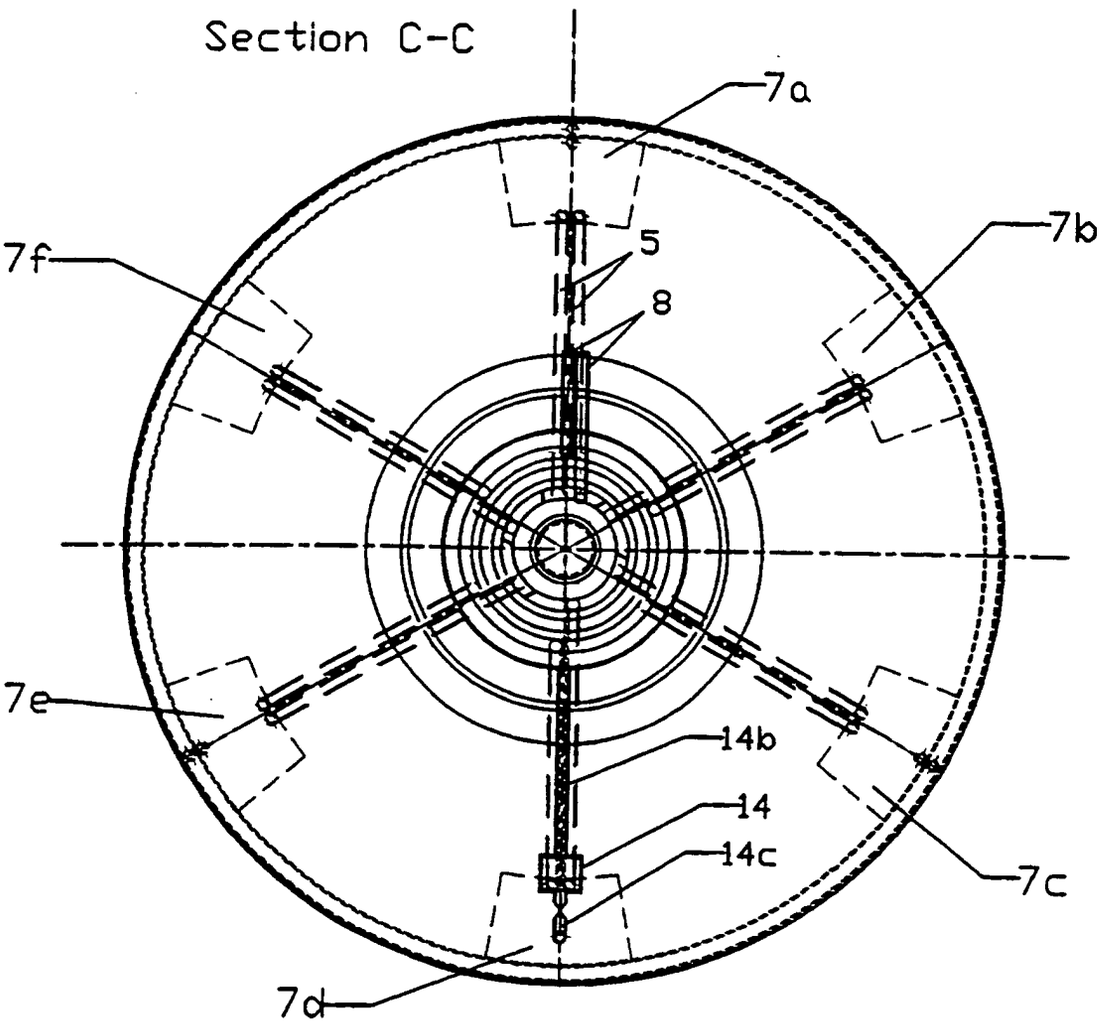


Fig 15

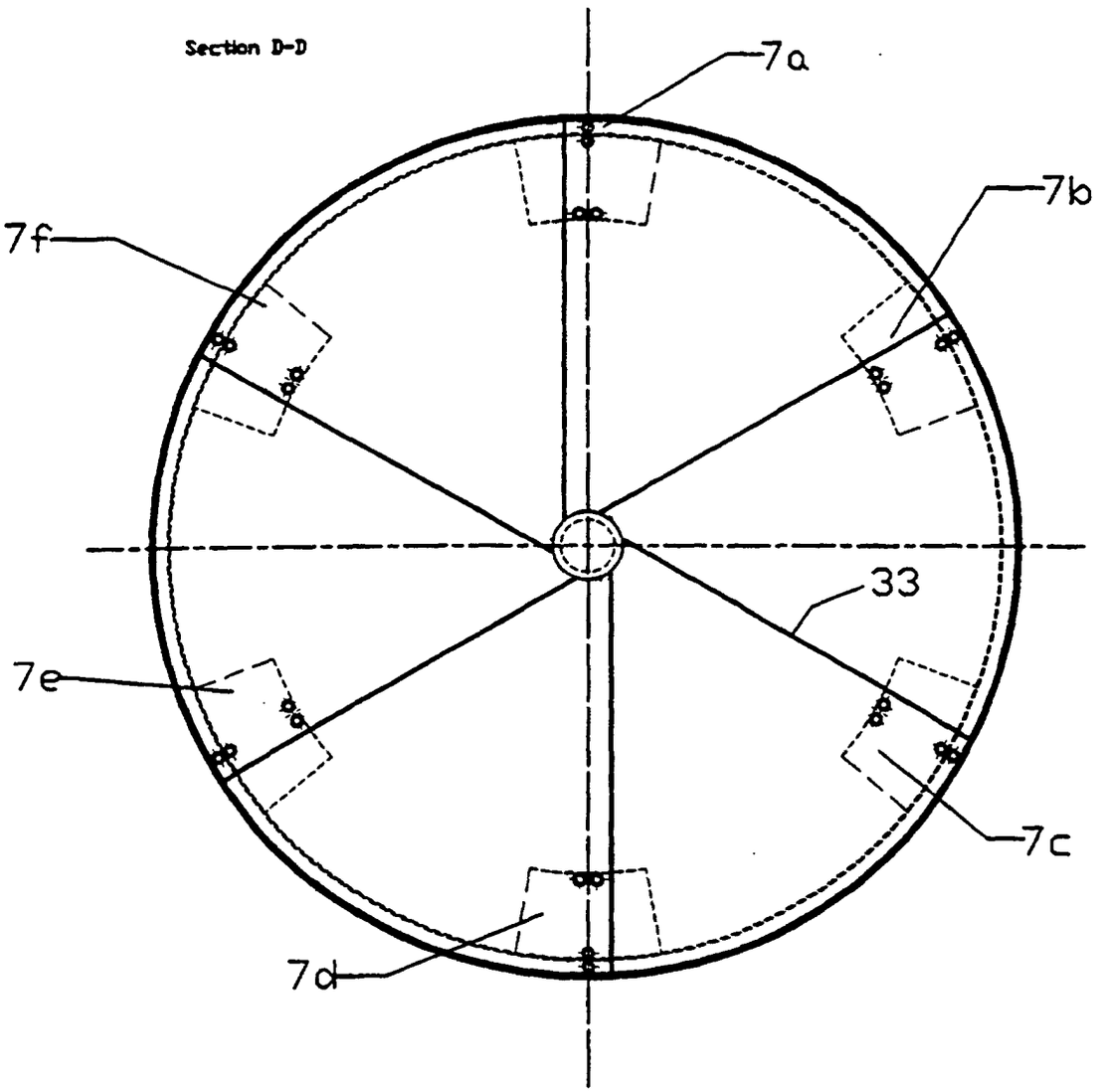


Fig 16

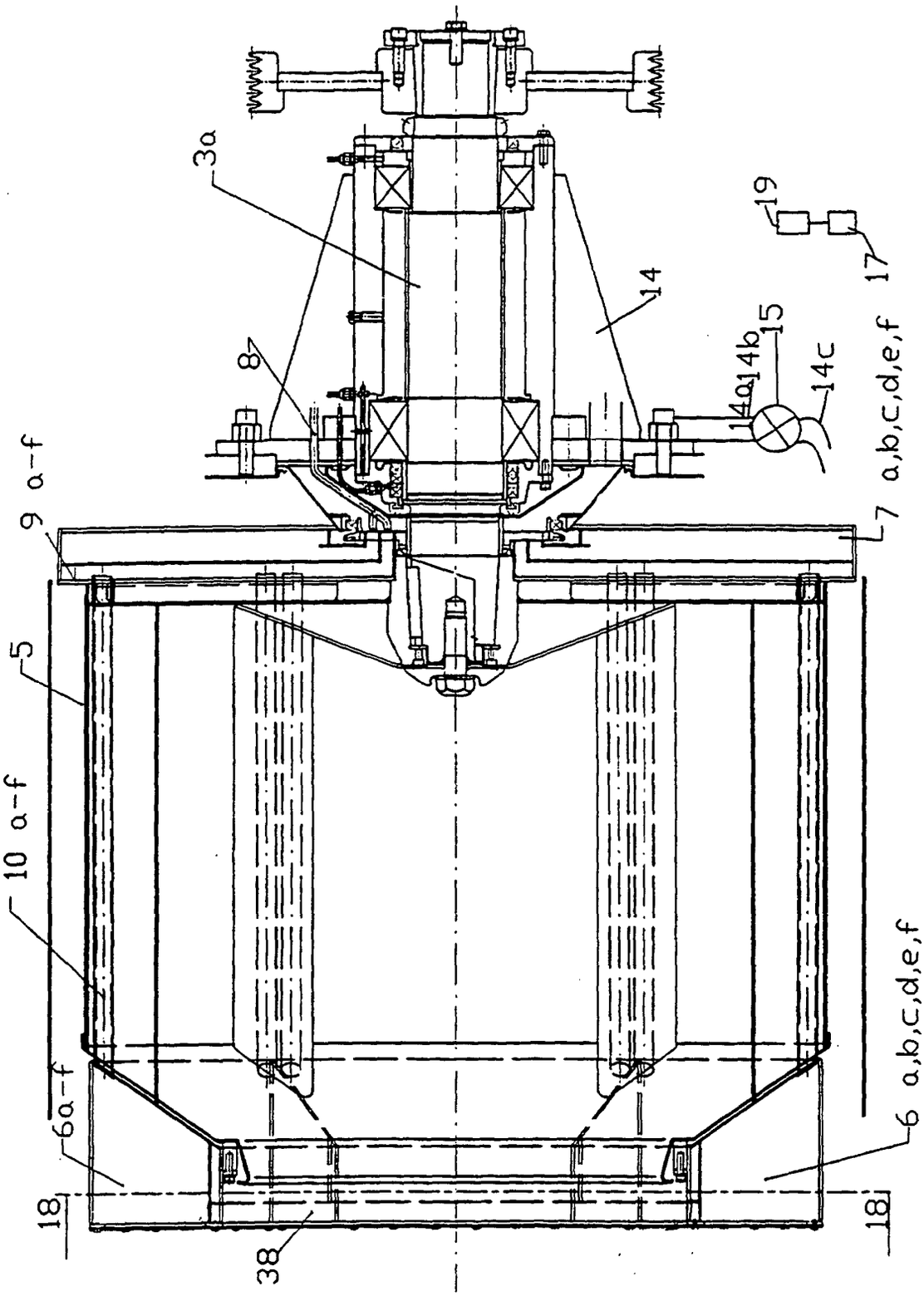

3a
19
17
14
15
14b
14a
14c
8
9 a-f
7 a,b,c,d,e,f
5
10 a-f
6a-f
6 a,b,c,d,e,f
18
18
38

Fig 17.

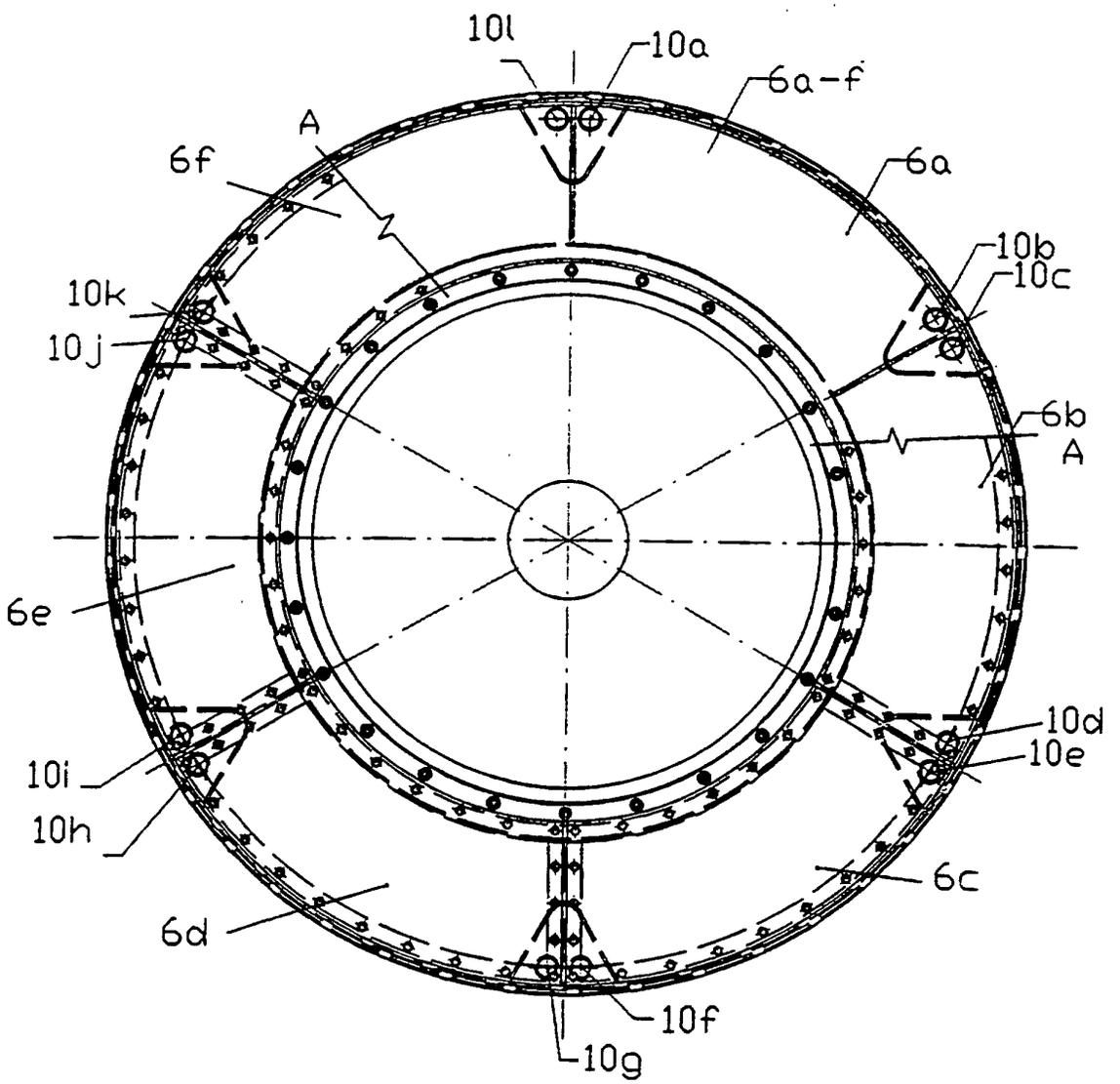

10l
10a
6a-f
A
6f
6a
10b
10c
10k
10j
6b
A
6e
10d
10e
10i
10h
6c
6d
10f
10g

Fig 18.