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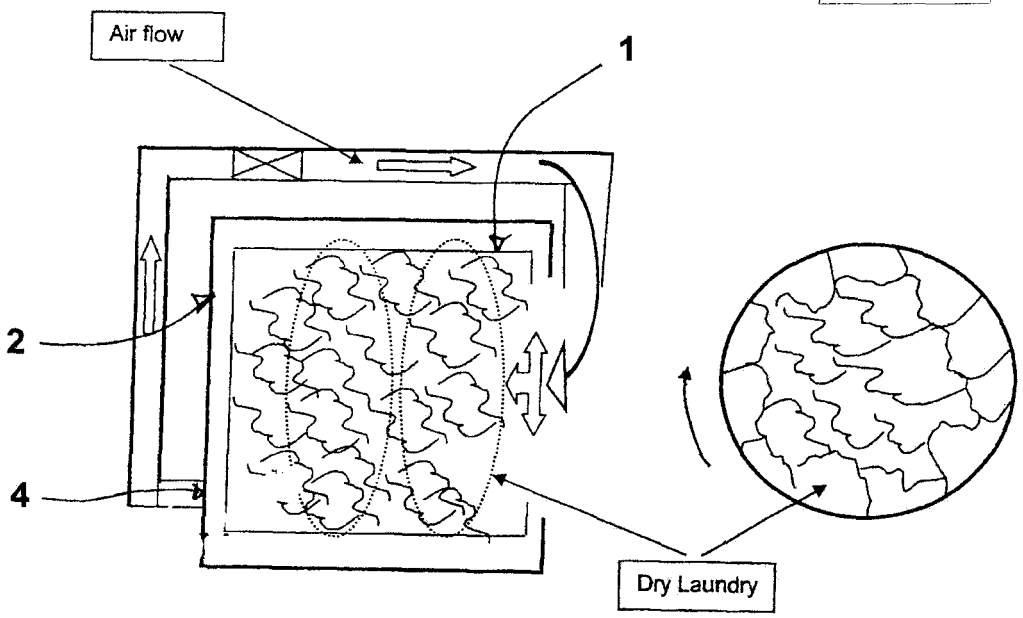
(54) Improvements in a clothes washing and drying machine

(57) Combined clothes washing and drying machine comprising a tub (2) provided with a substantially cylindrical wall, a rotating drum (1) mounted rotatably within it and provided with a number of perforations (6) in the cylindrical side surface thereof, a conduit (3) for exhausting or circulating the drying air as provided with a suction mouth (4) for taking in the air from the interior of said tub (2), said intake mouth (4) being situated on a portion of said substantially cylindrical wall, wherein during at least a definite interval of the drying phase, said drum (1) is driven to rotate at a ventilation speed that is sufficient to cause the washload to distribute on the inner drum surface wall, and contact therewith.
Preferably said definite interval is provided at the beginning of the drying phase, and said distribution speed is variable.

FIG. 3



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Description

[0001] The present invention refers to a so-called washer-dryer, i.e. combined clothes washing and drying machine, preferably of the kind used in household and residential applications, for washing and drying loads of clothes in a same appliance.

[0002] The combined clothes washing and drying machines, which the present invention generally refers to, are by now largely known as such in the state of the art. On the other hand, they have been described - along with detailed discussions of a technical nature on the particular advantages and drawbacks of various designs, conceptual solutions and embodiments thereof - in a number of patent publications, such as EP 1 657 343 A1, EP 1 650 338 A2, EP 1 302 586 A1, WO 01 11134 A1, as well as the number of other patent publications cited therein, which reference should therefore be made to for greater convenience and insight, while avoiding useless expatiations here.

[0003] Anyway, it can be summarily pointed out that such household combined clothes washing and drying machines are inherently conventional not only as a kind of appliances, but also in the structure and mode of operation thereof, in that they are basically regular washing machines, which the component parts and devices needed to perform the drying duty, i.e. to dry the load of clothes following them having been washed in the same machine, have been added to and

[0004] However, while the washing performance abilities of such combined machine keep being substantially unaffected by such addition and integration of the drying function and the related component parts and devices, substantial limitations are on the contrary encountered by the drying function itself due to a couple of circumstances, i.e.:

1) the first such circumstance depends on the fact that the inner volume of the rotating drum intended to hold a load of clothes for washing is generally considerably smaller than the inner volume of the rotating drum in a tumble dryer or similar drying-only appliances, owing basically to the fact that no outer drum, i.e. tub - and what' s more of an oscillating type - is used in a drying-only appliance as this on the contrary occurs in washing machines, so that the volume of the related rotating drum may in fact be expanded up to bringing the same drum to almost contact, i.e. in close proximity of the walls of the outer casing of the machine; anyway, this first circumstance does not fall within the scope of the present invention;

2) the second such circumstance refers to the illustration appearing in the accompanying Figure 1, showing that in a combined clothes washing and drying machine according to a prior-art embodiment there is provided a drum 1, which is adapted to hold the clothes to be washed and dried, and which is contained in an outer drum or tub 2 of a conventional kind, i.e. substantially cylindrical in its shape. Furthermore, associated to said outer drum 2 there is a conduit 3 for the drying air to be able to be circulated therethrough; regardless of the fact that the drying function of this machine is performed by either having the flow of hot moisture-laden air exiting the drum simply exhausted outside, i.e. into the atmosphere, or under implementation of the more advanced technique calling for the drying air to be re-circulated into the drum upon having been duly condensed and dehumidified for the removal of the moisture contained in said flow of hot moisture-laden drying air exiting the drum, the conduit into which the hot moisture-laden drying air exiting the drum is routed for further conveyance either to exhaust or back into the drum though the condenser - and which shall more simply be referred to as "suction conduit" hereinafter - branches off a definite aperture 4 provided on the cylindrical side wall of the same tub 2.

[0005] This constraint is due to the fact that - owing to the machine being a combined machine for both washing and drying clothes - the hot moisture-laden drying air cannot be caused or allowed to flow through conduits as they are generally provided and used in drying-only machines, i.e. through and from the rear rotating wall of the drum and an appropriate passage in correspondence to the front loading door or lid of the machine.

[0006] As a result, the above-cited aperture 4 is provided to draw in the air from the interior of the tub and, therefore, the thin hollow gap existing between the same tub and the rotating drum, and ultimately from the interior of the same rotating drum, thereby causing the air dwelling in the interior of the rotating drum to be forced back into said hollow gap by passing through the tiny perforations 6 provided in the side wall of the drum.

[0007] During the drying cycle, the hot air that is being blown into the drum - obviously from an aperture that is suitably provided in the zone of the bellows-like gasket, which is provided between the tub and the opening giving access into the drum, and which is of course firmly joined to the structure of the machine - will obviously tend to exit therefrom by flowing through the number of small perforations 6 provided in the cylindrical side wall of the same drum and, as a result, to follow a radial flowpath towards the outside.

[0008] If the drum is driven to rotate at a low speed, as this generally occurs, actually, since the clothes - although just spin-dried - are still substantially wet, the same clothes will basically remain lying on the bottom of the drum, where it tumbles back and forth, i.e. first in a direction and then in the other one, following the reversals in the direction of rotation of the same drum, so as to avoid getting tangled.

[0009] In addition, when the clothes remain in this way essentially on the bottom of the drum, they act as to ob-

struct the opening of the drum, in that they practically create a kind of "plug" that quite significantly hinders the inflow of hot air, which is generally known is blown into the drum through and from the front region thereof (it will be most readily appreciated that reference is of course made here to a clothes washing/drying machine of the so-called front-loading type).

[0010] As a result, the hot air that is blown or, anyway, let into the drum to drying purposes tends almost immediately to leak out therefrom through the above-cited small perforations provided in the side wall thereof, while hitting, i.e. affecting the mass of clothes on the bottom of the drum to only a limited extent, wherein it does so by almost solely involving the surface thereof.

[0011] As not only those skilled in the art, but also an average user are well aware of, such circumstance turns out as being effective in causing both the performance records and the energy efficiency of washer-dryer machines of this kind to suffer a significant curtailment; it also implies significantly longer drying times needed by these machines to complete a drying process as compared with the corresponding performance abilities ensured by a regular drying-only machine.

[0012] Briefly, none of the prior-art solutions as described in the afore-cited publications indicates a kind of machine and/or a related operating mode or method that would be effective in improving the performance abilities of the machine by cutting the overall time taken to complete the drying cycle with a correspondingly lower energy usage.

[0013] With particular reference to this second circumstance illustrated above, it would therefore be desirable, and it is a main object of the present invention, actually, to provide a combined clothes washing and drying machine that is capable of performing particularly well in the drying mode of operation thereof, while doing away with all drawbacks that usually derive from the fact that the drying air is let into the drum in the middle front region thereof and is blown radially towards and through the perforations provided in the cylindrical side wall of the same drum in a process that practically causes it to only laterally invest and affect the washload lying and rolling on the bottom of the drum.

[0014] According to the present invention, these aims, along with further ones that will become apparent from the following disclosure, are reached in a combined clothes washing and drying machine that incorporates the features as defined and recited in the claims appended hereto.

[0015] Features and advantages of the present invention will anyway be more readily understood from the description that is given below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 2 is a diagrammatical view of the characteristics of a drying cycle as provided and performed in a combined clothes washing and drying machine according to the present invention;
- Figure 3 is a symbolical view illustrating the physical distribution of the washload in the drum of a combined clothes washing and drying machine during the drying cycle according to the present invention;
- Figure 4 is a diagrammatical view of an improved mode of drying operation as compared with the mode of operation illustrated in Figure 2;
- Figure 5 is a diagrammatical view of still another improved mode of drying operation as compared with the modes of operation illustrated in the preceding Figures;
- Figures 6a through to 6c are views of a further improved mode of drying operation according to the present invention;
- Figure 6d is a schematical representation of the pattern followed by the rotational speeds of the drum in the operating modes shown in Figures 6a to 6c;
- Figure 7 is a diagrammatical view of an improved mode of washing operation of the machine that is effective in contributing to a still further enhanced overall efficiency of a machine according to the present invention;
- Figure 8 is a symbolical view of the falling movement and path of the washload within the drum at an intermediate rotational speed thereof.

[0016] In view of doing away with the afore-cited drawback of prior-art solutions, what the present invention contemplates is that, during a definite interval I of the drying cycle, the drum 1 is driven to rotate at a speed that is higher than the usual or normal one and, in particular, at a speed that shall be referred to as the "ventilation speed V" hereinafter, as represented in Figure 2, in such manner that the washload is substantially lifted off the bottom of the drum and distributed therewithin, thereby spreading out - due to the effect of the centrifugal force - over the entire inner cylindrical surface of the same drum.

[0017] The rotational speed of the drum, therefore, must be selected so as to be high enough to cause the still wet washload to lift off the bottom of the drum, as this is shown symbolically in Figure 3.

[0018] By doing so, a situation is created by virtue of which the flow of hot air that is blown into the drum in a substantially axial direction and then tends to move away from the middle region of the same drum by broadening out with a radial motion towards the outside, i.e. the afore-cited perforations 6 in the cylindrical wall of the drum, will obviously impinge transversally against said ring-like contour of the washload distributed all over the inner cy-

lindrical surface of the drum, and will of course pass through the clothes as it moves further on to eventually reach said perforations.

[0019] By having the flow of the hot drying air in this way caused to pass directly through the wet clothes as it moves towards the side wall of the drum, a moisture removal effect is practically brought about, which turns out as being particularly intensive and efficient, further to particularly advantageous from an energy efficiency point of view since it is effective in sensibly reduce the overall time required to complete the drying cycle and - as a result - also the overall energy usage.

[0020] The above-described invention allows for a number of advantageous improvements, i.e.:

1) a first such improvement consists in causing said drum rotation interval I to be carried out at the aforecited ventilation speed V during the initial period of the drying cycle; in such first period of the process, in fact, the clothes to be dried have a greater moisture content, so that also the above-described drying action proves to be more effective.

2) A second improvement is brought about by having said ventilation speed V adjusted so as to cause it to vary in a pre-defined manner, i.e. according to a pre-determined pattern that will anyway depend on certain functions; in particular, said ventilation speed V may be caused to increase in a progressive, programmed manner under the assumption that the clothes will dry in a known manner and, as a result, the innermost clothes lying closer to the axis of the drum - and therefore subject to quicker drying - will for this reason tend to break loose, i.e. come off the rest of the washload to thereby start to fluctuate in the inner region of the drum, thereby hindering the flow of the hot drying air moving from such inner region towards the side wall of the drum, as this is symbolically shown in Figure 4.

3) A third improvement consists in having said ventilation speed V of the drum caused to increase in accordance with the degree of moisture in the clothes, wherein such degree of moisture will not be a merely assumed parameter, as in the previously considered case, but rather an actual measured value.

It is in fact possible - and, for the matter, even quite easy - for the degree of moisture still existing in the clothes to be known at any moment, mainly on the basis of the value of the electrical conductivity of the same clothes as measured with the aid of means and methods of various kinds, all of them being anyway largely known as such in the art and, therefore, not falling within the scope of the present invention.

Therefore, this third improvement consists in having the rotational speed of the drum controlled in accordance with a certain function (that may be freely selected among the number of possible ones) of the degree of moisture in the clothes as measured and suitably processed by the appropriate sensor and processing means of the machine.

By using electric motors capable of rotating at a fully controllable and adjustable speed, such as for instance inverter-controlled motors or universal motors, along with any of the known techniques for measuring the degree of moisture and appropriate computing, processing and control algorithms, anyone skilled in the art will be fully capable of implementing a preferred embodiment of the present invention.

Accordingly, through this improvement the possibility is created for both energy usage and drying time to be optimized, since the flow of hot drying air is thereby enabled to pass at any and each moment - at least, and above all, during the initial period of the drying process, when the clothes are wetter, i.e. have a greater moisture content - directly through the clothes, without just moving laterally over them.

4) A fourth improvement is an alternative to the first two improvements cited above; in fact, in the case that a combined clothes washing a drying machine is used, which is not provided with any sophisticated electronic control means and related data storage capacities, it would practically prove impossible for the rotational speed of the drum to be controlled and adjust in accordance with the either assumed or actual value of the degree of moisture in the clothes to be dried.

Accordingly, to overcome, i.e. get over such limitation, and with reference to Figure 5, all it takes is practically defining a certain number of subsequent time sub-intervals of a pre-determined length S1, S2, ..., during which the drum is driven to rotate at a pre-defined, constant rotational speed, wherein the corresponding rotational speeds V1, V2, ... during each respective time sub-interval are adjusted in a graduated manner according to an increasing pattern.

Since such result can be obtained through the use of fully conventional techniques and means, the possibility is therefore given for an operating mode according to the present invention to be embodied, which is readily applicable to also rather simple machines based on the use of means and methods as they are generally known as such in the art.

5) A fifth improvement allowed for by the present invention is illustrated in Figures 6a through to 6d; this improvement is thought to account for the fact that, during the drying process, the clothes in the drum tend to dry in quite irregular a manner, in the sense that the portion of washload lying closer to the wall of the drum dries more slowly than the innermost washload portion that facing the middle region of the

drum, so that such quicker drying washload portion is likely to be pointlessly "overdried" under an excessive usage of energy to no useful purpose.
In order to do away with such drawback, the drum is therefore driven to rotate at variable speeds, as this is schematically represented in Figure 6d.
These variable rotational speeds of the drum are shared out among three corresponding phases, i.e.:

- a phase X, in which the rotational speed of the drum is the initial speed with the afore-described characteristics,

- a phase Y, in which the rotational speed of the drum is decreased to a lower value V_a, and

- a phase Z, in which the drum is slowed down to a still further extent.

Finally, the drum is stopped.
Next, the drum is driven again to rotate at the initial ventilation speed V, however in the reverse direction of rotation, so as to go through the above-described cycle again.
The purpose of this improvement is to allow the portion of washload, i.e. clothes lying closer to the axis of the drum to recurrently break loose, i.e. separate from the rest of such washload, owing to the rotational speed of the drum and, as a result, the centrifugal force being so reduced (phase Y), to move into a kind of "floating" arrangement along the axis of the drum, so as to be directly hit by the flow of hot air and be therefore able to dry in a significantly quicker manner.
Thereafter, in view of enabling also the remaining portion of washload to undergo a similar favourable treatment, the drum is slowed further down (phase Z) to such rotational speed as to cause the whole washload to move off the cylindrical periphery of the drum and fall onto the bottom thereof, so that it is now in a position as to be directly invested, i.e. hit by the flow of hot air for a short period of time, further to being tumbled and stirred so as to rearrange in a different manner in view of going through the next drum rotation cycle in the reverse direction. As a result, after a certain number of reversals in the direction of rotation of the drum, the whole washload will practically turn out as having been treated in substantially the same manner.
At the end of said third phase Z, the drum is stopped; in this way the entire washload is caused to fall back onto the bottom of the drum, whereby it loses its former shape and arrangement.
When the drum is then driven again, the same washload moves to distribute itself along the walls of the drum again, exactly as it did at the beginning of the process, however with a different arrangement of the clothes relative to each other, since - by falling back onto the bottom of the drum and redistributing along the walls thereof - it is substantially stirred and mixed up, so that the portion thereof, which was formerly in contact with or, anyway, facing the wall of the drum, will now be arranged at the centre of the drum, and vice-versa.
Furthermore, when the drum starts to be rotated in the reverse direction of rotation, and as illustrated in Figure 6d, it also appears appropriate that the highest rotational speed due to be reached in that particular phase is not reached in a straightaway manner, i.e. as a result of a continuous progression, actually, but such increasing progression of the speed is rather interrupted by a short sub-phase B-1, in which the speed is kept dwelling at an intermediate value that will be appropriately selected so that the washload is allowed to redistribute within the drum in a sufficiently even manner, so as to ensure that, in the next sub-phase to be performed at a higher rotational speed, and still indicated and referred to as phase X, the same washload is able to distribute all along the peripheral cylindrical region of the drum in an equally even manner, thereby enabling a most regular drying effect to be obtained.
As this has been found in the course of exhaustive testing done in this connection, the above-described effect enables all portions of a load of clothes to be dried to successively undergo the optimum treatment described afore for the portion of washload lying at the front, i.e. facing the innermost region of the drum, with the ultimate result of a substantial improvement in both the time and the amount of energy required to complete a drying cycle.

6) A sixth improvement allowed for by the present invention is more closely related to the washing operation of the machine, wherein such improvement can anyway be applied to a washing machine in a manner that is fully independent of a subsequent clothes drying cycle performed by the same machine; in particular, it can be applied to single-duty washing machines that are not provided with either the means for or the functional capabilities of also performing a drying duty.

[0021] This improvement, which is going to be illustrated in greater detail below, is conceived in order to particularly account for following facts: it is largely known in the art that, during a washing cycle, the drum is driven to rotate at a given speed in a definite direction of rotation, wherein such direction of rotation is periodically reversed in view of preventing the washload, i.e. the clothes from getting tangled.
[0022] However, when such reversal in the direction of rotation is due to take place, the drum stands still for a few seconds, so that, when all such standstill periods intervening at each reversal in the direction of the rotation of the drum included in a washing cycle are added to-

gether, the result is that the total time during which the drum is at a standstill, and no significant washing action takes substantially place or is performed on the clothes, turns out as being undesirably long, which clearly leads to the overall performance and efficiency of the machine being obviously affected.

[0023] For such problem to be overcome, a commonly known practice lies in having the duration of the individual drum rotation phases between each reversal and the next one sensibly lengthened, so as to practically reduce the total number of reversals performed.

[0024] Unfortunately, this corrective measures has itself a drawback in that a prolonged time of rotation of the drum in a same direction is quite likely to cause the washload to undergo increased tangling, which in turn reduces rubbing of the clothes against each other, i.e. an action that is commonly known to be a primary factor in removing soil from the clothes; in fact, the soil removal, i.e. cleaning action is in this case largely known to only take place at the beginning and at the end of each single phase, i.e. when the washload is shifted and stirred to take a definite position relative to the contiguous washload portions.

[0025] Known from the disclosure in EP 1 354 997 B1 is a clothes washing machine in which, in accordance with the amount of clothes to be washed, the drum is driven to rotate at different speeds; in particular, when there is a great amount of clothes to be washed, the time interval selected for the rotational speed of the drum to rise from the minimum to the maximum value thereof is longer than the same speed interval when a smaller amount of clothes is loaded in the drum for washing.

[0026] However, such procedure, although ameliorative in its effect, since it facilitates stirring of the washload, is not such as to really ensure that the washload is effectively mixed up in a desired manner by having the drum driven to periodically rotate at two different speeds, wherein the higher one of these speeds is the speed at which the entire washload is distributed, i.e. spread out all along the side wall of the drum, and the lower speed is the speed at which the washload heaps up onto the bottom of the drum.

[0027] To the purpose of ensuring a long duration of the washing phases between two successive reversals in the direction of rotation of the drum without incurring any penalty in the actual washing performance of the machine, the present improvement teaches to vary the rotational speed of the drum - between a reversal and the following one - from a maximum value (V_{max}) and a minimum value (V_{min}) thereof, and vice-versa, for a plurality of times. In addition, such variation in the rotational speed of the drum must be such as to duly allow for the actual amount of clothes loaded in the drum for washing, since - as it is largely known - the greater the amount of clothes in the washload, the higher the likelihood for the washload to get tangled.

[0028] Accordingly, this improvement is based on introducing a modification factor for the rotational speed of the drum during the washing phase in accordance with the actual weight of the washload. In detail, this occurs as follows:

* If the weight of the washload amounts to a maximum value, which is assumed to correspond to the rated capacity value of the machine in the case being discussed, then also the rated rotational speed of the drum during washing is varied from the maximum value V_{max} and the minimum value V_{min} thereof, such values being pre-defined for that certain weight of the washload, e.g. as this is illustrated in Figure 7 showing an intermittent, i.e. periodical variation of the speed between said two extreme values during a rotation of the drum in the same direction.

[0029] This speed variation, which preferably occurs at constant values so as to practically follow a pattern in the shape of the battlements of a tower, is therefore such to ensure that - without any need arising for the rotation of the drum to be stopped - the washload is able to disrupt from its configuration and change its arrangement, so as to avoid the afore-described undesired tangling effect (see Figure 8).

[0030] On the other hand, said two values of the rotational speed of the drum must most obviously be selected in a proper manner; in particular, it is preferable if, during the rotation of the drum at V_{max}, the washload spreads out along the cylindrical periphery of the drum, whereas, at the opposite speed V_{min}, the washload should on the contrary fall back onto the bottom of the drum.

[0031] It has in fact been found experimentally that exactly such continuous, repeated variation in the arrangement of the washload within the drum, which brings about the desired stirring or agitation effect in the same washload and, as a result, the desired rubbing effect of the clothes against each other favoured by the repeated variations in the rotational speeds of the drum, enables the drum to be kept rotating for a prolonged period of time in a same direction, without suffering any reduction in the level of the washing performance ensured by the machine, and without incurring any penalty in the form of the washload getting tangled.

* If the weight of the washload is on the contrary lower than said rated value, the rotational speed of the drum is then reduced by a value that may each time - and for each case - be found experimentally and/or defined theoretically; in fact, driving the drum to rotate at an excessive speed is found to be fully useless in this case and, in particular, the rotational speeds of the drum shall be selected on the basis of the twofold requirement that, at the higher one of such speeds, the outermost portion of the washload shall be able to keep adhering against the side wall of the drum, whereas, at the lower one of such speeds, the washload shall be able to substantially fall back onto the bottom of the drum so as to be

stirred and change its arrangement, wherein it can be most readily appreciated that, in front of a varying weight of the washload, said rotational speeds thereof shall be varied accordingly, as anyone skilled in the art is well aware of, in order to duly allow for the different effect exerted by the centrifugal force on different washloads.

[0032] Finally, a need arises at this point to specially point out that the above-described procedure and criteria do not solely apply to the drum rotating in a same direction of rotation, but also to the drum going through a plurality of successive rotation cycles in both directions of rotation.

[0033] In laundry machines of a more advanced design, and therefore also in modern combined clothes washing and drying appliances, the weight of the washload may of course be directly input, i.e. fed into the control unit of the machine by different means and methods. In the most immediate and simple of such methods, it is the same user that delivers an appropriate command to the machine; other methods - all of which largely known as such in the art - work in a variety of different manners, e.g. by measuring the inertia of the loaded drum on the basis of the motor torque, or the power used by the motor, or on the basis of the amount of water soaked up by the clothes, and so on.

Claims

1. Combined clothes washing and drying machine comprising a tub (2) provided with a substantially cylindrical wall, a rotating drum (1) mounted rotatably within said tub and provided with a number of perforations (6) in the cylindrical side surface thereof, a conduit (3) for exhausting or circulating the drying air as provided with a suction mouth (4) for taking in the air from the interior of said tub, said intake mouth being situated on a portion of said substantially cylindrical wall, **characterized in that,** during at least a definite interval (I) of the drying phase, said drum (1) is driven to rotate at a ventilation speed (V) that is sufficient to cause the washload to distribute into a cylindrical geometrical contour by spreading it out along he cylindrical wall of the drum in contact therewith.

2. Combined clothes washing and drying machine according to claim 1, **characterized in that** said definite interval (I) is provided at the beginning of the drying phase.

3. Combined clothes washing and drying machine according to claim 1 or 2, **characterized in that** said ventilation speed (V) is variable.

4. Combined clothes washing and drying machine according to claim 3, **characterized in that** said ventilation speed (V) follows a progressively rising pattern.

5. Combined clothes washing and drying machine according to claim 4, **characterized in that** said ventilation speed (V) rises according to the level of the electrical conductivity measured in the clothes being dried.

6. Combined clothes washing and drying machine according to any of the claims 1 to 3, **characterized in that** said ventilation speed (V) is variable at predefined values (V1, V2, ...), at which it dwells for corresponding pre-determined sub-intervals (S1, S2, ...).

7. Combined clothes washing and drying machine according to claim 6, **characterized in that** said predefined values (V1, V2, ...) correspond to progressively rising speeds.

8. Combined clothes washing and drying machine according to any of the claims 1 to 3, **characterized in that,** during the drying cycle, said drum is driven to rotate at different, progressively decreasing speeds and, in particular, at a first speed (V) in a first phase (X) and a second speed (V_a) in a second phase (Y), after which the drum is temporarily stopped.

9. Combined clothes washing and drying machine according to claim 8, **characterized in that** said second speed (V_a) is such as to enable a portion of the load of clothes to be dried to break loose, i.e. separate from the remaining portion thereof and keeps substantially "floating" in the middle region of the drum.

10. Clothes washing or combined clothes washing and drying machine comprising a tub (2) provided with a substantially cylindrical wall, a rotating drum (1) mounted rotatably within said tub and provided with a number of perforations (6) in the cylindrical side surface thereof, in which the rotational speed of the drum during the washing cycle is adjusted to repeatedly vary between two extreme speed values between successive reversal cycles of the direction of rotation, **characterized in that** the upper value (V_{max}) of said variable speed is the speed value at which the washload in the drum is caused to distribute and spread out along the inner surface of the side wall of the drum in contact therewith, and the lower value (V_{min}) of said variable speed is the speed value at which said washload is caused to break loose, i.e. separate from said wall of the drum to at least a limited extent, and **in that** the drum is set to rotate at both said upper and lower speed values as it rotates in a same direction.

11. Clothes washing or combined clothes washing and drying machine according to claim 10, **characterized in that** said speed variation pattern is an alternate pattern at constant values, moving alternately to and from said upper value (V_{max}) and said lower value (V_{min}).

12. Laundry machine according to claim 10 or 11, **characterized in that** said variation in the rotational speed of the drum is performed in both alternately reversed directions of rotation.

13. Laundry machine according to any of the claims 10 to 12, **characterized in that** said extreme, i.e. upper and lower speed values are dependent on the weight of the washload.

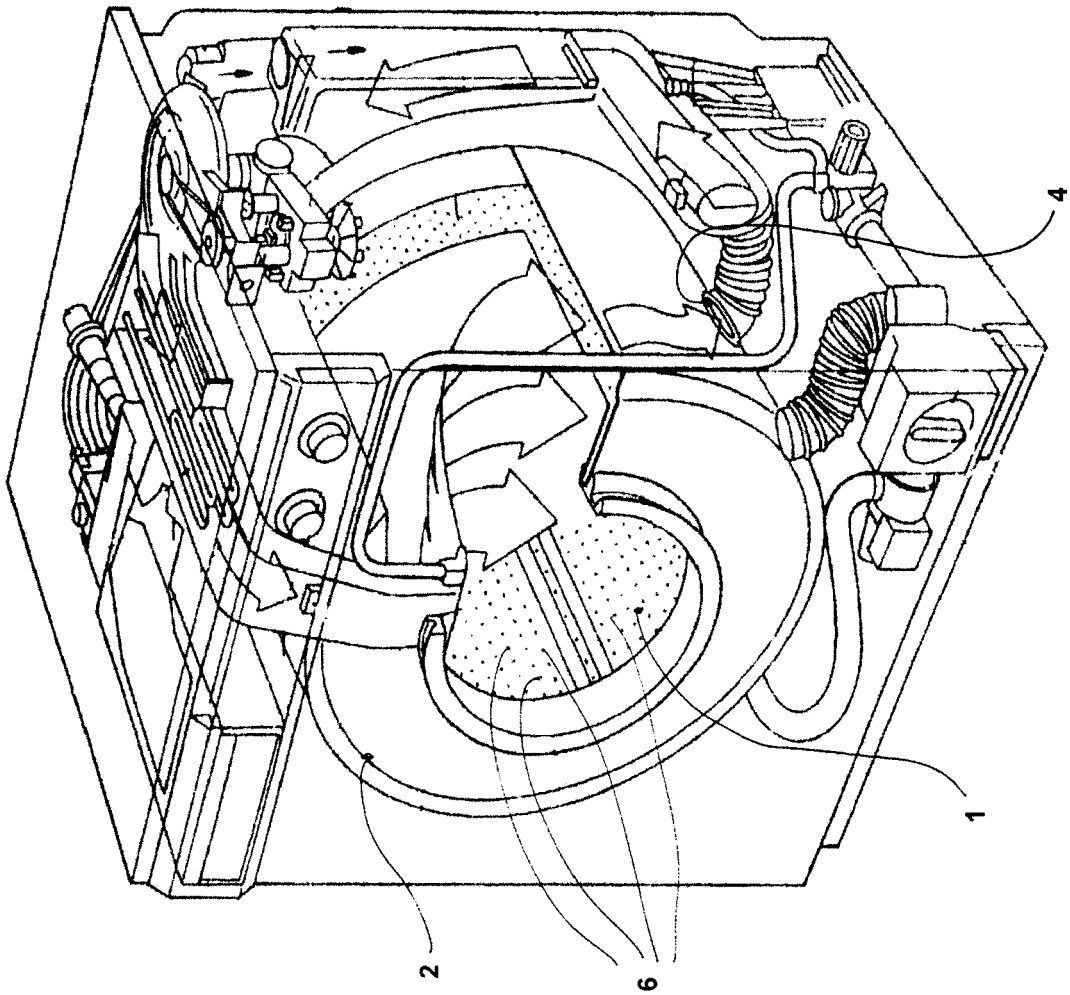
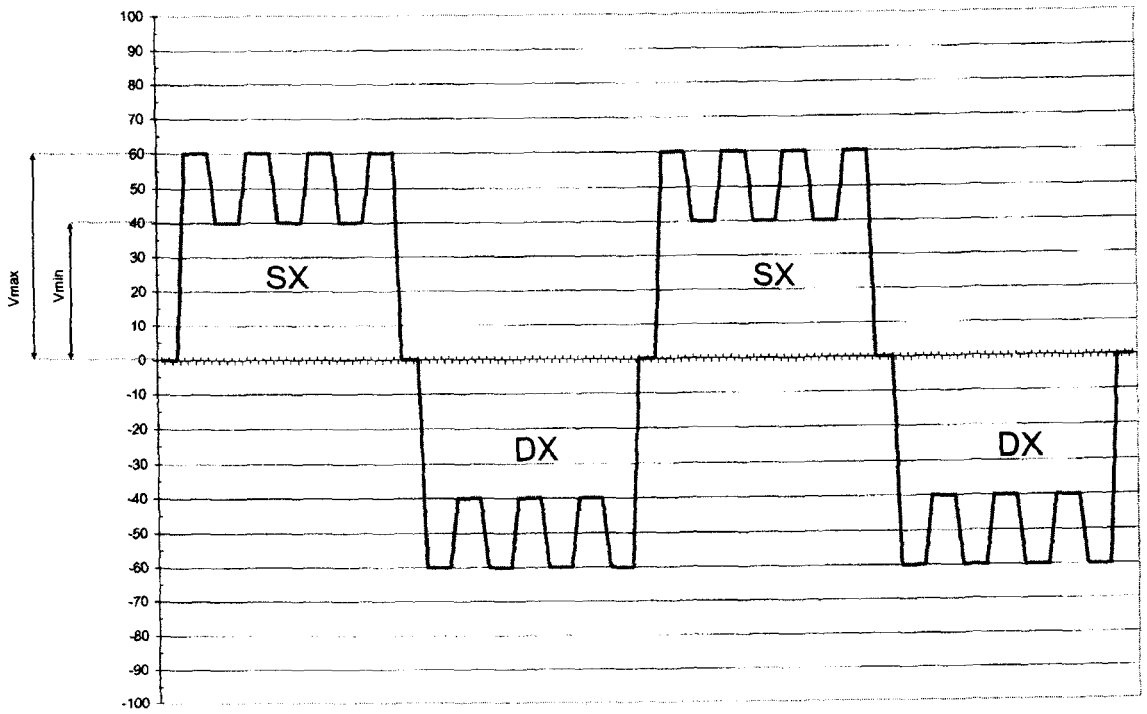


FIG. 1

FIG. 7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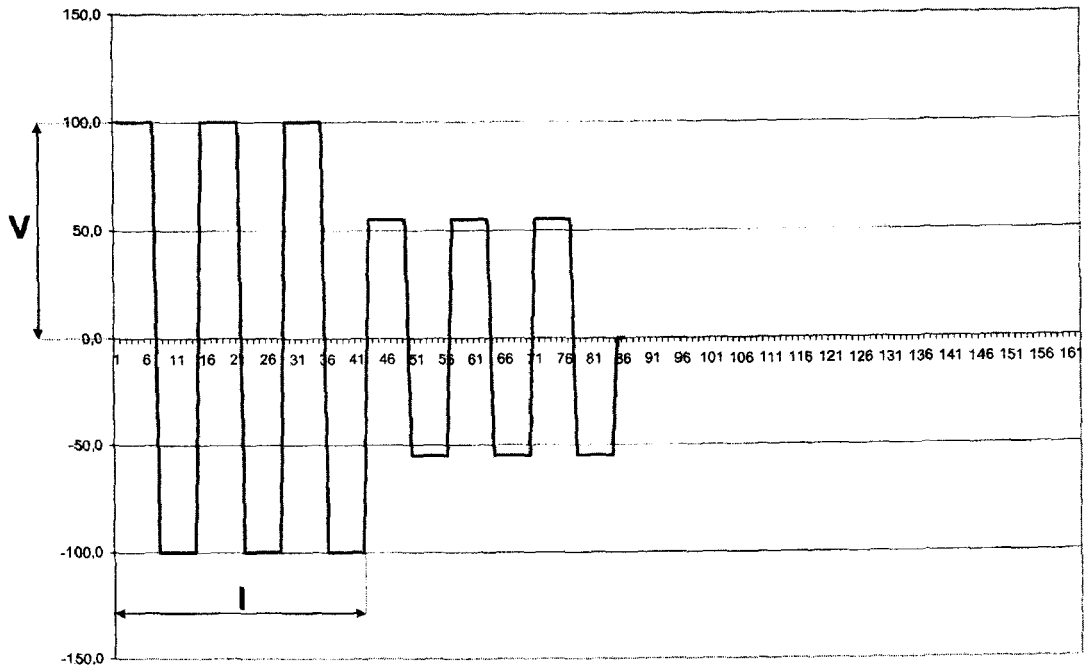
-90
-100
Vmax
Vmin
SX
SX
DX
DX

FIG. 2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50,0
0,0
-50,0
-100,0
-150,0
V
I
1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96 101 106 111 116 121 126 131 136 141 146 151 156 161

FIG. 3

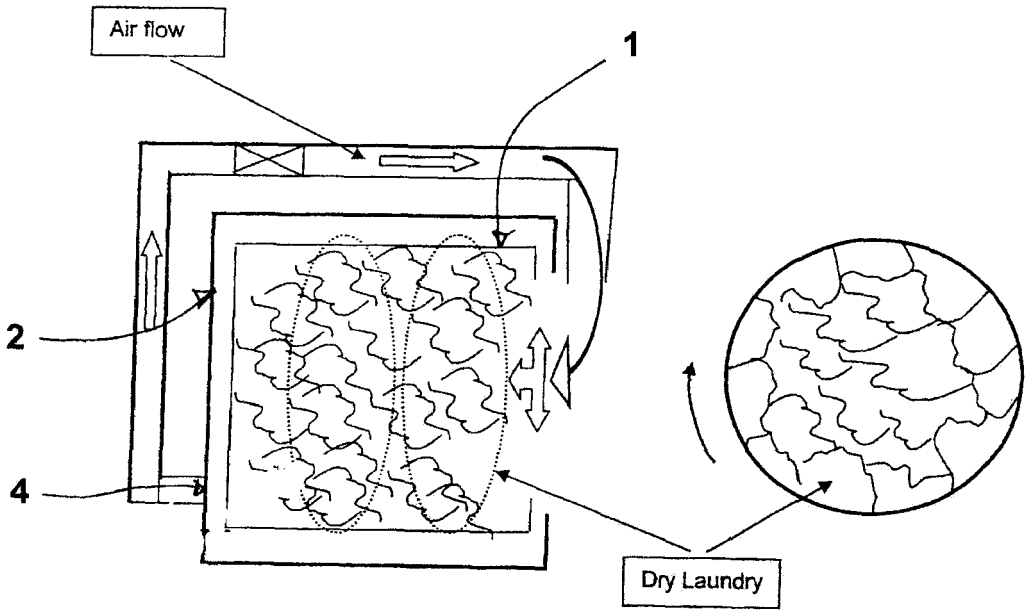
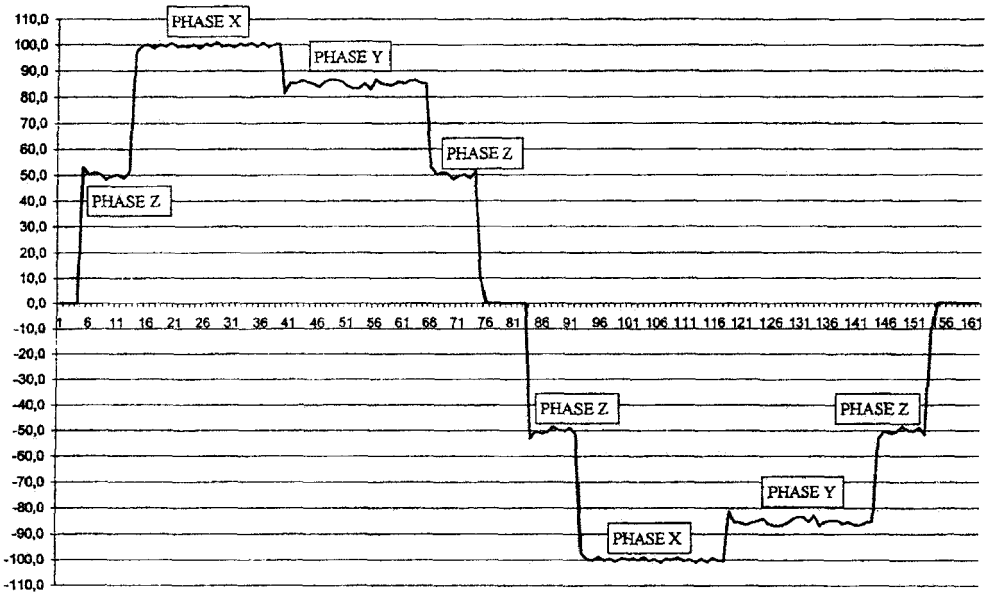

Air flow
1
2
4
Dry Laundry

FIG. 6d


PHASE X
PHASE Y
PHASE Z
PHASE Z
PHASE Z
PHASE Z
PHASE Y
PHASE X
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100,0
90,0
80,0
70,0
60,0
50,0
40,0
30,0
20,0
10,0
0,0
-10,0
-20,0
-30,0
-40,0
-50,0
-60,0
-70,0
-80,0
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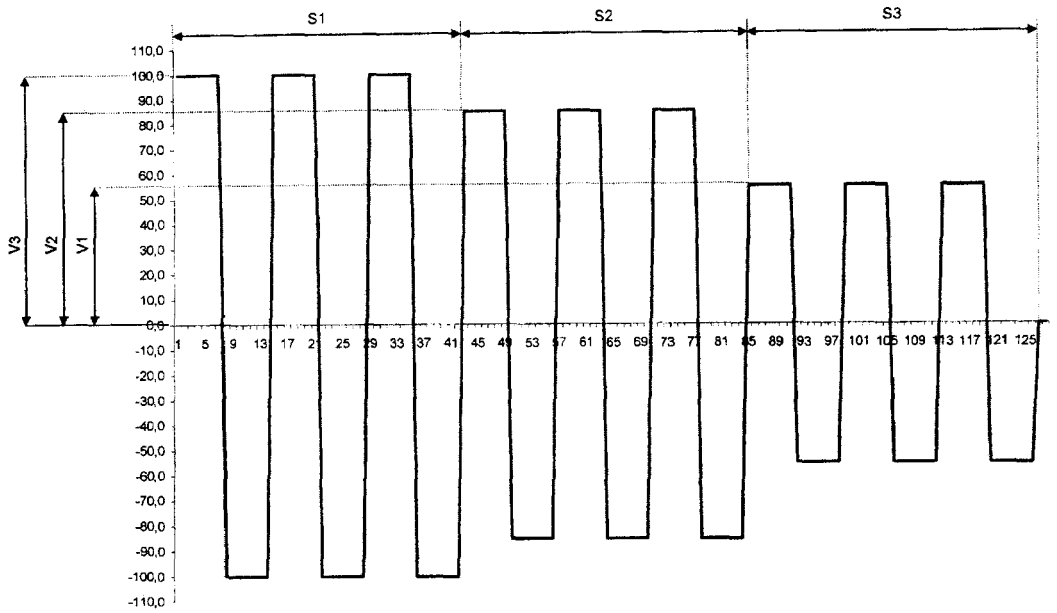
-100,0
-110,0
1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96 101 106 111 116 121 126 131 136 141 146 151 156 161

FIG. 5


S1
S2
S3
V3
V2
V1
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90,0
80,0
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60,0
50,0
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20,0
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0,0
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-70,0
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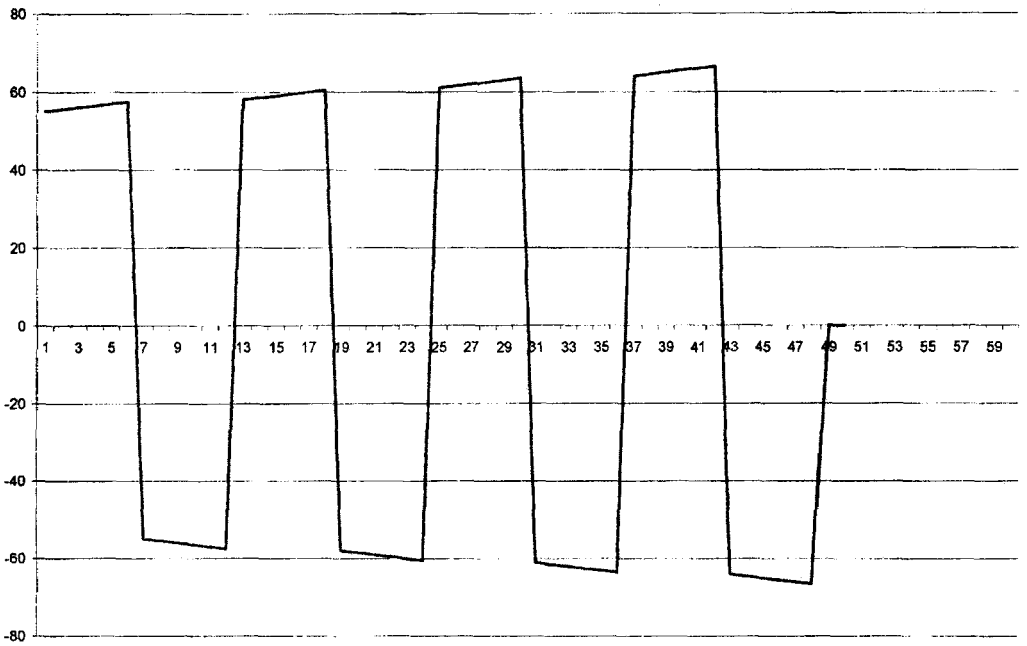
-100,0
-110,0
1 5 9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69 73 77 81 85 89 93 97 101 105 109 113 117 121 125

FIG. 4


80
60
40
20
0
-20
-40
-60
-80
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59

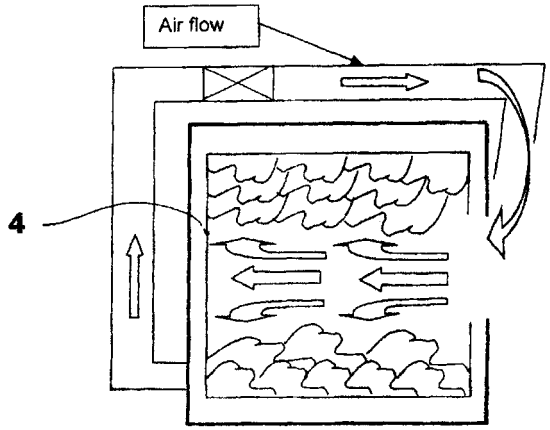
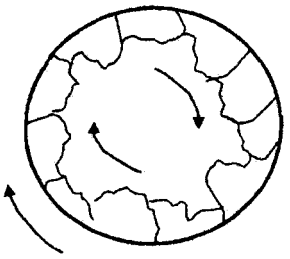


FIG. 6a

PHASE "X"



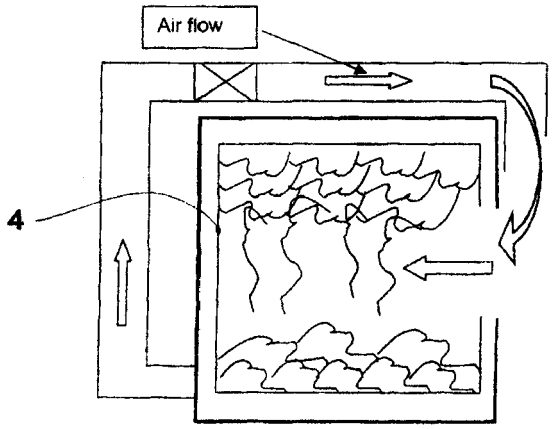
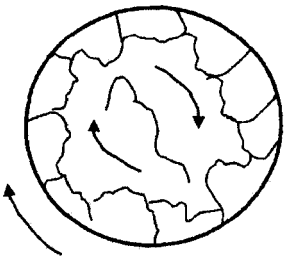


FIG. 6b

PHASE "Y"



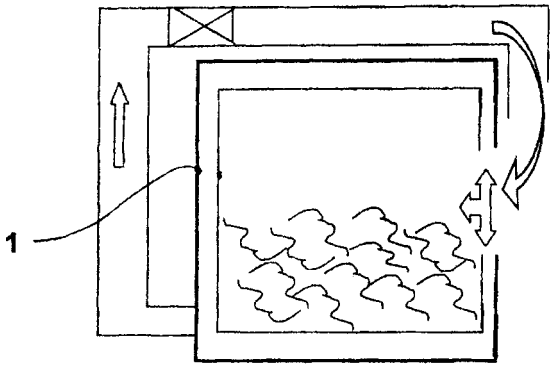
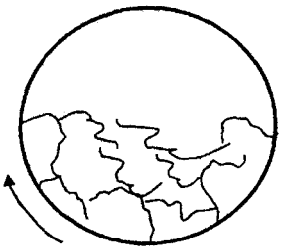


FIG. 6c

PHASE "Z"



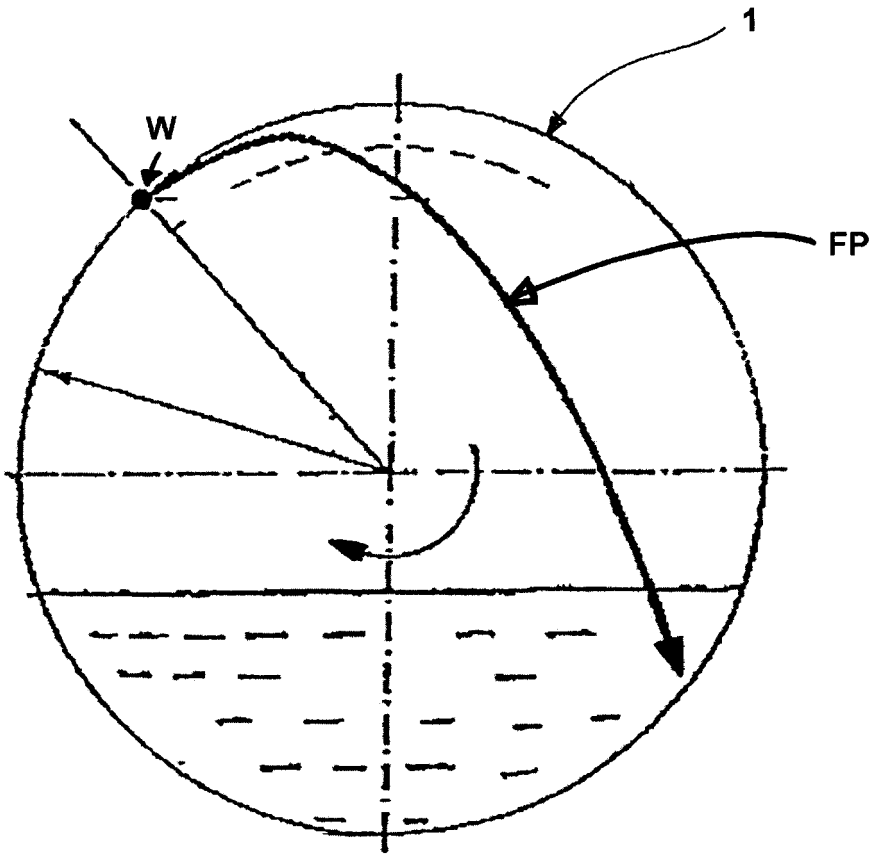


FIG. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 12 4094

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Place of search	Date of completion of the search	Examiner
Munich	19 June 2008	Clivio, Eugenio

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