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(54) **Washer-drier machine**

Wasch- und Trockenmaschine

Machine à laver séchante

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## Description

**[0001]** The present invention relates to a domestic washer-drier machine which provides for washing and drying the laundry.

**[0002]** Domestic washer-drier machines are known to comprise a support and housing structure, a washing tank being housed therein, which is provided with a front opening that can be closed by means of a porthole door that is hinged in front of the housing. Within the washing tank, a basket is pivotally housed about a horizontal or inclined axis, for the laundry to be accommodated therein to be washed and/or dried. The basket also defines a front opening that is located such as to match the opening of the washing tank, in order to load/unload the laundry.

**[0003]** The washing tank is suitable to contain the washing liquid during the laundry washing steps and to be a portion of the drying circuit during the laundry drying step.

**[0004]** A washing water delivery system that can be connected to the water supply is provided in order to load the tank with mains water and detergent substances and aids. On the bottom of the washing tank, a drain duct is provided with a discharge pump being associated therewith, which provides for the removal of the washing liquid from the tank and controls, together with the supply electrovalves, the level of liquid within the tank. For the recirculation of the washing liquid during the various washing and rinsing steps a recirculation duct complete with recirculation pump may be provided having a first intake end connected to the tank bottom to be capable of taking the washing liquid to be recirculated and a second re-feed end of the liquid to the laundry basket which is arranged proximate to the upper portion of the basket. An electric resistance being arranged within the tank in the gap between the tank wall and laundry basket is provided to heat the washing liquid contained in the tank.

**[0005]** The drying circuit of prior art washer-drier machines typically comprises an intake unit, a heat exchanger and a heating unit with electric resistances communicating with each other by means of a drying duct.

**[0006]** In such a loop circuit, the air flow generated by the intake unit is heated by the electric resistances and blown to the basket, where it causes the water contained within the tissues to evaporate as it passes through the wet laundry. In the heat exchanger, which is generally a container separate from the washing tank and provided with a spray nozzle, the wet air is cooled by a jet of cold water. Due to this cooling, the vapour condensates and is collected and discharged together with the cooling water. The dehumidified air is then sucked again by the intake unit and recirculated.

**[0007]** The cooling water is usually supplied to the heat exchanger by means of a cooling duct with a dedicated electrovalve which controls the loading of the mains water to the heat exchanger (condenser).

**[0008]** Prior art drying devices, while being satisfactory under many aspects, however, have a high consumption

of electric power and cooling water during the drying step.

**[0009]** It is further known, also in the household appliance field, to use zeolites for absorbing moisture. Zeolites are minerals with a regular crystalline and microporous structure comprising a high amount of micro-cavities with a very high total surface and a huge void volume within the crystals. Due to said configuration, zeolites are suitable to contain a considerable moisture amount by means of adsorption of water molecules on the wide surfaces of the microporous structure thereof. By subsequently heating the zeolite mineral, the water molecules are desorbed and released in the form of water vapour.

**[0010]** The experiences with dish-washing machines with zeolite dehumidification devices are not advantageously applicable to washer-drier machines for treating laundry, in that the passage of the drying air through one or more zeolite batteries would cause a considerable flow resistance and a corresponding power increase and power consumption of the intake unit. EP1500739A discloses an appliance according to the preamble of claim 1.

**[0011]** Accordingly, the object of the present invention is to provide a washer-drier machine, having such characteristics as to increase the drying power while reducing the energy and water consumption during the drying step.

**[0012]** This and other objects are achieved by means of a washer-drier machine according to claim 1. Advantageous embodiments are the object of the dependent claims.

**[0013]** According to a first aspect of the invention, the washer-drier machine comprises a washing tank suitable to contain the washing liquid, a basket suitable to accommodate the laundry and rotatably supported within the washing tank, a drying circuit with a intake unit, a heat exchanger and a heating unit communicating with each other by means of a drying circuit, and configured to convey a drying air flow through the basket, wherein the drying circuit further comprises an absorption device having:

- an absorption chamber defining a passage for the drying air flow,
- a zeolite cartridge arranged in the absorption chamber in contact with this drying air flow, such as to absorb the moisture therefrom,
- heating means arranged in a heat-exchange relationship with the zeolite cartridge and suitable to cause the release of the moisture from the zeolite cartridge,

wherein the washer-drier machine is configured such that, during a drying program, the drying air is conveyed both through the heat exchanger for a dehumidification through condensation and through the absorption device for a moisture absorption by means of the zeolite cartridge.

**[0014]** Due to the combined use of the condensation and adsorption by means of zeolites, on the one hand a cooling water saving and, on the other hand, a considerable reduction in the zeolite amount and accordingly

in the size and flow resistance as compared with a dehumidification based only on zeolite absorption are obtained.

**[0015]** In accordance with a further aspect of the present invention, the washer-drier machine comprises a recirculation duct and a recirculation pump associated therewith, which is suitable to take washing liquid from the tank bottom and re-feed the same in the basket, wherein this recirculation duct is arranged in a heat exchange relationship with the zeolite cartridge of the absorption device and wherein the washer-drier machine is configured such that, during a washing step, the heated and recirculated washing liquid heats the zeolite cartridge so that the latter releases the previously absorbed moisture.

**[0016]** Thereby, the thermal energy of the washing liquid is used to "regenerate" the zeolite cartridge, thus preparing the latter for absorbing moisture during a subsequent drying step.

**[0017]** In order to better understand the present invention and appreciate the advantages thereof, several embodiments thereof will be described below by way of non-limiting example, with reference to the annexed drawings, in which:

**[0018]** Fig. 1 is a side sectional view of a washer-drier machine according to an embodiment of the invention;

**[0019]** Fig. 2 is an enlarged view of a detail of the washer-drier machine section from Fig. 1;

**[0020]** Fig. 3 is an enlarged sectional view of a detail of the washer-drier machine according to an embodiment;

**[0021]** Fig. 4 is a schematic front view of a drying circuit of the washer-drier machine according to a further embodiment;

**[0022]** Fig. 4A illustrates a detail in Fig. 4;

**[0023]** Fig. 5 is a front schematic view of a drying circuit of the washer-drier machine according to a further embodiment;

**[0024]** Fig. 6 is a front schematic view of a drying circuit of the washer-drier machine according to a further embodiment.

**[0025]** With reference to the figures, a washer-drier machine 1 comprises a support and housing structure 2, a washing tank 3 being housed therein, which is provided with a front opening that can be closed by means of a porthole door 4 being hinged in the front of the housing 2. Within the washing tank 3, a basket 5 is pivotally housed about a horizontal or inclined axis, for the laundry to be accommodated therein to be washed and/or dried. The basket 5 also defines a front opening that is located such as to match the opening of the washing tank 3, in order to be capable of carrying out the loading/unloading of the laundry.

**[0026]** The washing tank 3 is suitable to contain the washing liquid during the laundry washing steps, and to be a portion of the drying circuit during the laundry drying step.

**[0027]** On the bottom 13 of the washing tank 3, a drain

duct 14 is provided with a discharge pump 15 being associated therewith, which provides for the removal of the washing liquid from the tank 3 and controls, together with the supply electrovalves 6, the level of liquid within the tank 3.

**[0028]** To heat the washing liquid contained within the tank 3, a coiled electric resistance 11 is provided, which is arranged within the tank 3, particularly on the bottom 13 of the latter, in the gap between the tank wall 3 and the laundry basket 5.

**[0029]** The washer-drier machine 1 further comprises a closed-loop drying circuit with a suction unit, for example an fan impeller 17 driven by an electric motor 18, a heat exchanger 10 as well as a heating unit with electric resistance 21, which communicate with each other by means of a drying duct 16.

**[0030]** In such a loop circuit, the air flow 22 generated by the suction unit 17, 18 is heated by the electric resistance 21 and blown to the basket 5, where it causes the water contained within the tissues to evaporate as it passes through the wet laundry. The heat exchanger 10 is arranged downstream of the laundry basket 5 (with reference to the direction of the drying air flow 22) and cools the wet air flowing from the basket 5.

**[0031]** Due to this cooling, the vapour condensates and is collected and discharged, for example together with a cooling water volume. The dehumidified air is then sucked back by the suction unit 17, 18 and recirculated.

**[0032]** According to a first aspect of the invention, the drying circuit further comprises an absorption device 23 suitable to absorb moisture from the drying air 22. The absorption device 23 comprises an absorption chamber 24 defining a passageway 25 for the drying air flow 22 and a zeolite cartridge 26 arranged in the absorption chamber 24 in contact with the drying air flow 22, such as to absorb the moisture therefrom.

**[0033]** The absorption device 23 further comprises heating means 27 arranged in a heat exchange relationship with the zeolite cartridge 26 and suitable to cause moisture to be released from the zeolite cartridge 26 (thermal "regeneration" of the zeolite mineral).

**[0034]** The washer-drier machine 1 is thus configured such that, during a drying program, the drying air 22 is conveyed both through the heat exchanger 10 for a dehumidification by means of condensation and through the absorption device 23 for moisture absorption through the zeolite cartridge 26.

**[0035]** Due to the combined use of condensation and adsorption by means of zeolites in a same drying circuit, on the one hand, a cooling water saving, and on the other hand, a considerable reduction in the amount of zeolite and accordingly of the consequent size and flow resistance are obtained as compared with a dehumidification based only on zeolite adsorption.

**[0036]** In order to facilitate a better understanding of the inventive concept, reference will be made throughout the description to an "absorption device containing at least one zeolite cartridge". However, the inventors do

not intend to limit this patent application to zeolite minerals. The latter are a preferred though non-limiting example of hygroscopic absorbing substances suitable to release moisture in response to heating. Accordingly, any particular reference to the "zeolite" material can be automatically intended as referred to one or more equivalent absorbing and thermally regenerable materials.

**[0037]** A first aspect of the invention, therefore, provides a washer-drier machine having the characteristics described above and being configured such that the drying air flow is dehumidified by means of two separate dehumidifiers (heat exchanger 10 and absorption device 23) which are the one based on the principle of cooling condensation and the other on the principle of water vapour adsorption.

**[0038]** According to the particular embodiment, the heat exchanger 10 and the absorption device 23 are arranged:

- in series between the tank 3 and the suction unit 17, 18 or
- in parallel between the tank 3 and the suction unit 17, 18

and can be operated simultaneously or alternately or one after the other during a same drying cycle.

**[0039]** A drying action in two steps, only one of them following the principle of water vapour adsorption by means of zeolites, permits the use of a very reduced zeolite mineral amount, and accordingly, the maintenance of air flow sections 22 which are substantially constant, indispensable for a low-energy consumption suction.

**[0040]** In accordance with a second aspect of the invention, the washer-drier machine comprises a recirculation duct 7 with a recirculation pump 8 associated therewith, which are suitable to take washing liquid from the tank 3 bottom and re-feed it in the basket 5 or more generally in the tank 3, for example in order to increase the soaking time during washing.

**[0041]** This recirculation duct 7 is advantageously arranged in a heat exchange relationship with the zeolite cartridge 26 of the absorption device 23 and the washer-drier machine 1 is configured such that, during a washing step, a heated and recirculated washing liquid 12 flow heats the zeolite cartridge 26 causing the latter to release the previously absorbed moisture.

**[0042]** Thereby, the thermal energy which is anyway required for the washing phase, is exploited for "regenerating" the zeolite cartridge, thereby preparing the latter to absorb moisture during a subsequent drying step.

**[0043]** In the exemplary embodiment in Fig. 1, the drying circuit 16 is connected to the bottom of the tank 3 in an inlet point 9 which is preferably arranged below the fill-up levels during the washing step 19 and rinsing step 20. Thereby, during the washing and rinsing steps, the lye closes the inlet 9 of the drying circuit 16, thereby preventing water vapour to be conveyed to the zeolite of the absorption device 23.

**[0044]** Downstream of the tank inlet point 9 (with reference to the drying air 22 flow direction) the drying duct 16 is extended, preferably vertically, upwards and defines a condensation chamber 28 of the heat exchanger 10. By way of example, a spraying nozzle 46 can be provided, which can be connected to the water network and suitable to inject a cold water jet in the condensation chamber 28.

**[0045]** The present invention is not limited to this particular embodiment and the heat exchanger 10 may be provided by means of cold sources alternative to the cold water jet.

**[0046]** Downstream of the heat exchanger 10, the drying duct 16 is connected to the absorption device 23, which is arranged above the condensation chamber 28 to prevent the risk of cooling water or condensate flowing to the zeolite cartridge 26.

**[0047]** The absorption device 23 comprises a support structure 29 with a side wall 30 innerly defining a substantially tubular, preferably cylindrical absorption chamber 24 with zeolite cartridge seats along the side wall 30, as well as a heating jacket 27 externally formed about the side wall 30, such as to be capable of heating the zeolite cartridge/s 26 arranged in their respective seats.

**[0048]** In accordance with an embodiment, the heating jacket 27 comprises a heating fluid duct 45 connected to the recirculation duct 7 for recirculating the hot washing liquid 12 during the washing steps. This duct can be configured as an annular cross section tube provided around the side wall 30.

**[0049]** In accordance with a further embodiment, the heating jacket 27 further comprises an electric resistance 31 in a heat exchange relationship with the inside of the heating fluid duct 45, preferably arranged within this duct 45.

**[0050]** The electric power supply of this electric resistance 31 is controlled by the control unit 38 to be capable of increasing the temperature of the heating jacket 27 relative to the temperature of the hot washing liquid 12, in order to further facilitate the thermal regeneration of the absorbing material, particularly a zeolitic one.

**[0051]** The zeolite cartridges 26 are provided and accommodated within the absorption chamber 24 such as to define the air passageway 25. The absorbing material (zeolite) of the zeolite cartridge 26 is advantageously enclosed in a reticular or filtering protection cover.

**[0052]** Downstream of the absorption device 23, the drying duct 16 leads the drying fluid to the suction unit 17, 18 arranged proximate to the top or above the washing tank 3. From the suction unit 17, 18, the drying duct 16 is extended to a mouth 32 thereof which is arranged proximate to the loading opening of the basket 5 where it re-feeds the drying air 22 to the basket 5. Along this last tract of the duct 16, downstream of the suction unit 17, 18 the heating unit 21 is arranged, for example an electric resistance placed within the duct 16.

**[0053]** In accordance with an alternative embodiment, the heat exchanger 10 can comprise a condensation sur-

face provided by cooling water accommodated on the tank bottom. To the purpose, the washing tank 3 can define therein a condensation space 33 suitable to contain a cooling water volume 34 that forms a free water surface spaced away from the basket 5 such as to be capable of cooling the drying air flow 22 downstream of the basket 5 within the washing tank 3.

**[0054]** Preferably, this condensation space 33 is formed at the tank bottom 13, approximately below the basket 5.

**[0055]** Fig. 3 illustrates an embodiment of the drying circuit, in which the absorption device 23 and the heat exchanger 10 are arranged in parallel in the drying duct 16 downstream of the tank 3 and upstream of the suction unit 17, 18. A selection valve 35 suitable to adjust the flow rate of the partial air flows 22 through the absorption device 23 and the heat exchanger 10 can be arranged downstream of these devices 10, 23 in a junction point 36 (this is the preferred solution, in order to avoid deposit accumulation in the valve area) or, alternatively, upstream of said devices 10, 23 in a bifurcation point of the duct 16.

**[0056]** The selection valve can be advantageously configured as an electro-thermal valve, i.e. controlled by means of a thermal expansion element (for example, wax) that can be heated by means of a control electric current.

**[0057]** In accordance with an embodiment, the absorption device 23 defines an air passageway longer and/or with a greater flow section than that of the heat exchanger 10, in order to allow for a high vapour absorption, while maintaining the flow characteristics similar to those of the air flow through the heat exchanger 10.

**[0058]** In accordance with an embodiment, the absorption device 23 and the heat exchanger 10 are configured as a prefabricated individual dehumidification accessory, which can be connected to the drying duct 16 and placeable outside the washing tank 3 and optionally outside the housing 2 of the washer-drier machine 1.

**[0059]** Advantageously, the washer-drier machine comprises a control unit 38 configured to control the selection valve 35 such as to divide the drying air flow 22 in two partial flows which are conveyed the one through the heat exchanger 10 and the other through the absorption device 23 and to adjust the flow rate ratio of the two partial flows as a function of the residual moisture in the laundry (which can be detected, in a known manner, for example by means of electric conductivity means or by means temperature sensors of the drying air 22 temperature upstream and downstream of the basket 5 and comparison of the detected values) or, in an indirect manner, as a function of the drying time, by preferring the dehumidification by condensation with very wet laundry (at the beginning of the drying cycle) and dehumidification by adsorption with not very wet laundry (almost at the end of the drying cycle).

**[0060]** The control unit 38 can be further configured and/or set by the user such that the drying air flow 22 is

alternatively conveyed through the heat exchanger 10 and the absorption device 23. Preferably, the control unit 38 is configured to allow selecting a drying program, wherein during a first time interval the dehumidification is carried out by means of condensation and during a subsequent second time interval the dehumidification is carried out by means of absorption.

**[0061]** Fig. 4 and 4A illustrate an embodiment in which the absorption device 23 is connected in series with the heat exchanger 10. The absorption chamber 24 has an elongated arched shape and circumferentially extends very proximate to the side wall 39 of the tank 3 in order to lengthen the drying air passage 22 along the absorbing material as much as possible.

**[0062]** Similarly, the heat exchanger 10 can be also provided with an elongated arched shape circumferentially extended proximate to the side wall 39 of the washing tank 3.

**[0063]** In order to reduce the depth size of the washer-drier machine is advantageous to arrange the heat exchanger 10 and absorption device 23 in a same vertical plane. The inlet aperture 40 of the heat exchanger 10 is arranged below the lower third  $H/3$  of the total height  $H$  of the tank 3 and the outlet port 41 of the heat exchanger 10 positioned above two thirds  $2H/3$  of the total height  $H$  of the tank 3. The absorption device 23 is placed approximately diametrically opposite the heat exchanger 10 (with reference to the basket rotation axis) and also the inlet port 42 of the absorption device 23 is positioned below the lower third  $H/3$  of the total height  $H$  of the tank 3 and the outlet opening 43 of the absorption device 23 is positioned above two thirds  $2H/3$  of the total height  $H$  of the tank 3.

**[0064]** The outlet port 41 of the heat exchanger 10 is connected to inlet port of the absorption device 23 by means of a tube in the shape of an inverted siphon 44.

**[0065]** The invention also contemplates that both the condensation chamber 28 and the absorption chamber can be partially defined by the rear and/or partially defined by the rear and/or side wall of the washing tank 3 and, possibly by one or more lid elements which are separately fabricated and subsequently connected to the tank.

**[0066]** This allows using the same tank base for washing machines (without additional lids) and for washer-drier machines (with added lids defining together with the tank) the condensation 10 and absorption 23 chambers.

**[0067]** Fig. 5 illustrates a further embodiment of the invention, wherein the heat exchanger 10 and the absorption device 23 are connected in parallel in the drying duct 16 and at least partially provided by the tank wall 3, as described above with reference to the embodiment in Fig. 4.

**[0068]** The supply of the drying air flow 22 to the heat exchanger and absorption device can be piloted by the control unit 38 as described with reference to Fig. 3.

**[0069]** Fig. 6 illustrates a further embodiment of the invention, wherein the heat exchanger 10 and the ab-

sorption device 23 are connected in parallel in the drying circuit and wherein the inlet port 40 of the heat exchanger 10 (condenser) is arranged above a tank fill-up level to create a free surface of cooling water 34 in the tank 3, whereas the inlet port 42 of the absorption device 23 is arranged below this fill-up level.

[0070] This particular configuration allows executing three different dehumidification steps by the drying air flow 22.

[0071] A first dehumidification step provides two condensation steps:

[0072] - along the free surface of cooling water 34 in the tank 3 and

[0073] - through the heat exchanger 10,

[0074] provided that the inlet of the absorption device is sealed by means of the cooling water 34 on the tank bottom. The inlet tube section of the absorption device 23 is sized such that the depression created by the intake unit 17, 18 cannot raise the water level to the absorbing material cartridge.

[0075] A second dehumidification step provides simultaneously carrying out the condensation by means of the heat exchanger 10 and the absorption by means of the absorption device 23,

[0076] provided that the absorption device inlet is cleared by means of the lowering or complete drainage of the cooling water 34 on the tank bottom.

[0077] It will be thus appreciated that said dehumidification steps can be controlled by controlling the cooling water level on the tank bottom, and accordingly by means of a targeted piloting of the electrovalves for the supply and the water discharge pump.

[0078] A third possible dehumidification step provides only moisture absorption by means of the absorption device 23. To the purpose, a selection or control valve 35 (shown in dotted lines in Fig. 6) piloted by the control unit 38 and suitable to open and close and/or control the air passing through the heat exchanger.

[0079] Obviously, to the washer-drier machine according to the present invention, those skilled in the art, aiming at meeting contingent and specific requirements, may carry out further modifications and variations, all being however contemplated within the scope of protection of the invention, such as defined in the annexed claims.

## Claims

1. A washer-drier machine (1) for washing and drying the laundry comprising:

- a washing tank (3) suitable to contain the washing liquid;
- a basket (5) suitable to accommodate the laundry and being pivotally supported within the washing tank (3);
- a drying circuit with a suction unit (17, 18), a heat exchanger (10) and a heating unit (21)

which communicate with each other by means of a drying duct (16), said drying circuit being suitable of delivering a drying air flow (22) through said basket (5),

the drying circuit further comprising an absorption device (23), having:

- an absorption chamber (24) in communication with the drying duct (16) and defining a passageway (25) for the drying air flow (22),
- a cartridge (26) of absorbing material arranged in the absorption chamber (24) in contact with the passageway (25),
- heating means (27) arranged in a heat exchange relationship with the cartridge (26) of absorbing material and suitable to cause the release of the moisture from the cartridge (26),

wherein the washer-drier machine (1) is configured such that, during a drying program, the drying air (22) is conveyed both through said heat exchanger (10) for a dehumidification by means of condensation and through the absorption device (23) for a moisture absorption by means of the absorbing material, **characterized in that** said heating means comprise a recirculation duct (7) with recirculation pump (8) which take, during a washing step, hot washing liquid from the bottom of the tank (3) and re-feed it in the tank (3), wherein said recirculation duct (7) is arranged in a heat exchange relationship with the absorbing material cartridge (26).

2. The washer-drier machine (1) according to claim 1, wherein said heat exchanger (10) and said absorption device (23) are arranged in series between the tank (3) and the suction unit (17, 18).
3. The washer-drier machine (1) according to claim 1, wherein said heat exchanger (10) and said absorption device (23) are arranged in parallel between the tank (3) and the intake unit (17, 18) and can be activated simultaneously or alternatively or one after the other during a same drying cycle.
4. The washer-drier machine (1) according to any preceding claims, wherein said cartridge (26) of absorbing material comprises zeolite.
5. The washer-drier machine (1) according to any preceding claim, wherein the drying duct (16) is connected to the bottom of the tank (3) in an inlet point (9) arranged below the fill-up levels during the washing step (19) and during the rinsing step (20), such that the lye closes the inlet (9) of the drying duct (16), thereby preventing the water vapour from being conveyed to the absorption device (23).

6. The washer-drier machine (1) according to the preceding claim, wherein the heat exchanger (10) comprises a condensation chamber (28) and a spraying nozzle (46) connectable to the water network and suitable to inject a cold water jet in the condensation chamber (28). 5
7. The washer-drier machine (1) according to claim 2 and those depending therefrom, wherein the absorption device (23) is arranged downstream and above the condensation chamber (28). 10
8. The washer-drier machine(1) according to any preceding claim, wherein the absorption device (23) comprises a side wall (30) which internally defines said tubular absorption chamber (24) with cartridge seats along the side wall (30), as well as a heating jacket (27) provided outside around the side wall (30), such as to be capable of heating the absorbing material cartridge (26) arranged within the seat thereof. 15 20
9. The washer-drier machine (1) according to the preceding claim, wherein the heating jacket (27) comprises a heating fluid duct (45) connected to the recirculation duct (7) as well as an electric resistance (31) in a heat exchange relationship with the inside of the heating fluid duct (45). 25
10. The washer-drier machine (1) according to any preceding claim, wherein the heat exchanger (10) comprises a condensation space (33) provided by the tank (13) bottom and suitable to contain a volume of cooling water (34) which forms a free water surface spaced from the basket (5) such as to cool the drying air flow (22) downstream of the basket (5) within the washing tank (3). 30 35
11. The washer-drier machine (1) according to claim 3 and the ones depending therefrom, comprising a selection valve (35) suitable to adjust the flow rate of the partial flows in the area (22) through the absorption device (23) and the heat exchanger (10). 40
12. The washer-drier machine (1) according to the preceding claim, comprising a control unit (38) configured to control the selection valve (35) such as to divide the flow of drying air (22) in two partial flows the one being conveyed to the heat exchanger (10) and the other through the absorption device (23) and to adjust the flow rate ratio of the two partial flows as a function of the residual moisture in the laundry. 45 50
13. Washer-drier machine(1) according to any preceding claim, wherein said absorption device (23) defines a longer air passage and/or with a higher flow section than that of the heat exchanger (10). 55
14. Washer-drier machine(1) according to any preceding claim, wherein the absorption device (23) and the heat exchanger (10) are configured as a prefabricated dehumidification unit, which can be connected to the drying duct (16) and placed outside the washing tank (3).
15. The washer-drier machine (1) according to any preceding claim, wherein the absorption chamber (24) has an arched elongate shape and is extended circumferentially very proximate to a side wall (39) of the tank (3).
16. The washer-drier machine (1) according to any preceding claim, wherein the heat exchanger (10) and the absorption device (23) are connected in parallel in the drying circuit and an inlet port (40) of the heat exchanger (10) is arranged above a tank fill-up level to create a free surface of cooling water (34) within the tank (3), while an inlet port (42) of the absorption device (23) is arranged below this fill-up level, wherein the washer-drier machine is configured to activate and deactivate the absorption device (23) by controlling the level of the cooling water on the tank bottom.

#### Patentansprüche

##### 1. Wasch-Trocknermaschine (1), welche aufweist:

einen Waschtank (3), der zur Aufnahme der Waschflüssigkeit geeignet ist;  
 eine Trommel (5), die zur Aufnahme der Wäsche geeignet und in dem Waschtank (3) drehbar gelagert ist,  
 einen Trocknungskreislauf mit einer Saugereinheit (17, 18), einem Wärmeaustauscher (10) und einer Heizeinheit (21), die mittels einer Trocknungsleitung (16) miteinander in Verbindung stehen, wobei der Trocknungskreislauf geeignet ist, um eine Trocknungsluftströmung (22) durch die Trommel (5) zu leiten, wobei der Trocknungskreislauf ferner eine Absorptionsvorrichtung (23) aufweist, mit:

einer Absorptionskammer (24), die mit der Trocknungsleitung (16) in Verbindung steht und einen Kanal (25) für die Trocknungsluftströmung (22) definiert,  
 einer Absorptionsmaterialpatrone (26), die in der Absorptionskammer (24) in Kontakt mit dem Kanal (25) angeordnet ist, Heizmitteln (27), die in Wärmeaustauschbeziehung mit der Absorptionsmaterialpatrone (26) angeordnet und geeignet ist, um die Freisetzung der Feuchtigkeit aus der Patrone (26) zu bewirken,

- worin die Wasch-Trocknermaschine (1) derart konfiguriert ist, dass, während eines Trocknungsprogramms, die Trocknungsluft (22) durch sowohl den Wärmeaustauscher (10) zur Entfeuchtung mittels Kondensation als auch durch die Absorptionsvorrichtung (23) zur Feuchtigkeitsabsorption mittels des Absorptionsmaterials gefördert wird, **dadurch gekennzeichnet, dass** die Heizmittel eine Rückführleitung (7) mit einer Rückföhrpumpe (8) aufweisen, die während eines Waschschriffs heiÖe Waschflüssigkeit vom Boden des Tanks (3) aufnehmen und sie wieder in den Tank (3) zurückföhrden, wobei die Rückführleitung (7) in einer Wärmeaustauschbeziehung mit der Absorptionsmaterialpatrone (26) angeordnet ist.
2. Die Wasch-Trocknermaschine (1) nach Anspruch 1, worin der Wärmeaustauscher (10) und die Absorptionsvorrichtung (23) in Serie zwischen dem Tank (3) und der Saugeinheit (17, 18) angeordnet sind.
  3. Die Wasch-Trocknermaschine (1) nach Anspruch 1, worin der Wärmeaustauscher (10) und die Absorptionsvorrichtung (23) parallel zwischen dem Tank (3) und der Einlasseinheit (17, 18) angeordnet sind und gleichzeitig oder alternativ oder nacheinander während des gleichen Trocknungszyklus aktiviert werden können.
  4. Die Wasch-Trocknermaschine (1) nach einem der vorhergehenden Ansprüche, worin die Absorptionsmaterialpatrone (26) Zeolit aufweist.
  5. Die Wasch-Trocknermaschine (1) nach einem vorhergehenden Anspruch, worin die Trocknungsleitung (16) mit dem Boden des Tanks (3) in einem Einlasspunkt (9) verbunden ist, der unterhalb der Auffüllpegel während des Waschschriffs (19) und des Spülschriffs (20) angeordnet ist, so dass die Lauge den Einlass (9) der Trocknungsleitung (16) verschließt, um hierdurch zu verhindern, dass der Wasserdampf zu der Absorptionsvorrichtung (23) gefördert wird.
  6. Die Wasch-Trocknermaschine (1) nach dem vorhergehenden Anspruch, worin der Wärmeaustauscher (10) eine Kondensationskammer (28) und eine Spröhdüse (46) aufweist, die mit der Wasserversorgung verbindbar ist und geeignet ist, um einen kalten Wasserstrahl in die Kondensationskammer (28) einzuspritzen.
  7. Die Wasch- und Trockenmaschine (1) nach Anspruch 2 und den davon abhängigen Ansprüchen, worin die Absorptionsvorrichtung (23) stromab und oberhalb der Kondensationskammer (28) angeordnet ist.
  8. Die Wasch- und Trockenmaschine (1) nach einem vorhergehenden Anspruch, worin die Absorptionsvorrichtung (23) eine Seitenwand (30) aufweist, die im Inneren die rohrförmige Absorptionskammer (24) mit Patronensitzen entlang der Seitenwand (30) definiert, sowie einen Heizmantel (27), der außen um die Seitenwand (30) herum vorgesehen ist, so dass er in der Lage ist, die Absorptionsmaterialpatrone (26) zu heizen, die in dem Sitz davon angeordnet ist.
  9. Die Wasch-Trocknermaschine (1) nach dem vorhergehenden Anspruch, worin der Heizmantel (27) eine Heizfluidleitung (45) aufweist, die mit der Rückführleitung (7) verbunden ist, sowie einen elektrischen Widerstand (31) in Wärmeaustauschbeziehung mit der Innenseite der Heizfluidleitung (45).
  10. Die Wasch-Trocknermaschine (1) nach einem vorhergehenden Anspruch, worin der Wärmeaustauscher (10) einen Kondensationsraum (33) aufweist, der durch den Boden des Tanks (13) vorgesehen und geeignet ist, ein Kühlwasservolumen (34) aufzunehmen, das eine freie Wasseroberfläche mit Abstand von der Trommel (5) bildet, um die Trocknungsluftströmung (22) stromab der Trommel (5) in dem Waschtank (3) zu kühlen.
  11. Die Wasch-Trocknermaschine (1) nach Anspruch 3 und den davon abhängigen Ansprüchen, die ein Wählventil (35) aufweist, das dazu geeignet ist, die Strömungsrate der Teilströmungen in dem Bereich (22) durch die Absorptionsvorrichtung (23) und den Wärmeaustauscher (10) einzustellen.
  12. Die Wasch-Trocknermaschine (1) nach dem vorhergehenden Anspruch, die eine Steuereinheit (38) aufweist, die konfiguriert ist, um das Wählventil (35) so anzusteuern, dass es den Trocknungsluftstrom (22) in zwei Teilströme aufteilt, wobei einer zu dem Wärmeaustauscher (10) gefördert wird und der andere danach die Absorptionsvorrichtung (23), und um das Strömungsverhältnis der zwei Teilströme als Funktion der Restflüssigkeit in der Wäsche einzustellen.
  13. Die Wasch-Trocknermaschine (1) nach einem vorhergehenden Anspruch, worin die Absorptionsvorrichtung (23) einen längeren Luftkanal und/oder einen größeren Strömungsquerschnitt definiert, als die/der des Wärmeaustauschers (10).
  14. Die Wasch-Trocknermaschine (1) nach einem vorhergehenden Anspruch, worin die Absorptionsvorrichtung (23) und der Wärmetauscher (10) als vorgefertigte Entfeuchtungseinheit konfiguriert sind, die

mit der Trocknungsleitung (16) verbunden und außerhalb des Waschtanks (3) angeordnet werden kann.

15. Die Wasch-Trocknermaschine (1) nach einem vorhergehenden Anspruch, worin die Absorptionskammer (24) eine längliche Bogenform hat und sich umfangmäßig sehr nahe an einer Seitenwand (39) des Tanks (3) erstreckt. 5
16. Die Wasch-Trocknermaschine (1) nach der vorhergehenden Ansprüche, worin der Wärmeaustauscher (10) und die Absorptionsvorrichtung (23) parallel in dem Trocknungskreislauf angeschlossen sind, und eine Einlassöffnung (40) des Wärmeaustauschers (10) oberhalb eines Tankauffüllpegels angeordnet ist, um eine freie Oberfläche von Kühlwasser (34) innerhalb des Tank (3) zu erzeugen, während eine Einlassöffnung (42) der Absorptionsvorrichtung (23) unterhalb dieses Auffüllpegels angeordnet ist, wobei die Wasch- und Trockenmaschine konfiguriert ist, um die Absorptionsvorrichtung (23) durch Steuern des Kühlwasserpegels am Tankboden zu aktivieren und zu deaktivieren. 10 15 20 25

## Revendications

1. Machine à laver et sécher le linge (1) pour laver et sécher le linge comprenant : 30
- un réservoir de lavage (3) convenant pour contenir le liquide de lavage ;
- un panier (5) convenant pour accueillir le linge et supporté de manière pivotante dans le réservoir de lavage (3) ;
- un circuit de séchage avec une unité d'aspiration (17, 18), un échangeur de chaleur (10) et une unité de chauffage (21) qui communiquent ensemble au moyen d'un conduit de séchage (16), ledit circuit de séchage convenant pour délivrer un flux d'air de séchage (22) à travers ledit panier (5),
- le circuit de séchage comprenant en outre un dispositif d'absorption (23), comportant : 40 45 50
- une chambre d'absorption (24) en communication avec le conduit de séchage (16) et définissant un passage (25) pour le flux d'air de séchage (22),
- une cartouche (26) de matériau absorbant agencée dans la chambre d'absorption (24) en contact avec le passage (25),
- des moyens de chauffage (27) agencés dans une relation d'échange de chaleur avec la cartouche (26) de matériau absorbant et convenant pour causer la libération de l'humidité de la cartouche (26), 55

dans laquelle la machine à laver et sécher le linge (1) est configurée de telle manière que, pendant un programme de séchage, l'air de séchage (22) est convoyé à la fois à travers ledit échangeur de chaleur (10) pour une déshumidification par condensation et à travers le dispositif d'absorption (23) pour une absorption d'humidité au moyen du matériau absorbant, **caractérisé en ce que** lesdits moyens de chauffage comprennent un conduit de recirculation (7) avec une pompe de recirculation (8) qui prend, pendant une étape de lavage, du liquide de lavage chaude venant du fond du réservoir (3) et le réalimente dans le réservoir (3), dans laquelle ledit conduit de recirculation (7) est agencé dans une relation d'échange de chaleur avec la cartouche (26) de matériau absorbant.

2. Machine à laver et sécher le linge (1) selon la revendication 1, dans laquelle ledit échangeur de chaleur (10) et ledit dispositif d'absorption (23) sont agencés en série entre le réservoir (3) et l'unité d'aspiration (17, 18).
3. Machine à laver et sécher le linge (1) selon la revendication 1, dans laquelle ledit échangeur de chaleur (10) et ledit dispositif d'absorption (23) sont agencés en parallèle entre le réservoir (3) et l'unité d'admission (17, 18) et peuvent être activés simultanément ou alternativement ou l'un après l'autre pendant un même cycle de séchage.
4. Machine à laver et sécher le linge (1) selon l'une quelconque des revendications précédentes, dans laquelle ladite cartouche (26) de matériau absorbant, comprend de la zéolite.
5. Machine à laver et sécher le linge (1) selon l'une quelconque des revendications précédentes, dans laquelle le conduit de séchage (16) est relié au fond du réservoir (3) dans un point d'entrée (9) agencé sous les niveaux de remplissage pendant l'étape de lavage (19) et pendant l'étape de rinçage (20), de telle manière que la lessive ferme l'entrée (9) du conduit de séchage (16), empêchant ainsi la vapeur d'eau d'être convoyée vers le dispositif d'absorption (23).
6. Machine à laver et sécher le linge (1) selon la revendication précédente, dans laquelle l'échangeur de chaleur (10) comprend une chambre de condensation (28) et une buse de pulvérisation (46) pouvant être connectée au réseau d'eau et convenant pour injecter un jet d'eau froide dans la chambre de condensation (28).

7. Machine à laver et sécher le linge (1) selon la revendication 2 et celles qui en dépendent, dans laquelle le dispositif d'absorption (23) est agencé en aval et au-dessus de la chambre de condensation (28). 5
8. Machine à laver et sécher le linge (1) selon l'une quelconque des revendications précédentes, dans laquelle le dispositif d'absorption (23) comprend une paroi latérale (30) qui définit intérieurement ladite chambre d'absorption (24) tubulaire avec des sièges de cartouche le long de la paroi latérale (30), ainsi qu'une chemise de chauffage (27) placée à l'extérieur autour de la paroi latérale (30), de façon à pouvoir chauffer la cartouche (26) de matériau absorbant agencée dans le siège de celle-ci. 10
9. Machine à laver et sécher le linge (1) selon la revendication précédente, dans laquelle la chemise de chauffage (27) comprend un conduit de fluide de chauffage (45) relié au conduit de recirculation (7) ainsi qu'une résistance électrique (31) dans une relation d'échange de chaleur avec l'intérieur du conduit de fluide de chauffage (45). 20
10. Machine à laver et sécher le linge (1) selon l'une quelconque des revendications précédentes, dans laquelle l'échangeur de chaleur (10) comprend un espace de condensation (33) fourni par le fond du réservoir (13) et convenant pour contenir un volume d'eau de refroidissement (34) qui forme une surface d'eau libre espacée du panier (5) de façon à refroidir le flux d'air de séchage (22) en aval du panier (5) dans le réservoir de lavage (3). 25 30
11. Machine à laver et sécher le linge (1) selon la revendication 3 et celles qui en dépendent, comprenant une soupape de sélection (35) convenant pour régler le débit des écoulements partiels dans la surface (22) à travers le dispositif d'absorption (23) et l'échangeur de chaleur (10). 35 40
12. Machine à laver et sécher le linge (1) selon la revendication précédente, comprenant une unité de commande (38) configurée pour commander la soupape de sélection (35) de façon à diviser le flux d'air de séchage (22) en deux flux partiels, l'un étant convoyé vers l'échangeur de chaleur (10) et l'autre à travers le dispositif d'absorption (23) et pour régler le rapport de débit des deux flux partiels en fonction de l'humidité résiduelle dans le linge. 45 50
13. Machine à laver et sécher le linge (1) selon l'une quelconque des revendications précédentes, dans laquelle ledit dispositif d'absorption (23) définit un passage d'air plus long et/ou avec une section d'écoulement plus grande que celle de l'échangeur de chaleur (10). 55
14. Machine à laver et sécher le linge (1) selon l'une quelconque des revendications précédentes, dans laquelle le dispositif d'absorption (23) et l'échangeur de chaleur (10) sont configurés comme une unité de déshumidification préfabriquée, qui peut être reliée au conduit de séchage (16) et placée à l'extérieur du réservoir de lavage (3).
15. Machine à laver et sécher le linge (1) selon l'une quelconque des revendications précédentes, dans laquelle la chambre d'absorption (24) a une forme arquée allongée et s'étend circonférentiellement très proche d'une paroi latérale (39) du réservoir (3).
16. Machine à laver et sécher le linge (1) selon l'une quelconque des revendications précédentes, dans laquelle l'échangeur de chaleur (10) et le dispositif d'absorption (23) sont reliés en parallèle dans le circuit de séchage et un orifice d'entrée (40) de l'échangeur de chaleur (10) est agencé au-dessus d'un niveau de remplissage de réservoir pour créer une surface libre d'eau de refroidissement (34) dans le réservoir (3), alors qu'un orifice d'entrée (42) du dispositif d'absorption (23) est agencé sous ce niveau de remplissage, dans laquelle la machine à laver et sécher le linge est configurée pour activer et désactiver le dispositif d'absorption (23) en commandant le niveau de l'eau de refroidissement dans le fond du réservoir.

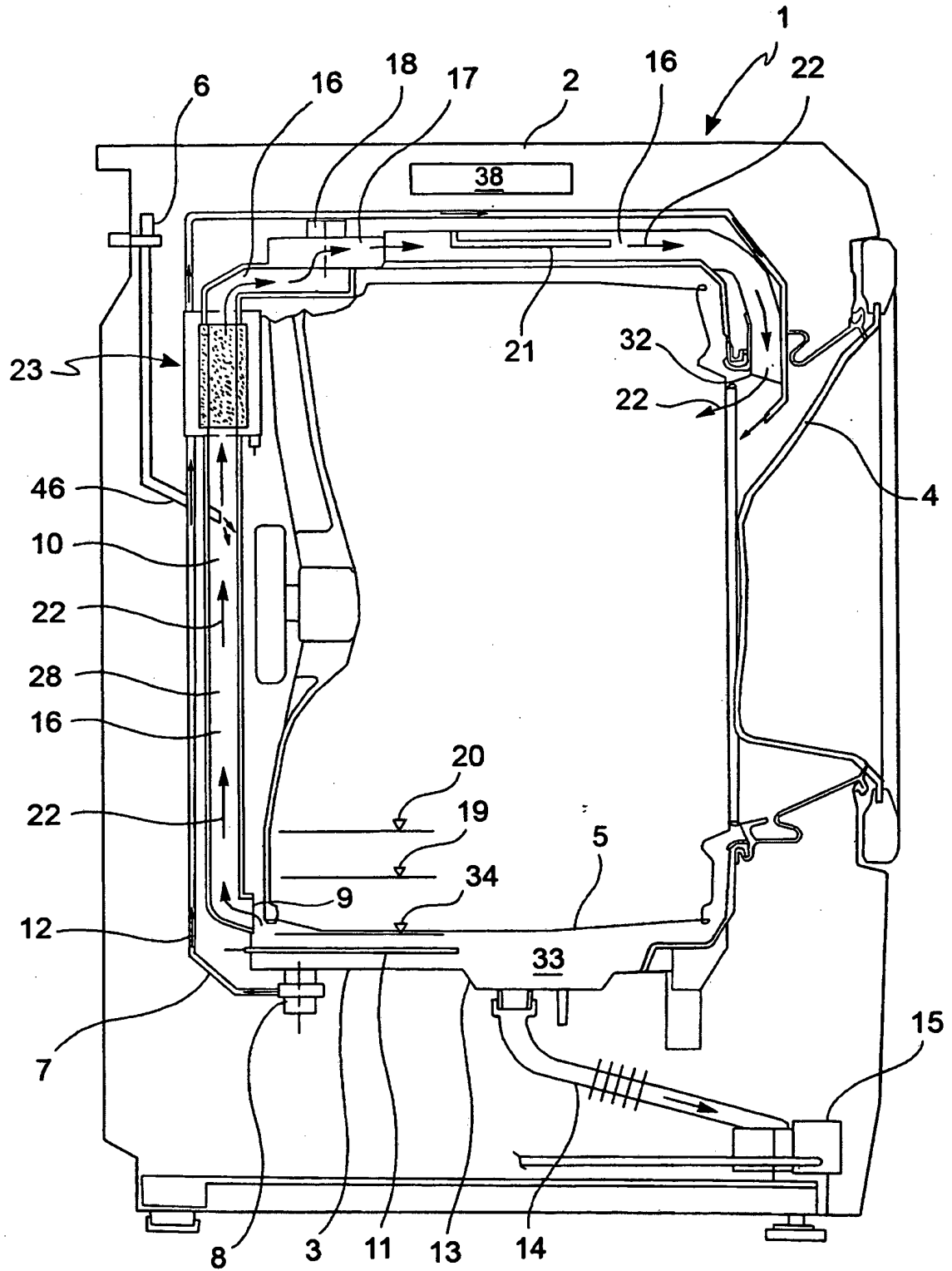


FIG. 1

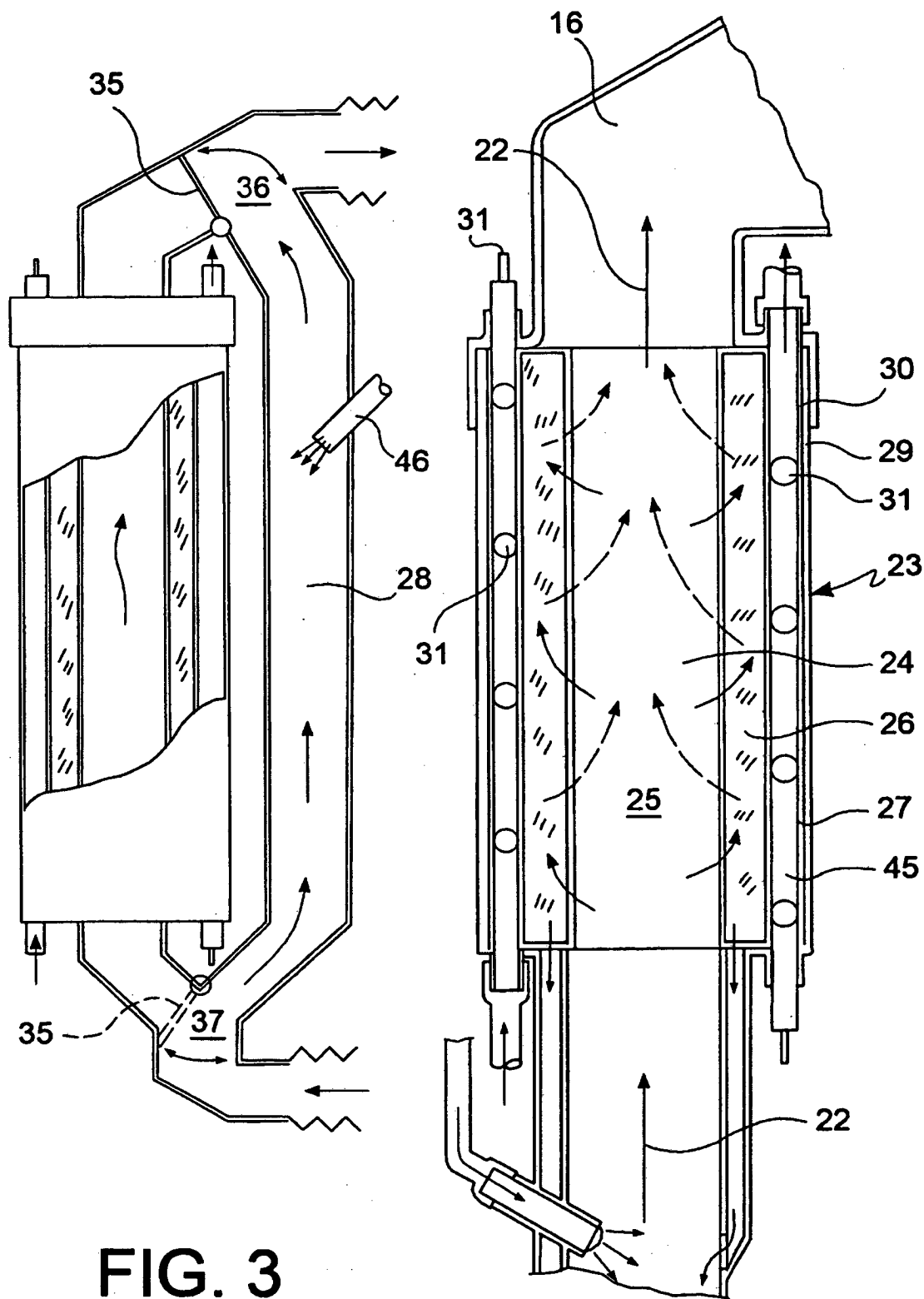


FIG. 3

FIG. 2

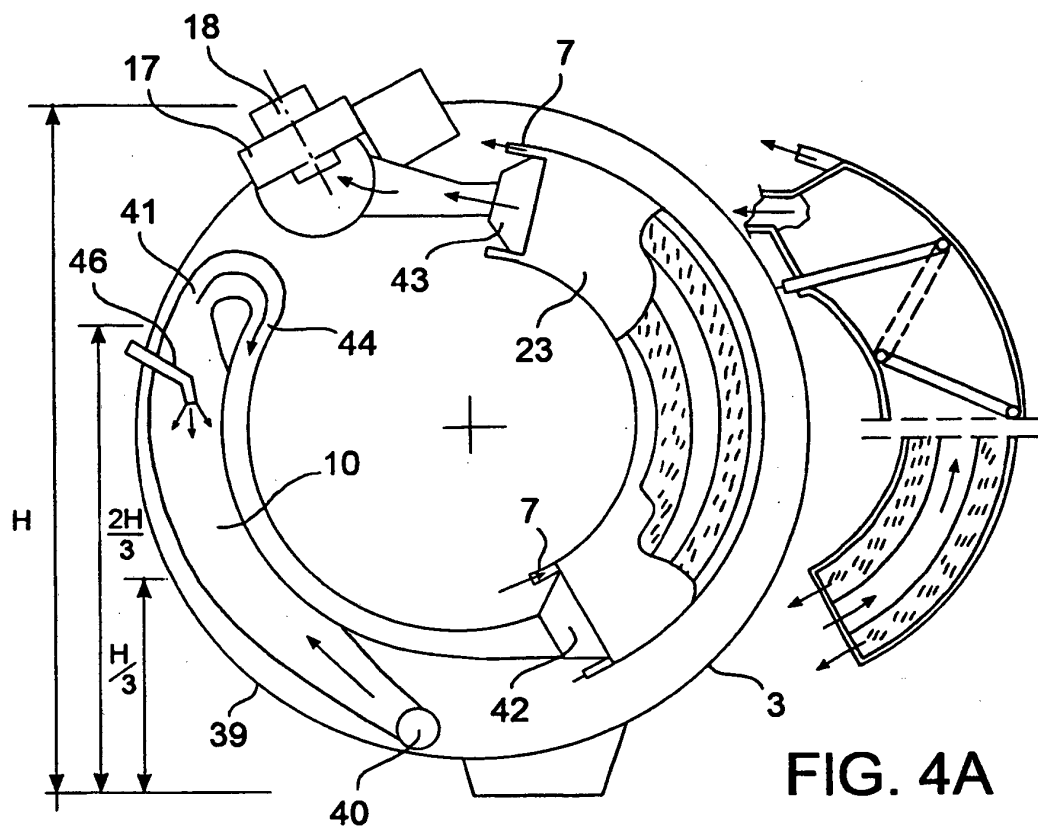
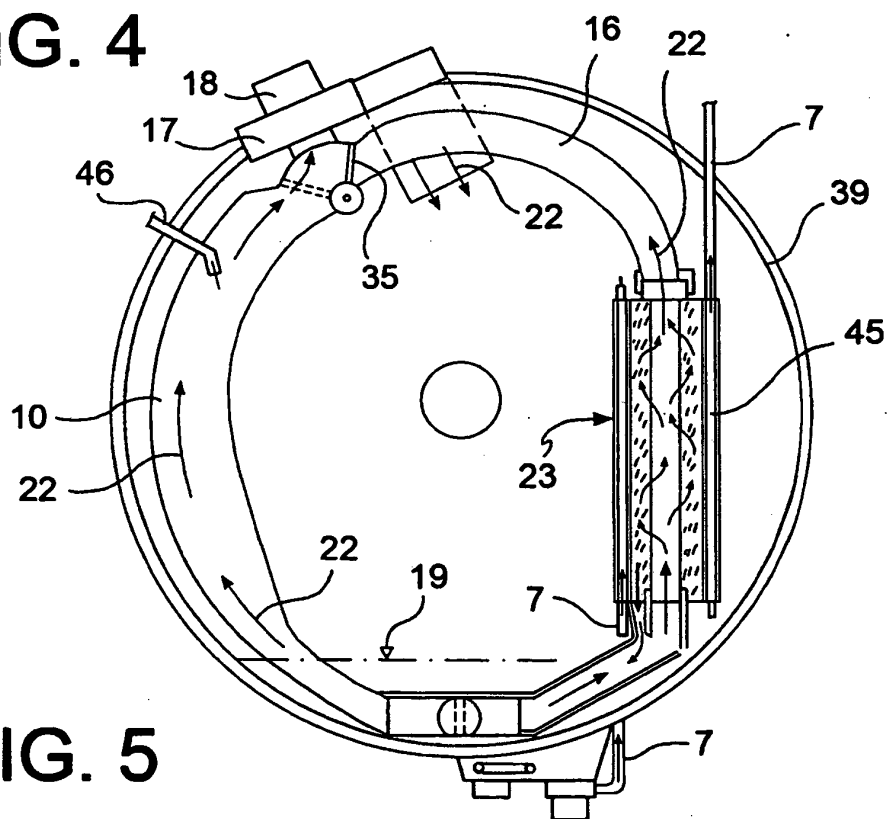


FIG. 4



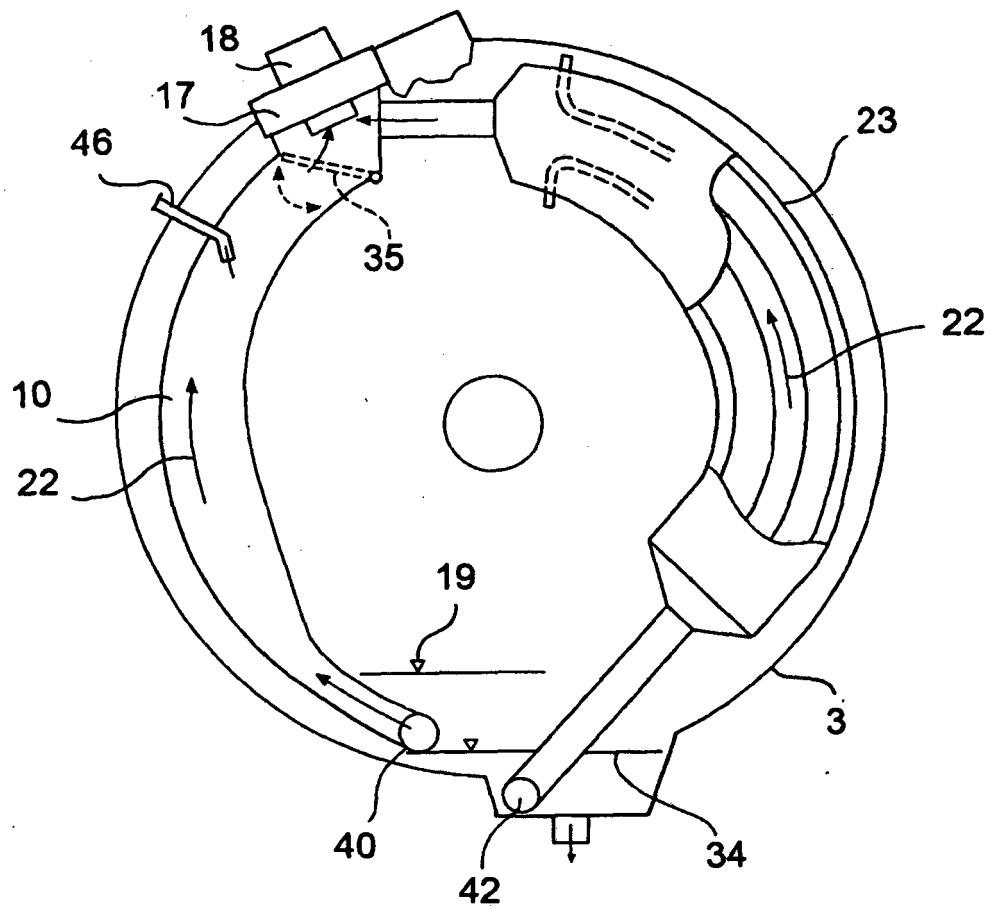


FIG. 6

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- EP 1500739 A [0010]