



US 20110120511A1

(19) **United States**(12) **Patent Application Publication****Jerg et al.**(10) **Pub. No.: US 2011/0120511 A1**(43) **Pub. Date: May 26, 2011**(54) **DISHWASHER MACHINE COMPRISING A
SORPTION DRYING DEVICE IN A
SUB-MODULE**(30) **Foreign Application Priority Data**

Jul. 28, 2008 (DE) 10 2008 040 789.5

Aug. 20, 2008 (DE) 10 2008 038 504.2

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A47L 15/42 (2006.01)(52) **U.S. Cl.** **134/115 R**(73) Assignee: **BSH Bosch und Siemens
Hausgerate GmbH**, Munich (DE)(57) **ABSTRACT**

A dishwasher is provided that has a washing compartment for items to be washed, wherein the washing compartment has a base. The dishwasher also includes a drying device to dry items that have been washed, wherein the drying device has a sorption container to hold a reversibly dehydrated sorption agent. The dishwasher further includes an air-transmitting air duct between the drying device and the washing compartment to generate an air exchange between the washing compartment and the sorption container, and a bottom sub-module underneath the base of the washing compartment that accommodates the sorption container.

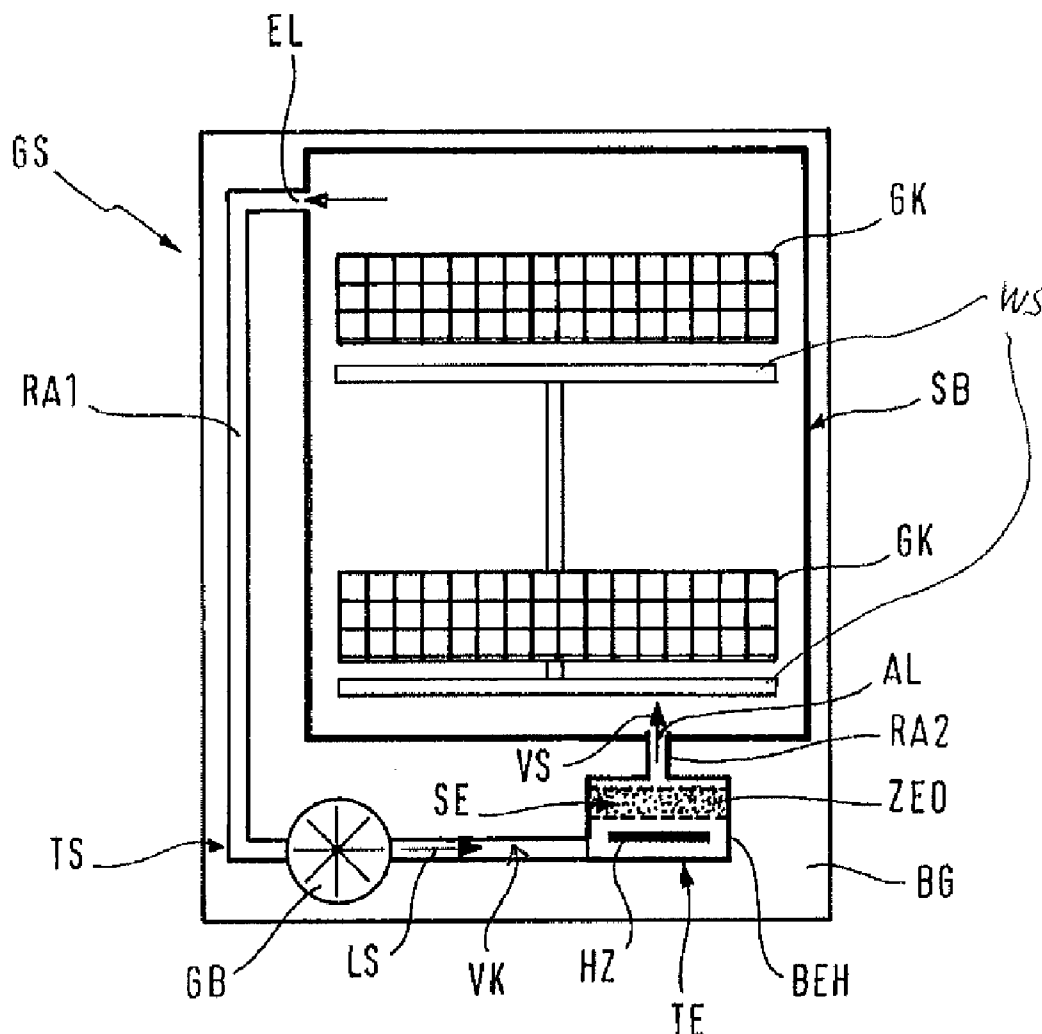
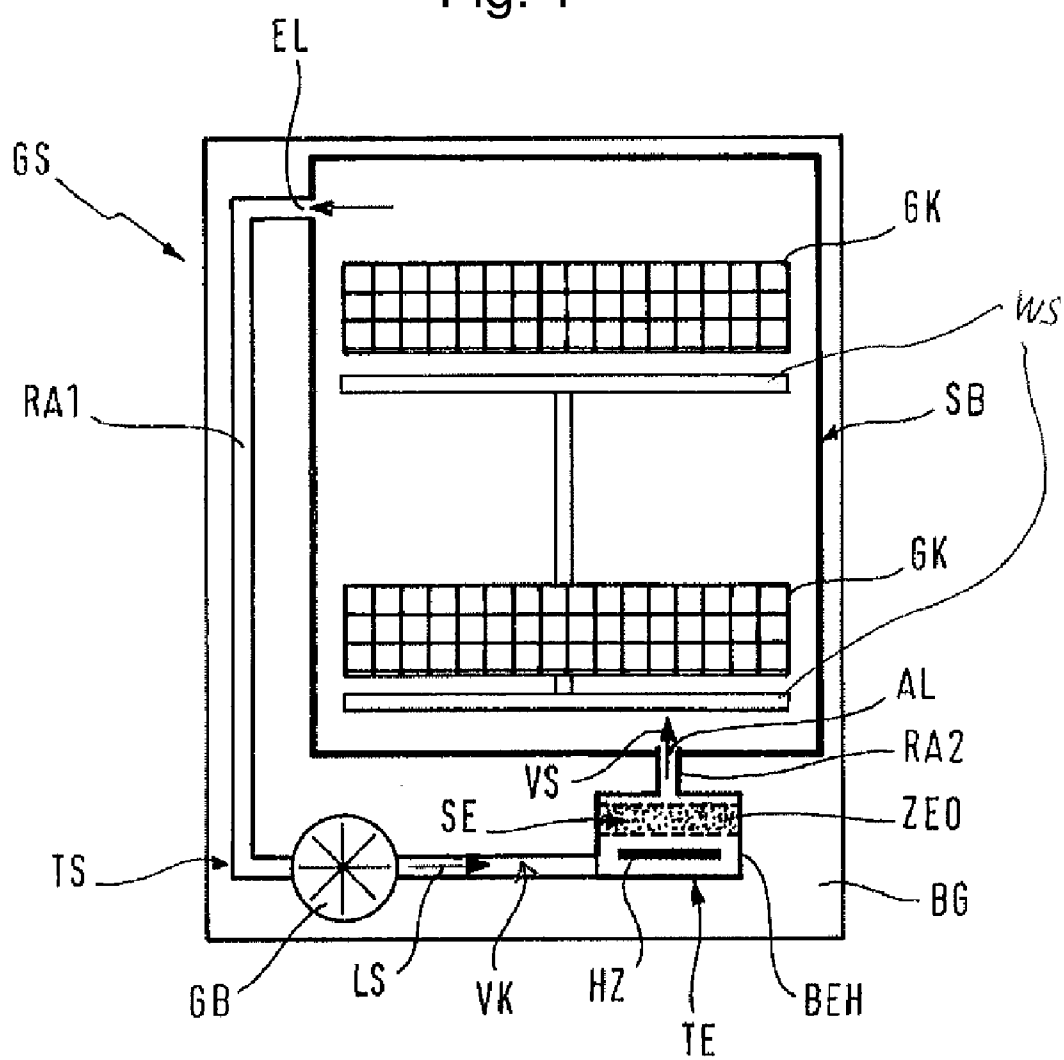
(21) Appl. No.: **13/054,572**(22) PCT Filed: **Jul. 28, 2009**(86) PCT No.: **PCT/EP2009/059710**§ 371 (c)(1),
(2), (4) Date:**Jan. 18, 2011**

Fig. 1



**DISHWASHER MACHINE COMPRISING A
SORPTION DRYING DEVICE IN A
SUB-MODULE**

[0001] The present invention relates to a dishwasher, in particular a domestic dishwasher, with at least one washing compartment and at least one drying device for drying items which have been washed, in which the drying device has at least one sorption container for holding a sorption agent which can be reversibly dehydrated, in particular zeolite, and with at least one air-transmitting air duct between the drying device and the washing compartment, for generating an exchange of air between the washing compartment and the sorption container.

[0002] Dishwashers with a so-called sorption column for drying crockery are known, for example, from DE 103 53 774 A1, DE 103 53 775 A1 or DE 10 2005 004 096 A1. Here, for the purpose of drying the crockery, in a subprogram step "Dry" of the relevant dishwashing program in the dishwasher, a blower passes moist air from the dishwasher's washing compartment through the sorption column, and by condensation its reversibly dehydratable drying material extracts moisture from the air which is fed through it. For the purpose of regeneration, i.e. desorption of the sorption column, its reversibly dehydratable drying material is heated up to very high temperatures. Water stored in this material thereby issues as hot steam, and is fed into the washing compartment by the airflow produced by means of the blower. By this means, any rinse liquor and/or any items which are in the washing compartment can be heated up together with the air which is in the washing compartment. A sorption column of this type has proved to be very advantageous for energy-saving and quiet drying of the crockery. For the purpose of avoiding local overheating of the drying material during the desorption operation, DE 10 2005 004 096 A1 has for example a heater arranged before the air inlet to the sorption column, looking in the direction of flow of the air. In spite of this "air heating" during desorption, it remains difficult in practice to dry out the reversibly dehydratable drying material adequately and satisfactorily.

[0003] The object of the invention is to provide a dishwasher, in particular a domestic dishwasher, with which a further improved result can be achieved for the sorption and/or desorption of the reversibly dehydratable drying agent in the sorption unit of its sorption drying device.

[0004] For a dishwasher of the type mentioned in the introduction, this object is achieved by accommodating the sorption container in a bottom sub-module underneath the base of the washing compartment.

[0005] This permits a quantity of sorption material which is sufficient for a satisfactory sorption and/or desorption effect to be compactly accommodated in the dishwasher. This arrangement of the sorption container, in the bottom sub-module underneath the base of the washing compartment, also avoids wasting installation space in the region of the sidewalls of the washing compartment. Thus the internal and external dimensions of the dishwasher can remain largely unchanged. This is particularly advantageous in the case of a domestic dish-washer for which, for example, an installation space with particular internal dimensions is provided in a kitchen.

[0006] In accordance with an advantageous development of the invention, there is provided in the sorption container a

quantity of the reversibly dehydratable sorption agent, for the absorption of a quantity of moisture transported by the exchange of air, which is of such a weight that the quantity of moisture absorbed by the sorption agent is less than the quantity of liquid applied to the items to be washed, in particular the quantity of liquid applied in a final rinsing step. Adjusting the weight of sorption agent in the sorption container in such a way that out of the total quantity of liquid it only takes up a part, which is less than the total quantity of liquid applied to the items to be washed, enables efficient binding of the moisture in the air while using little sorption agent. This permits a compact construction of the sorption container.

[0007] At the same time, this ensures that the energy consumption for the complete regeneration of the sorption agent, by heating it by means of a heater, can be reduced because the quantity of sorption agent which is heated up is adjusted or measured out to be only just sufficient for the satisfactory drying of the items to be washed.

[0008] In accordance with a first expedient development of the invention, the sorption container is expediently provided with a quantity of the reversibly dehydratable sorption agent which is of such a weight that the quantity of moisture absorbed by the reversibly dehydratable sorption agent corresponds essentially to the amount of dampness which dampens the items to be washed after the end of the final rinsing step. Here, the amount of dampness is, in particular, the amount of liquid which, after the end of the final rinsing step in which the items which have previously been cleaned have had water mixed with a wetting agent applied, is left behind on the items to be washed, the crockery/cutlery baskets which hold the items to be washed and/or on the internal walls of the washing compartment and does not flow away to the bottom of the washing compartment under the influence of gravity. The effect achieved by this adjustment of the quantity by weight of the sorption agent is that the capacity of the sorption agent for taking up moisture is sufficient for it to bind or take up almost completely the amount used for wetting, by means of the air exchange.

[0009] Preferably, the quantity by weight of the sorption agent accommodated in the sorption container will be such that the quantity of moisture absorbed corresponds to between 4% and 25%, in particular 5 to 15%, of the quantity of liquid applied onto the items to be washed.

[0010] It is advantageous if the quantity by weight of reversibly dehydratable sorption agent present in the sorption container is between 0.2 kg and 5 kg, in particular between 0.3 kg and 3 kg, preferably between 0.5 kg and 2.5 kg.

[0011] In accordance with one expedient form of embodiment, the drying device can be connected by at least one air duct with at least one outlet and with at least one inlet on the washing compartment. This permits air to be circulated in a closed circuit.

[0012] In particular, it can be expedient that the air duct is arranged to be largely outside the washing compartment, so that the usable space in the washing compartment is retained, i.e. is not made smaller.

[0013] Provision can be made, in particular, that the section of the piping for the air duct on the outlet side is connected to at least one inlet to the washing compartment in a region close to the floor of the latter. This is expedient if the sorption container is accommodated in the bottom sub-module of the dishwasher, in this way, the outflow path for the dried air, from the sorption container to where it flows into the dish-

washer's washing compartment, can be kept short so that unwanted heat losses are largely avoided.

[0014] In particular, provision can be made that the section of the piping for the air duct on the inlet side is connected to at least one outlet into the washing compartment above the latter's base, in particular in the region close to its top cover. This largely avoids the possibility of spray water, from a spray device in the washing compartment, penetrating into the entry aperture of the section of piping for the air duct on the inlet side, for example during a cleaning or final rinsing operation or an intermediate rinsing operation. This would otherwise lead to an unwanted partial or complete saturation of the sorption agent, in particular to a detrimental effect on or even damage to the sorption agent in respect of its original sorption and/or desorption properties, and make it partially or completely unusable for drying moist air from the washing compartment.

[0015] Furthermore, it may be advantageous that the section of piping for the air duct on the inlet side opens out into the sorption container of the drying device in a region close to its base in such a way that the direction of inflow from it is diverted, in particular by about 90°, into the direction of flow through the sorption container, which will preferably be vertical. On the one hand, this permits the moist air from the washing compartment to be fed via at least one section of piping for the air duct on the inlet side, which is arranged on a sidewall and/or a rear wall of the washing compartment. On the other hand, the section of piping for the air duct on the outlet side can run in a broadly straight line between the outlet opening of the sorption container and the inlet opening of the washing compartment, and can be kept relatively short. This is particularly advantageous if the section of piping for the air duct on the outlet side is connected to at least one inlet into the washing compartment in a region close to its base. The section of piping for the air duct on the outlet side can then, for example, open out into an opening in the base of the washing compartment. This enables heat losses, in particular during the desorption of the sorption agent, to be largely avoided because the air which is heated up during desorption, which emerges from the sorption container, can flow into the washing compartment largely without loss on the way, i.e. directly. The efficiency of the sorption drying device is thereby improved, in particular during desorption.

[0016] In accordance with a further expedient development, at least one blower can be provided before the drying device, looking in the direction of flow of the airflow, for the purpose of generating the airflow. This permits a particularly efficient forced draft ventilation of the sorption agent.

[0017] In accordance with a further expedient development, at least one dedicated heating element for desorption purposes can be provided between the blower and the drying device, looking in the direction of flow. This makes possible the regeneration of the sorption agent, so that it is then available again in largely regenerated form for the next dishwashing operation, for the purpose of drying the items to be washed.

[0018] It can be expedient, in particular, if the sorption container is provided as a component with at least one heating element, in particular an electrical heating element, which When looking in the direction of flow is in the sorption container before the sorption unit with the reversibly dehydratable sorption agent, for the desorption of the latter. This provides air heating, i.e. hot air can flow largely uniformly

through the sorption agent. In this way, so called "hot spots", i.e. local overheating sites in the mass of the sorption agent filler can be largely avoided.

[0019] In accordance with one expedient development, the drying device has at least one sorption unit with reversibly dehydratable drying material or drying agent, in particular a solid zeolite bed or a bed of packed zeolite. A bed of packed zeolite is formed, in particular, from loose zeolite granules, preferably in the form of little spheres. The drying material or sorption agent is preferably accommodated as a layer of broadly uniform thickness in a container or housing of the sorption unit. The container for the sorption unit is, at each of the latter's air inlet opening and/or air outlet opening, preferably bounded or covered, as appropriate, by at least one sieve. This is a practicable way to enable the compact storage of the sorption material combined with adequate permeability for air, so that the sorption agent can not only adequately absorb moisture by condensation from air flowing through it but can also by being heated up give up again or desorb stored moisture to air which is flowing through it.

[0020] Miscellaneous developments of the invention are reflected in the subclaims.

[0021] The invention and its developments are explained in more detail below by reference to a single FIGURE:

[0022] The single figure shows in schematic form a dishwasher GS with a washing compartment SB and a sorption drying system TS. This is preferably provided externally, i.e. outside the washing compartment SB of the dishwasher GS. As its main components it incorporates an air duct VK, at least one blower or fan GB together with a drying device TE. Accommodated in the washing compartment SB is/are, for example, one or more wire baskets GK for holding and washing items of crockery. The drying device TE is connected via the air duct VK to at least one outlet EL and to at least one inlet. AL in the washing compartment SB. Here, the air duct VK is arranged largely outside the washing compartment SB. In detail, the section of piping RA1 for the air duct VK on the inlet side is connected to the outlet EL from the washing compartment SB in a region of the latter close to its top cover or upper region, which lies away from the base of the washing compartment. The section of piping RA2 for the air duct VK on the outlet side leads to the inlet AL into the washing compartment SB in a region close to the latter's base. In this way, air can be fed from the interior of the washing compartment SB via the air duct VK to the drying device TE, e.g. during a drying step in a dishwashing program, and from here having been dried back to the washing compartment SB, i.e. circulate through the sorption drying system TS. The air inlet being in the upper region of the washing compartment SB largely avoids the possibility of water, from the sump (which for the sake of clarity has been omitted from the figure) in the base of the washing compartment or from its water spray system WS, getting into the air duct and into the sorption container BEH in the drying device TE, which would otherwise make the sorption agent there impermissibly damp and unusable.

[0023] The drying device TE is here, in the exemplary embodiment, advantageously accommodated in a bottom sub-module or built-under unit BG underneath the base of the washing compartment SB. It is in the form of a so-called sorption column. This incorporates, in the shared housing or container BEH at least one heating element HZ and, downstream of this in the direction of flow, one sorption unit SE which contains a reversibly dehydratable sorption agent such

as, for example, zeolite ZEO. The sorption unit contains in particular a solid bed of sorption agent, preferably a solid zeolite bed, as a molecular sieve, or a packing of loose sorption agent, preferably packed zeolite. A packing of sorption agent, in particular packed zeolite, is in particular formed by loose granules or other particles, preferably zeolite particles, preferably spherical in shaped. The drying material or sorption agent will preferably be accommodated, as a single or multiple layer with a broadly uniform layer thickness, in the container or housing BEH of the drying device TE, in the space between two sieves or perforated grids which are separated from one another in the upward direction by an empty gap to form the sorption unit SE. Here, the two sieves are arranged parallel to each other at a definable height spacing apart and with coincident projections in horizontal planes. Here, each sieve is constructed to be essentially planar or fiat. The two sieves are surrounded or enclosed right round their outer perimeters by the external cladding of the housing BEH as an outer boundary. As a result the sorption unit SE is arranged in the housing BEH in an essentially horizontal plane of lie. This means that, at its air inlet opening and/or at its air outlet opening, the sorption unit is in each case preferably bounded or covered by at least one sieve or grid, so that particles of sorption agent, in particular zeolite particles, are prevented from falling out of the container BEH of the sorption unit SE, and at the same time air can flow through the interior of the sorption agent, from the air inlet opening to the air outlet opening, broadly with little flow resistance. The sorption unit will preferably have a largely planar inflow surface on its entry side and a largely planar outflow surface on its exit side. A sorption unit of this type is a practicable way of enabling the sorption agent to be compactly stored at the same time as giving adequate ease of air transmission, so that the sorption agent can, for a sorption operation, by condensation adequately absorb moisture from air flowing through it and also, for a desorption operation to regenerate the sorption agent, by being heated up give up again or desorb stored moisture to air flowing through it.

[0024] The housing BEH of the drying device TE is shaped in a way, and is positioned underneath the base of the washing compartment GS, such that an essentially vertical airflow can pass through it. That is to say, it permits a direction of through ventilation from below to above through its integrated sorption unit SE. For the purpose of feeding in air, the downstream end section of the section of piping RA1 for the air duct VK the inlet side opens out into the housing BEH in the region of the latter's housing base or housing floor. Here, in the exemplary embodiment, the downstream end section of the section of piping RA1 on the inlet side runs essentially in a horizontal plane of lie up to the base of the housing BEH, it is also attached to the housing BEH essentially closely beneath its base. It is connected to the housing BEH close to its base, in such a way that an airflow which passes through it is turned, in this case through about 90°, from a through-flow direction LS which was originally roughly horizontal to a through-flow direction VS which runs roughly vertically through the housing BEH. Generally speaking, an airflow LS arriving in the section of piping RA1 on the inlet side is turned from its original direction of inflow, in the region close to the base of the housing BEH or in the region of the base of its chamber, into its through-flow direction VS. This means that the direction VS of through-flow through the housing BEH is, in particular, a direction of through-flow which passes through the housing essentially in a straight line from the closed base

of the housing to an outlet opening on the top cover or to an outlet gland in the top cover of the housing BEH—here in an essentially vertical direction—to which is connected the upstream end section of the section of piping RA2 of the air duct GS on the outlet side. With a direction of flow of this type, the roughly horizontally positioned layer with the sorption agent in the sorption unit SE is penetrated by or has forced through it an essentially vertical through air flow.

[0025] For the desorption of the reversibly dehydratable sorption agent, in particular zeolite ZEO, of the sorption unit SE, at least one heating element HZ is provided within the housing BEH, in a position closely before the entry area to the sorption unit SE, to provide air heating of the sorption agent SE. Here, the heating element HZ is positioned in a plane of lie before the entry area, with a definable spacing gap from the latter to avoid local overheating of the sorption agent at its entry surface, and running essentially parallel to the latter. The heating element HZ will preferably be in the form of a heating bar or a heating coil. In particular, the heating element HZ concerned extends essentially across the entire clear width of the cross-section of the entry area to the sorption unit SE containing the reversibly dehydratable dry material. This makes it possible to heat up the air flow even in the region of the lengthwise walls which extend backwards, i.e. in particular just as much at the side edges of the sorption unit SE as in the central region of the cross-sectional width of the sorption unit SE. This avoids there being local damp areas in the drying material, in particular in the region of the side walls of the sorption unit SE, during the desorption, i.e. it is possible to ensure uniform drying of the sorption agent. If the width of the sorption unit SE corresponds essentially to the internal width of the housing BEH of the drying device TE, the heating element HZ before the cross-section of the entry area to the sorption unit will preferably run across essentially the entire internal width of the housing BEE. In order to be able to heat up the cross-section of the entry area to the sorption unit SE, for the desorption of the mass of its sorption agent, as far as possible across its entire area and hence broadly homogeneously, so that local gaps in the heating of the mass of the sorption agent are largely avoided, the heating element HZ will preferably be laid in the shape of a snaking line or meander when looking into the depth of the sorption unit, in particular of the housing BEH. The meandering turns of the heating element will preferably run backwards and forwards in the depth direction across the entire internal width of the entry area to the sorption unit SE, between the two side walls of the housing BEH. In particular, the windings of the heating element HZ will then lie in roughly the same plane of lie.

[0026] For the purpose of generating a forced draft through the air duct VK, the blower GB is provided in the section of piping RA1 on the inlet side, before the sorption unit SE of the sorption container BEH when looking in the direction of flow.

[0027] As a summary view then, the air duct VK leads from a starting point in the washing compartment GS to the drying device TE and from there back again into the washing compartment SB. Arranged in the air duct VK before the drying unit TE is the blower GB, by which air is extracted from the washing compartment SB and is blown back through the drying device TE into the washing compartment. In the sorption container BEH of the drying device TE, extracted air is on the one hand dried, in that the reversibly dehydratable sorption agent which it contains takes up moisture, and on the other hand the sorption agent is at defined intervals of time

dried out again, i.e. dehydrated, with the help of at least one heating element, so that it is made ready to take up moisture again from the air.

[0028] It is advantageous if the quantity of reversibly dehydratable sorption agent, in particular zeolite ZEO, which is provided in the sorption container BEH for the purpose of absorbing quantities of moisture transported by the air exchange, is of such a weight that the quantity of moisture absorbed by the sorption agent is less than the amount of liquid applied onto the items to be washed, in particular the quantity of liquid applied in a final rinsing step, Adjusting the weight of the sorption agent in the sorption container BEH in such a way that out of the total quantity of liquid it only takes up a part, which is less than the total quantity of liquid applied to the items to be washed, enables efficient binding of the moisture in the air while using little sorption agent. This permits a compact construction of the sorption container.

[0029] At the same time, this ensures that the energy consumption for the complete regeneration of the sorption agent, by heating it up by means of a heater, can be reduced because the quantity of sorption agent which is heated up is adjusted or measured out to be just sufficient for the satisfactory drying of the items to be washed.

[0030] In particular, the quantity of the reversibly dehydratable sorption agent provided in the sorption container can expediently be of such a weight that the quantity of moisture absorbed by the reversibly dehydratable sorption agent corresponds essentially to the amount of dampness which dampens the items to be washed after the end of the final rinsing step. Here, the amount of dampness is, in particular, the amount of liquid which, after the end of a final rinsing step in which the items which have already been cleaned are sprayed with water mixed with a wetting agent, is left behind on the items to be washed, the crockery/cutlery baskets which hold the items to be washed and/or the internal walls of the washing compartment and which does not flow away to the base of the washing compartment under the influence of gravity. This adjustment of the quantity by weight of the sorption agent achieves the effect that its capacity for taking up moisture is sufficient for the sorption agent to bind or take up almost completely the amount used for wetting, by means of the air exchange.

[0031] Preferably, the quantity by weight of the sorption agent accommodated in the sorption container will be such that the quantity of moisture absorbed corresponds to between 4% and 25% in particular 5% to 15%, of the quantity of liquid sprayed onto the items to be washed.

[0032] It is advantageous if the quantity by weight of reversibly dehydratable sorption agent present in the sorption container is between 0.2 kg and 5 kg, in particular between 0.3 kg and 3 kg, preferably between 0.5 kg and 2.5 kg.

1-13. (canceled)

14. A dishwasher, comprising:

- a washing compartment for items to be washed, the washing compartment having a base;
- a drying device to dry items that have been washed, the drying device having a sorption container to hold a reversibly dehydrated sorption agent;
- an air-transmitting air duct between the drying device and the washing compartment to generate an air exchange between the washing compartment and the sorption container; and

a bottom sub-module underneath the base of the washing compartment, the bottom sub-module accommodating the sorption container.

15. The dishwasher of claim 14, wherein the dishwasher is a domestic dishwasher and wherein the reversibly dehydrated sorption agent is zeolite.

16. The dishwasher of claim 14, wherein a quantity of the reversibly dehydratable sorption agent is provided in the sorption container in order to absorb a moisture quantity transported by the air exchange, the quantity of the reversibly dehydratable sorption agent having a weight such that the moisture quantity absorbed by the reversibly dehydratable sorption agent is less than a liquid quantity applied to the items to be washed.

17. The dishwasher of claim 16, wherein the liquid quantity is applied in a final rinsing step.

18. The dishwasher of claim 14, wherein a quantity of the reversibly dehydratable sorption agent provided in the sorption container has a weight such that a moisture quantity absorbed by the reversibly dehydratable sorption agent corresponds essentially to an amount of dampness that dampens the items to be washed after the end of a final rinsing step.

19. The dishwasher of claim 16, wherein the moisture quantity absorbed is between 4% and 25% of the liquid quantity applied to the items to be washed.

20. The dishwasher of claim 19, wherein the moisture quantity absorbed is between 5% to 15% of the liquid quantity applied to the items to be washed.

21. The dishwasher of claim 16, wherein a quantity by weight of the reversibly dehydratable sorption agent present in the sorption container is between 0.2 kg and 5 kg.

22. The dishwasher of claim 21, wherein the quantity by weight of the reversibly dehydratable sorption agent present in the sorption container is between 0.3 kg and 3 kg.

23. The dishwasher of claim 22, wherein the quantity by weight of the reversibly dehydratable sorption agent present in the sorption container is between 0.5 kg and 2.5 kg.

24. The dishwasher of claim 14, wherein the drying device is connected by the air-transmitting air duct to an outlet and an inlet on the washing compartment.

25. The dishwasher of claim 24, wherein the air-transmitting air duct is arranged, to a predetermined extent, outside the washing compartment.

26. The dishwasher of claim 14, further comprising a piping section for the air-transmitting air duct on an outlet side that is connected to an inlet of the washing compartment in a region close to the floor of the washing compartment.

27. The dishwasher of claim 14, further comprising a piping section for the air-transmitting air duct on an inlet side that is connected to an outlet of the washing compartment above the base of the washing compartment.

28. The dishwasher of claim 27, wherein the piping section for the air-transmitting air duct on the inlet side is connected to the outlet of the washing compartment in a region close to a ceiling of the washing compartment.

29. The dishwasher of claim 27, wherein the piping section for the air-transmitting air duct on the inlet side opens out into the sorption container of the drying device in a region close to the base such that an inflow direction of the air-transmitting air duct is diverted into a flow-through direction of the sorption container.

30. The dishwasher of claim 29, wherein the inflow direction is diverted by about 90°.

31. The dishwasher of claim **14**, further comprising a blower to generate an airflow that is, when viewed in a flow direction of the airflow, provided before the drying device.

32. The dishwasher of claim **31**, further comprising a dedicated heating element for desorption purposes that is, when viewed in the flow direction, arranged between the blower and the drying device.

33. The dishwasher of claim **14**, wherein the sorption container has a heating element that is, when viewed in flow direction, arranged before a sorption unit the reversibly dehydratable sorption agent for desorption of the reversibly dehydratable sorption agent.

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