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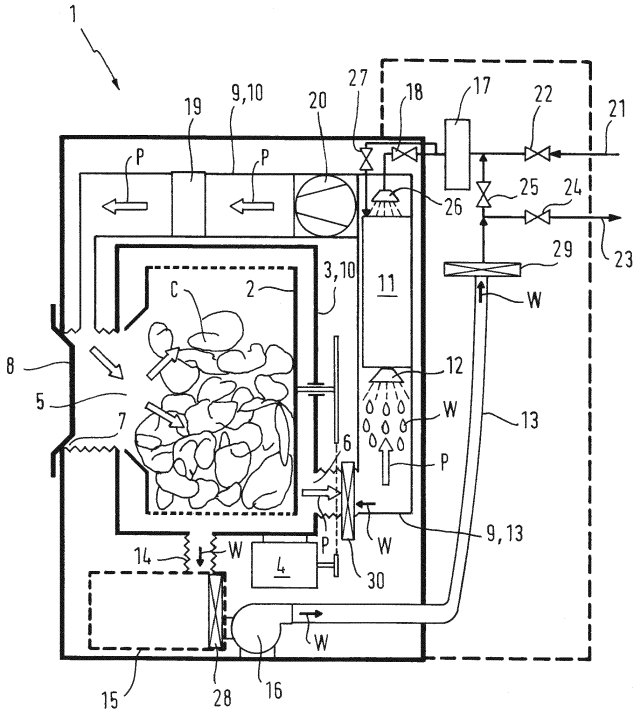
(54) HOUSEHOLD APPLIANCE HAVING A PROCESS AIR CIRCUIT

(57) A household appliance 1, 31, in particular washer-dryer, comprises a process air circuit 10 comprising a treatment chamber 2, 3 having an air inlet opening 5 and an air outlet opening 6 and a process air channel 9 connecting the openings 5, 6, a water/process air heat exchanger 11 adapted to cool process air P flowing within the process air channel 9, and a water spray device 12 adapted to spray water W into the process air channel 9. The invention is particularly useful for a laundry care apparatus, in particular for a clothes washer/dryer combination or washing machine with drying function ("washer-dryer"), in particular having a heat pump.

Fig. 1



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Description

[0001] The invention relates to a household appliance, comprising a process air circuit comprising a treatment chamber having an air inlet opening and an air outlet opening and a process air channel connecting the openings, and the household appliance comprising a water/process air heat exchanger adapted to cool the process air flowing within the process air channel and a water spray device adapted to spray water into the process air channel. The invention is particularly useful for a laundry care apparatus, in particular for a clothes washer/dryer combination or washing machine with drying function ("washer-dryer"), in particular having a heat pump.

[0002] One kind of known washer-dryers uses vented drying, i.e. drying by evacuating warm humid process air out of the washer-dryer. In this case, drying of the wet laundry or clothes takes place by applying a flow of dry and warm process air to the laundry which extracts water contained in the laundry. The process air to be applied to the laundry can be heated, for example, by means of an electrical heater (e.g. having one or more resistance heating elements) or by a heating light device directed into the drum. The heating light device may e.g. comprise at least one infrared heating lamp. The subsequently humid process air is then discharged to the outside.

[0003] Another kind of known washer-dryers uses a closed-loop process air circuit to apply a flow of dry and warm process air to the laundry generating humid process air, then to condensate the humid process air resulting in a dryer and cooler process air, then to re-heat the cooler process air, and then to re-apply the re-heated and dry process air to the laundry. Such a drying process is also called "air condensation drying" or "air circulation drying". Concerning the air condensation drying, at least the following three different methods can be differentiated:

a) Condensation Using Ambient Air

[0004] In this case, condensation of the humid air is carried out by means of an air/air heat exchanger. In the air/air heat exchanger, heat is transferred from the humid air to cool ambient air (which are flowing in separate but thermally connected channels), thus cooling down the humid process air and lowering its humidity. The ambient air is then expelled back into the ambient. Such washer-dryers have the disadvantage that the surrounding room may be heated as well. Additionally, condensation using ambient air has low energy efficiency.

b) Condensation Using Fresh Water

[0005] In this case, condensation of the humid air is carried out by cooling it with fresh, cool water taken from a water supply (e.g. tap water). This can be achieved in two ways, namely by 'indirect' water condensation or by 'direct' water condensation. The indirect water condensation refers to a method in which the humid process air coming from the laundry is cooled down and dried by passing through a water/process air heat exchanger with the cool water being one fluid and the humid air being the other fluid. The direct water condensation refers to a method in which the humid process air coming from the laundry is being cooled down and thus dried by crossing a cold water stream, typically in the form of a spray. In both cases, the water is subsequently removed from the washer-dryer and thus does not flow in a water circuit. These washer-dryers have the disadvantage of high water and energy consumption.

c) Condensation Using a Heat Pump

[0006] Also, washer-dryers using a heat pump are known. The heat pump typically comprises a compressor, a condenser, an expansion valve and an evaporator forming a circuit in which refrigerant flows. In these washer-dryers, the process air to be applied to the laundry is heated by means of the hot condenser. The condenser acts as a refrigerant/process air heat exchanger in which the process air flows along heat transfer surfaces of the condenser.

[0007] The cooling and resultant condensation of the humid process air coming from the laundry is effected by passing it through heat transfer surfaces of the evaporator. The evaporator thus acts as another refrigerant/process air heat exchanger. These washer-dryers have the drawback that the heat pumps take up a significant volume of space, which in turn may lead to an undesirably voluminous device or to a reduction in load capacity of the washer-dryer to fit the heat pump into its housing or body.

[0008] It is the object of the present invention to at least partially overcome the problems associated with the prior art. It is a particular object of the present invention to provide a washer-dryer with an improved thermodynamic efficiency for the drying phase while enabling lowered water consumption and/or a compact design. It is another object to provide a related household appliance that is particularly easy to assemble and/or easy to integrate in existing water condensation washer-dryers. It is yet another object to provide a related household appliance that provides particularly flexible drying modes.

[0009] The object is achieved according to the features of the independent claims. Advantageous facultative embodiments are defined in the dependent claims, the subsequent description and the attached drawing.

[0010] The object is achieved by a household appliance, comprising a process air circuit, the process air circuit comprising a treatment chamber having an air inlet opening and an air outlet opening as well as a process air channel connecting the openings. The household appliance further comprises a water/process air heat exchanger adapted to cool the process air flowing within the process air channel and a water spray device adapted to spray water into the process air channel.

[0011] In this household appliance, the humid process air flowing out of the treatment chamber can thus pass through the water/process air heat exchanger and the water spray device to be cooled down and thus to be dehumidified. This gives the advantage that the process air can be cooled by both kinds of water cooling methods, i.e. the direct water cooling method and the indirect water cooling method. It can therefore combine the advantages of both methods. For example, the process air can be cooled with a higher effectiveness compared to only one of these methods. Also, the humid process air can be freed from lint by the direct water cooling method. Additionally, such a household appliance is easy to assemble. Furthermore, by setting the relative condensation strength of the water/process air heat exchanger and the water spray device (e.g. by setting their relative water flow volume), the drying process or drying modes can be adapted in a flexible way.

[0012] It is an embodiment that the household appliance is a laundry care appliance, in particular a clothes drying appliance, in particular a washer-dryer or a clothes dryer. Thus, the goods to be dried may include clothes or laundry. The corresponding treatment chamber may be a drum, in particular a rotatable drum, in particular a horizontally rotatable drum. The drum may be positioned in a respective housing ("drum housing"). Alternatively, the household appliance may e.g. be a dishwasher. In this case, the goods to be dried may include dishes, cutlery etc.

[0013] The air inlet opening and/or the air outlet opening of the housing of the drum may have one or more sections or air holes.

[0014] The treatment chamber can be loaded with to be dried goods by a user, e.g. through a loading port that can be closed by a door.

[0015] The water/process air heat exchanger may comprise at least one channel that channels water. The tubes may be made of metal (e.g. copper and/or aluminium) or of plastic. Cool water can flow through the at least one channel and causes the warmer process air flowing through the water/process air heat exchanger (e.g. along heat transfer surfaces) to cool down. The water may be regarded as the primary fluid while the process air may be regarded as the secondary fluid.

[0016] It is an embodiment that the water/process air heat exchanger is made of at least one capillary tube mat. Up to now, capillary tube mats are known to be used for radiant cooling of buildings and for thermal building component activation. A capillary tube mat may be a composite structure of thin tubes (capillaries) with a distributor tube and a collector tube. Capillary tube mats are typically made of plastic and have the advantage that they are inexpensive, light, and easy to assemble. Since the capillary tubes are very thin-walled, a lower heat conductivity of plastic compared to metals has no adverse effect on the heat transmission. The plastic may e.g. be made of polypropylene which is highly resistant to many chemicals and therefore very durable. Polypropylene is also very easy to recycle. Additionally, the capillary tube mat may be mechanically flexible and may thus be easily shaped into a desired form and/or density of its capillaries by bending etc.

[0017] The capillary tube mat may have capillary tubes with an external diameter of less than 5 mm. This makes the mat very flexible. In particular, the individual capillary tubes of a yet unbent mat may be arranged in a grid with a spacing of 10 to 50 mm from each other.

[0018] The at least one capillary tube mat may be produced by means of standard plastic-processing techniques such as extrusion, thermal plastic welding and injection molding.

[0019] The water/process air heat exchanger may be placed or positioned within the process air channel and/or may be integrated into at least one wall section of the process air channel.

[0020] The water spray device may comprise at least one spray head (e.g. at least one spray nozzle) to spray water into the process air channel. At least one spray head may be placed or positioned within the process air channel and/or may be integrated into at least one wall section of the process air channel.

[0021] The process air circuit may comprise at least one heater (e.g. an electrical heater) to heat the process air before it enters the treatment chamber. The process air circuit may comprise at least one fan to generate a flow or movement of the process air. In particular, within the process air channel, the process air may flow through the treatment chamber, then to the water/process air heat exchanger and the water spray device, then to the heater and then back into the treatment chamber.

[0022] It is an embodiment that the water/process air heat exchanger and the water spray device are components of a common water circuit. This advantageously enables a design that is particularly simple to implement. The water circuit advantageously enables - by its design as a closed loop - a particularly low water consumption. To keep the temperature of the water circulating in the water circuit low, the water circuit may comprise a water cooling device, in particular positioned before the water/process air heat exchanger and the water spray device. Such a water cooling device may e.g. be an electric cooling device or an water/process air heat exchanger that uses flowing ambient air as one of its fluids.

[0023] It is an embodiment that the household appliance further comprises a heat pump having a condenser for heating the process air and an evaporator for cooling the water of the water circuit, in particular the water flowing to the water/process air heat exchanger and/or to the water spray device. The heat pump enables a particularly high degree of energy efficiency. For example, the condenser may be used alternatively or additionally to an electric heater and/or a heating light device. The evaporator may be used alternatively or additionally to an electric cooler or to a water/air heat exchanging cooling device.

[0024] The household appliance according to this em-

bodiment thus uses three thermally intersecting closed-loop circuits to achieve its objects, namely one process air circuit, one water circuit, and one refrigerant circuit (i.e., the heat pump). The process air circuit and the water circuit thermally intersect at the water/process air heat exchanger and in the section of the process air circuit in which also the water spray is present. The process air circuit thermally intersects with the refrigerant circuit at the condenser, and the refrigerant circuit thermally intersects with the water circuit at the evaporator.

[0025] The condenser may be a conventional finned tube exchanger or a fin-and-tube exchanger with pipes and/or made of copper and/or aluminium. Also, a so-called micro-channel heat exchanger can be used, e.g. using compact tubes and/or capillary tube mats. In all cases, the refrigerant may be regarded as the primary fluid while the process air may be regarded as the secondary fluid. The heat exchanger can be fit in the air channel simply by mechanical pressure (e.g. clamping or clipping), by being screwed in, riveted, snap-fitted, or glued etc.

[0026] It is an embodiment that the evaporator is positioned outside of the process air circuit. Thus, the evaporator is not heated by the process air. It follows that the evaporator can cool down the water circulating in the water circuit in a particularly efficient manner.

[0027] It is an embodiment that the evaporator is a heat exchanger comprising a channel for channeling refrigerant of the heat pump wherein the channel is immersed in the water of the water circuit. For example, the refrigerant channel is immersed in a water tank, the water tank in particular being part of the water circuit. In this case, a conventional finned tube exchanger or fin-and-tube exchanger as described for the refrigerant/process air heat exchanger can be used, wherein water may be regarded as the secondary fluid. Aluminum or steel are preferred materials for the tubes or pipes to avoid forming of copper oxides. Additionally, at least one channel for the refrigerant similar to a channel of a heat exchanger as used for the condenser and/or the water/process air heat exchanger can be used (e.g. without fins which amounts to using just a pipe coil). Also, to form a channel for the refrigerant, metal tubes may directly be joined (e.g. welded or glued) to a supporting metal plate (e.g. made from copper, aluminium or stainless steel) or a stamped metal plate heat exchanger may be used.

[0028] It is an additional or alternative embodiment that the evaporator is a cross-flow heat exchanger comprising a channel for channeling the refrigerant of the heat pump and another channel for channeling the water. These two channels are connected in a heat-exchanging manner. Here, refrigerant and water are exchanging heat through a conductive surface while having a relative counterflow or crossflow movement between the refrigerant and the water. Plate heat exchangers or tube-in-tube heat exchangers are only two examples of this kind.

[0029] A piping system that connects heat pump components (evaporator, condenser, compressor, expansion valve ...) may e.g. be made of bended copper pipes, be made of flexible hoses made of stainless steel, and/or be made of thermo-stable polymers.

[0030] A fluidically hermetical connection between the heat pump components may e.g. be achieved by brazing, soldering or eutectic processes. Also, a connection can be achieved by using a mechanical non-reversible hermetical pressure mechanism such as Vulkan Lokring. In another variant, a hermetical and non-reversible mechanical connection may be achieved using thermal shock. In another variant, a connection can be achieved by screwing parts together.

[0031] It is an embodiment that the water/process air heat exchanger and the water spray device can be activated individually. This gives the advantage that the condensation of the process air can be adapted with a particularly large degree of flexibility. In one possible mode of operation, only the water/process air heat exchanger is activated. In another possible mode of operation, only the water spray device is activated.

[0032] It is an embodiment that the water circuit comprises or is connected to a switchable (e.g. by a valve) water inlet for connection to a water supply (e.g. providing tap water) and a switchable water outlet. This advantageously enables a precise exchange of tap water and water circulating in the water circuit. This can be used e.g. to set and/or control the temperature of the water flowing in the water circuit.

[0033] It is an embodiment that the water circuit and the process air circuit partly coincide. This gives the advantage of a particularly compact design. For example, the water may partly flow through the process air circuit before it is collected to be re-introduced into another part of the water circuit.

[0034] It is an embodiment that a water outlet opening of the water/process air heat exchanger opens into the process air circuit. As a result, the water circuit and the process air circuit partly coincide. This gives the advantage of a particularly compact design and also enables a particular simple and low-cost design of the water circuit. For example, the water may partly flow through the process air circuit before it is collected to be re-introduced into another part of the water circuit.

[0035] It is an embodiment that the household appliance further comprises a sump for collecting "free" water arising in the process air circuit, and a water pump for pumping the water from the sump to the water/process air heat exchanger and the water spray device. This embodiment gives the advantage of having a particularly compact and robust design. The "free" water can be understood water to be basically free to move and is thus not bound, e.g. in wet clothes. The free water may e.g. comprise condensed water and water sprayed from the water spray device. The sump may be a water collection device (e.g., a water tank or water reservoir). The water collection device may be connected to a floor of the treatment chamber, e.g. to a floor of a housing of a drum of a washer-dryer. In particular, the water collection device

may be connected to a suction side of the pump while the water/process air heat exchanger and the water spray device are directly or indirectly (i.e., via at least one another functional element, e.g. via at least one valve and/or a heat exchanger) connected to a pressure side of the pump.

[0036] The water stored in the water collection device may be able to draw thermal energy from its surrounding or ambient thus allowing a following washing and drying cycle to start at a higher water temperature than that of tap water. This advantageously achieves further water savings and improves energy efficiency. The water collection device may be placed inside the appliance or may be integrated in a bottom part of the process air circuit.

[0037] It is an embodiment that the water spray device is positioned below the water/process air heat exchanger.

[0038] It is an embodiment that the household appliance comprises an additional water spray device being positioned above the water/process air heat exchanger. This gives the advantage that the spray water not only cools down the process air and removes lint, fluff, hairs etc. from the process air but also acts as a cleaning liquid for the water/process air heat exchanger. For example, lint etc. adhering to the water/process air heat exchanger can be removed by the spray water.

[0039] It is an embodiment that the water spray device is positioned above the water/process air heat exchanger. This also gives the advantage that the spray water not only cools down the process air and removes lint etc. from the process air but also acts as a cleaning liquid for the water/process air heat exchanger. This embodiment can be implemented using only one water spray device.

[0040] Generally, there can be as many water/process air heat exchangers or water/process air heat exchanger sections and water spray devices as desired, in particular positioned in series, in particular along a vertical direction.

[0041] It is an embodiment that the water circuit comprises at least one filter. This allows holding back lint, fluffs, hairs, dirt etc. (the filter may thus also be called a lint filter). This in turn protects components of the process air circuit and/or of the water circuit that may be sensitive to clogs produced by lint etc. Additionally, the lint could accumulate on the secondary surface (fins) of the water/process air heat exchanger. Furthermore, the lint could be caught by the sprayed water and then introduced into the water/refrigerant heat exchanger's secondary surface.

[0042] The at least one filter can be positioned, e.g., after the sump, before a valve, before the evaporator and/or after the water/process air heat exchanger. In particular, if the filter is positioned in the process air circuit, it is an embodiment that the filter is highly permeable for the process air in order to reduce resistance to the flow of the process air.

[0043] In particular, a filter may be present in a discharge pipe or at an entrance of the discharge pipe of the water collection device in order to avoid that lint etc. reaches the water circulation pump and/or the water/refrigerant heat exchanger. Advantageously, this filter is accessible for a customer. For example, this filter can be placed inside the water collection device.

[0044] Additionally or alternatively, a filter may be present between the water circulation pump and the refrigerant/water heat exchanger (evaporator). Advantageously, this filter is accessible for a customer.

[0045] Also, a filter may be present in the process air channel between the water-air heat exchanger and the water spray device on the one hand and the treatment chamber on the other hand.

[0046] To remove lint from at least one filter, the water circulation pump may be reversed to create a water flow in an opposite direction shortly before water is to be drained from the appliance through a drain or water exhaust of the appliance, e.g. by means of a drain pump.

[0047] The refrigerant/air heat exchanger acting as the condenser may also be sensitive to secondary surface (fins) clogging due to lint in the process air. A filtering or cleaning solution (for example, by providing an additional spraying system) in addition to the water-air heat exchanger may be used to ensure proper performance during lifetime.

[0048] Generally, heat insulation may be present to decrease heat losses, e.g. from the process air circuit and/or the appliance. To this effect, heat insulation elements can be either glued, riveted, screwed or snap fitted etc. to the desired surface. For example, the evaporator (water/refrigerant heat exchanger) may be insulated to avoid thermal losses and/or condensation inside the washer-dryer cabinet.

[0049] By the above described household appliance, inter alia, one or more of the following advantages can be achieved: An improved thermodynamic efficiency for the drying phase is achieved compared to conventional washer-dryers and therefore gaining an appliance energy efficiency improvement. The recirculation of waste water leads to lower water consumption during the drying cycles. A better conjoint performance of the drying modes in the same appliance is achieved. Integrating the described condensation system into existing condensation concepts using a heat pump is simple. The heat pump can be integrated as part of an existing water condensation washer-dryer platform with reduced complexity and low effort for the heat pump integration. Flexibility and adaptability of the design: Different drying speeds and efficiencies can be devised, utilizing different refrigerants, regulating the temperature of the water by providing different mixing rates (between waste water and mains water), cooling circuit components settings and/or complementary heating devices. The evaporator is not necessarily integrated inside the appliance.

[0050] The above described features and advantages of the invention as well as their kind of implementation will now be schematically described in more detail by at least one embodiment in the context of one or more fig-

ures of the attached drawing.

Fig.1 shows a cross-sectional side view of a household appliance according to a first embodiment;
Fig.2 shows a cross-sectional side view of a household appliance according to a second embodiment;
Fig.3 shows a side view of a water/process air heat exchanger according to a third embodiment; and
Fig. 4 shows a cross-sectional view of a household appliance according to a fourth embodiment.

[0051] **Fig.1** shows a cross-sectional side view of a household appliance in form of a washer-dryer 1 according to a first embodiment. The washer-dryer 1 comprises a treatment chamber 2, 3 which, in turn, comprises a frontally open drum 2 and a drum housing 3. The drum 2 is horizontally rotatable, e.g. by a motor 4.

[0052] The drum housing 3 comprises a frontal air inlet opening 5 and an air outlet opening 6 on the back. The drum 2 can be loaded with laundry or clothes C through the air inlet opening 5 via a loading port 7. The loading port 7 can be closed by a front door 8. The air inlet opening 5 and the air outlet opening 6 are connected by a process air channel 9. The treatment chamber 2, 3 (or at least its housing 3) and the process air channel 9 form a process air circuit 10.

[0053] The washer-dryer 1 further comprises a water/process air heat exchanger 11 adapted to cool down process air P (as indicated by the large arrows) flowing within the process air circuit 10 and a water spray device 12 adapted to spray water W into the process air channel 9. Concerning the flow of the water W, the water/process air heat exchanger 11 and the water spray device 12 are fluidically arranged in series in this order such that the water W first flows through the water/process air heat exchanger 11 and then through the water spray device 12. The water W leaves the water spray device 12 by being sprayed into the process air channel 9, here: into a vertical section of the process air channel 9. To this effect, the water spray device 12 is positioned below the water/process air heat exchanger 11.

[0054] The water/process air heat exchanger 11 and the water spray device 12 are positioned within the process air channel 9 downstream the air outlet opening 6 such that warm, humid process air P coming from the drum 2 can be cooled down by these condensation components 11, 12. The water/process air heat exchanger 11 and the water spray device 12 may be regarded as components of the process air circuit 10.

[0055] The water/process air heat exchanger 11 and the water spray device 12 are also components of a common closed-loop water circuit 13. The water circuit 13 further comprises a section of the process air circuit 10, i.e. a section of the process air channel 9 and the housing 3 in which the water W coming out of the water spray device 12 is flowing. In the shown embodiment, this is a section that leads from the water spray device 12 to a water outlet 14 at the bottom of the housing 3. Therefore, in this section, the water circuit 13 and the process air circuit 10 coincide.

[0056] The water W flowing into the water outlet 14 is collected in a water collection device in form of a water reservoir 15. The water reservoir 15 is placed below the housing 3 and is connected to a suction side of a water circulation pump 16. The water circulation pump 16 pumps the water W to a water cooling device in form of an evaporator 17 of a heat pump. From the evaporator 17 the water W can flow to the water/process air heat exchanger 11 depending on a valve position (open/close/intermediate position) of a valve 18 that is placed in the water circuit 13 between the evaporator 17 and the water/process air heat exchanger 11.

[0057] Of the heat pump, only its condenser 19 is also shown. The condenser 19 is placed in the process air channel 9 between the air cooling components 10, 11 and the housing 3 (and thus also the drum 2). Not shown are e.g. a compressor and an expansion valve of the heat pump. The working fluid of the heat pump is a refrigerant (not shown).

[0058] Thus, there are three closed-loop fluid circuits, namely the process air circuit 10, the water circuit 13, and refrigerant circuit (i.e., the heat pump 17, 19).

[0059] Regarding the process air circuit 10, a flow of the process air P can be created by a blower or fan 20. Thus, warm and relatively dry process air P can pick up water W from the wet clothes C and thereby increases its humidity. The now warm and humid process air P flows through the air outlet opening 6 into the process air channel 9. This process air P first passes through the water spray created by the water spray device 12. The water spray causes the process air P to cool down and to loose lint. After having passed through the water spray, the already cooled down process air P flows through the water/process air heat exchanger 11, cooling down further. By cooling down, the process air P condenses or rains out, thus producing condensate that contributes to the volume of water W. The now dehumidified und thus cooler and dryer process air P flows to the condenser 19 which heats up the process air P. The now warm and dry process air P is re-introduced into the housing 3 and drum 2, respectively, thus starting this cycle anew.

[0060] Regarding the water circuit 13, the water W running down the process air channel 9 may comprise tap water, condensate and/or spray water which is collected in the water reservoir 15. This water W may be warmer than fresh tap water and may be further warmed up by its ambient. The water W is then pumped to the evaporator 17 where it is cooled down. Coming from the evaporator 17, the water W then flows through the water/process air heat exchanger 11 and the water spray device 12 and then back into the process air channel 9.

[0061] Regarding the refrigerant circuit, the heat pump 17,19 acts so that the refrigerant entering the evaporator 17 remains on a relatively low temperature while the refrigerant entering the condenser 19 remains on a relatively high temperature. In particular, to enable the low

temperatures of the evaporator 17, it is advantageous that the evaporator 17 is positioned outside the process air circuit 10 and may even be positioned outside of an outer housing of the washer-dryer 1.

[0062] Thus, the process air circuit 10 and the water circuit 13 thermally intersect at the water/process air heat exchanger 11 and in the section of the process air circuit 10 in which also the water spray is present. The process air circuit 10 thermally intersects with the refrigerant circuit at the condenser 19, and the refrigerant circuit thermally intersects with the water circuit 13 at the evaporator 17.

[0063] In particular, the evaporator 17 may be a heat exchanger comprising a channel for channeling the refrigerant which channel is at least partially immersed in the water W of the water circuit 13 in a respective water tank (not shown). Alternatively, the evaporator 17 is a cross-flow heat exchanger comprising a channel for channeling the refrigerant and another channel for channeling the water W, wherein both channels are in thermal or heat exchanging communication.

[0064] Optionally, the temperature of the water W can also be adjusted by the water circuit 13 comprising or being connected to a tap water inlet 21 (switchable via a valve 22) and to a water outlet 23 (switchable via a valve 24). Within the water circuit 13 and positioned between the branches to the tap water inlet 21 (also called 'net') and to the water outlet 23 (also called 'drain') is positioned another valve 25. Thus, cool tap water can be introduced into the water circuit 13 through the water inlet 21 and used water W can be discharged from the water circuit 13 through the water outlet 23. This exchange of water can e.g. be initiated if the temperature of the water W in the water circuit 13 exceeds a certain threshold value (to be measured e.g. by a respective temperature sensor, not shown). Another advantage of a water exchange can be a discharge of lint containing used water W.

[0065] In order to achieve an even stronger cooling of the process air P and/or to additionally clean the water/process air heat exchanger 11 by the water spray, the washer-dryer 1 may comprise an additional water spray device 26 which, in the shown embodiment, is positioned above the water/process air heat exchanger 11. A water inlet of the additional water spray device 26 is connected to the evaporator 17 via a valve 27. Thus, the additional water spray device 26 is fluidically connected in parallel to the water/process air heat exchanger 11. Therefore, the additional water spray device 26 on the one hand and the water/process air heat exchanger 11 and the water spray device 12 on the other hand can be activated individually by individually setting the valves 27 and 18, respectively.

[0066] In order to reduce the amount of lint of the water W circulating in the water circuit 13, the water circuit 13 may comprise several lint filters 28 to 30. For example, a lint filter 28 is placed within the water reservoir 15 at the entrance to the water circulation pump 16. Additionally or alternatively, a lint filter 29 may be placed between the water circulation pump 16 and the evaporator 17, more specifically between the water circulation pump 16 and the valve 25. Additionally or alternatively, a lint filter 30 may be placed within the process air channel 9 between the housing 3 on the one hand and the water/process air heat exchanger 11 and the water spray device 12 on the other hand. The lint filter 30 may also be used to remove lint from the process air P.

[0067] **Fig.2** shows a cross-sectional side view of a household appliance in form of a washer-dryer 31 according to a second embodiment. The washer-dryer 31 distinguishes itself from the washer-dryer 1 by a different arrangement of the water/process air heat exchanger 11 and the water spray device 12. In the washer-dryer 31, the water spray device 12 is positioned such that its water spray reaches the water/process air heat exchanger 11. This gives the advantage that the water/process air heat exchanger 11 can be cleaned from lint etc. without need for the additional water spray device 26. Also, the water/process air heat exchanger 11 and the water spray device 12 can now be activated individually. A water outlet opening 11c (see fig.3) of the water/process air heat exchanger 11 now directly opens into the process air channel 9 and thus into the process air circuit 10.

[0068] **Fig.3** shows a side view of one possible variant of the water/process air heat exchanger 11. The water/process air heat exchanger 11 is a capillary tube mat made of plastic and comprises a long, e.g. curved, section ("tube section") 11a comprising a multitude of capillaries 32, a distributor tube 33 comprising a water inlet opening 11 b (e.g. connected to the valve 18), and a collector tube 34 comprising a water outlet opening 11c (e.g. connected to the evaporator 17 of fig.2 or left open according to fig.1). The flexible capillaries 32 may be arranged in a fluidically parallel arrangement.

[0069] **Fig. 4** shows a fourth embodiment which closely resembles the first embodiment of Fig. 1 and wherein the heat pump 17, 19 has been replaced by a single electric heater 19'. In all other respects the elements of the fourth embodiment are similar to the elements of the first embodiment. Accordingly the detailed explanation of the first embodiment as above applies, relieving of any need for repeating in the context of Fig. 4 insofar.

[0070] In the embodiment of Fig. 4 most features of heat exchange between water and process air are retained within a simplified and cheap embodiment that includes no heat pump but relies on an electric heater 19' as a simple and cheap means for heating the process air after having extracted the humidity. The cooling effect applied relies on the temperature difference between the process air and the tap water entered into the process via inlet 21.

[0071] Of course, the invention is not restricted to the described embodiments described.

[0072] For example, the washer-dryers 1 or 31 may be arranged without the filters 28 to 30. Also, as another example, the valve 25 may not be present. Furthermore, the washer-dryers 1 or 31 may be arranged without the

water reservoir 15. Also, the fan 20 may be placed at another location within the process air channel 9. Moreover, only one valve may be used instead of the two valves 18 and 27 such that costs and complexity can be reduced. Generally, a clothes dryer instead of a washer-dryer may be adapted to use the described invention.

[0073] Generally, the washer-dryers 1 or 31 may be arranged without a heat pump and may comprise a heating device and a cooling device instead of the condenser 19 and the evaporator 17. Such heating device may be e.g. be an electrical heater etc. The cooling device may e.g. be a water/ambient air heat exchanger.

LIST OF REFERENCE NUMERALS

[0074]

1	washer-dryer
2	drum
3	housing
4	motor
5	air inlet opening
6	air outlet opening
7	loading port
8	door
9	process air channel
10	process air circuit
11	water/process air heat exchanger
11a	tube section
11b	water inlet opening
11c	water outlet opening
12	water spray device
13	water circuit
14	water outlet
15	water reservoir
16	water circulation pump
17	evaporator
18	valve
19	heating device, condenser
19'	heating device, electric heater
20	fan
21	tap water inlet
22	valve
23	water outlet
24	valve
25	valve
26	additional water spray device
27	valve
28	lint filter
29	lint filter
30	lint filter
31	washer-dryer
32	capillary
33	distributor tube
34	collector tube
C	clothes
P	process air
W	water

Claims

1. A household appliance (1; 31), in particular washer-dryer, comprising

   - a process air circuit (10) comprising a treatment chamber (2, 3) having an air inlet opening (5) and an air outlet opening (6) and a process air channel (9) connecting the openings (5, 6),
   - a water/process air heat exchanger (11) adapted to cool process air (P) flowing within the process air channel (9), and
   - a water spray device (12) adapted to spray water (W) into the process air channel (9).

2. The household appliance (1; 31) according to claim 1, wherein the water/process air heat exchanger (11) and the water spray device (12) are components of a common water circuit (13).

3. The household appliance (1; 31) according to claim 2, further comprising a heat pump (17, 19) having a condenser (19) for heating the process air (P) and an evaporator (17) for cooling the water (W) of the water circuit (13).

4. The household appliance (1; 31) according to claim 3, wherein the evaporator (17) is positioned outside the process air circuit (10).

5. The household appliance (1; 31) according to any of the claims 3 to 4, wherein the evaporator (17) is a heat exchanger comprising a channel for channeling refrigerant of the heat pump (17, 19) that is immersed in water (W) of the water circuit (13).

6. The household appliance (1; 31) according to any of the claims 3 to 4, wherein the evaporator (17) is a cross-flow heat exchanger comprising a channel for channeling refrigerant of the heat pump (17, 19) and another channel for channeling the water (W).

7. The household appliance (31) according to any of the preceding claims, wherein the water/process air heat exchanger (11) and the water spray device (12) can be activated individually.

8. The household appliance (1; 31) according to any of the claims 2 to 7, wherein the water circuit (13) is connected to a switchable water inlet (21) for tap water and a switchable water outlet (23).

9. The household appliance (1; 31) according to any of the claims 2 to 8, wherein the water circuit (13) and the process air circuit (10) partly coincide.

10. The household appliance (1; 31) according to claim 9, wherein the water/process air heat exchanger (11)

comprises a water outlet opening (11 c) that opens into the process air circuit (10).

11. The household (1; 31) appliance according to any of the claims 2 to 10, further comprising

- a sump (15) for collecting water (W) arising in the process air circuit (10), and
- a pump (16) for pumping the water (W) from the sump (15) to the water/process air heat exchanger (11) and the water spray device (12).

12. The household appliance (1) according to any of the preceding claims, wherein the water spray device (12) is positioned below the water/process air heat exchanger (11).

13. The household appliance (1) according to claim 11, further comprising an additional water spray device (26) being positioned above the water/process air heat exchanger (11).

14. The household (1; 31) appliance according to any the claims 2 to 11, wherein the water spray device (26; 12) is positioned above the water/process air heat exchanger (11).

15. The household appliance (1; 31) according to any of the claims 2 to 14, wherein the water circuit (13) comprises at least one filter (28-30).

Fig. 1

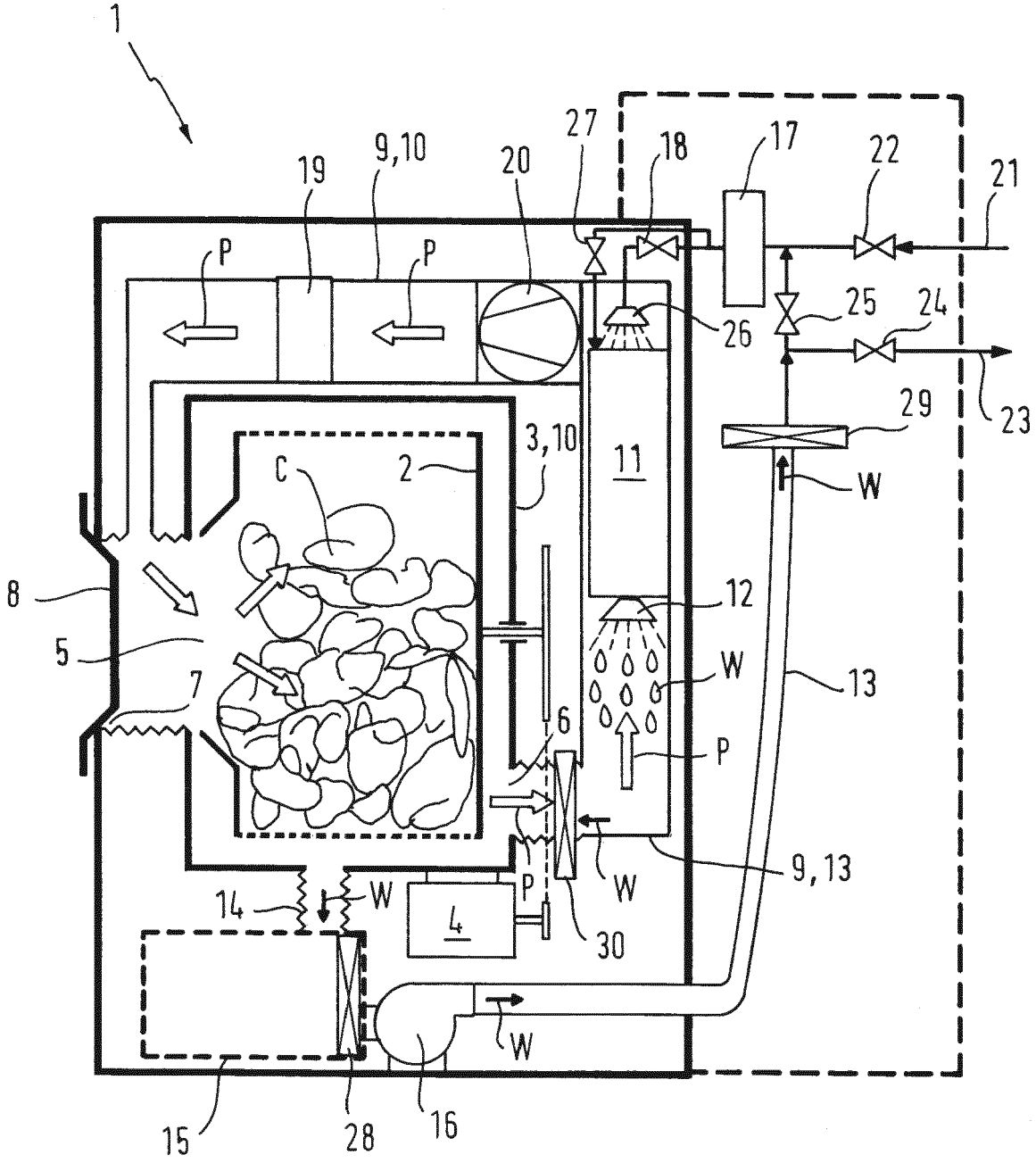
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Fig. 2

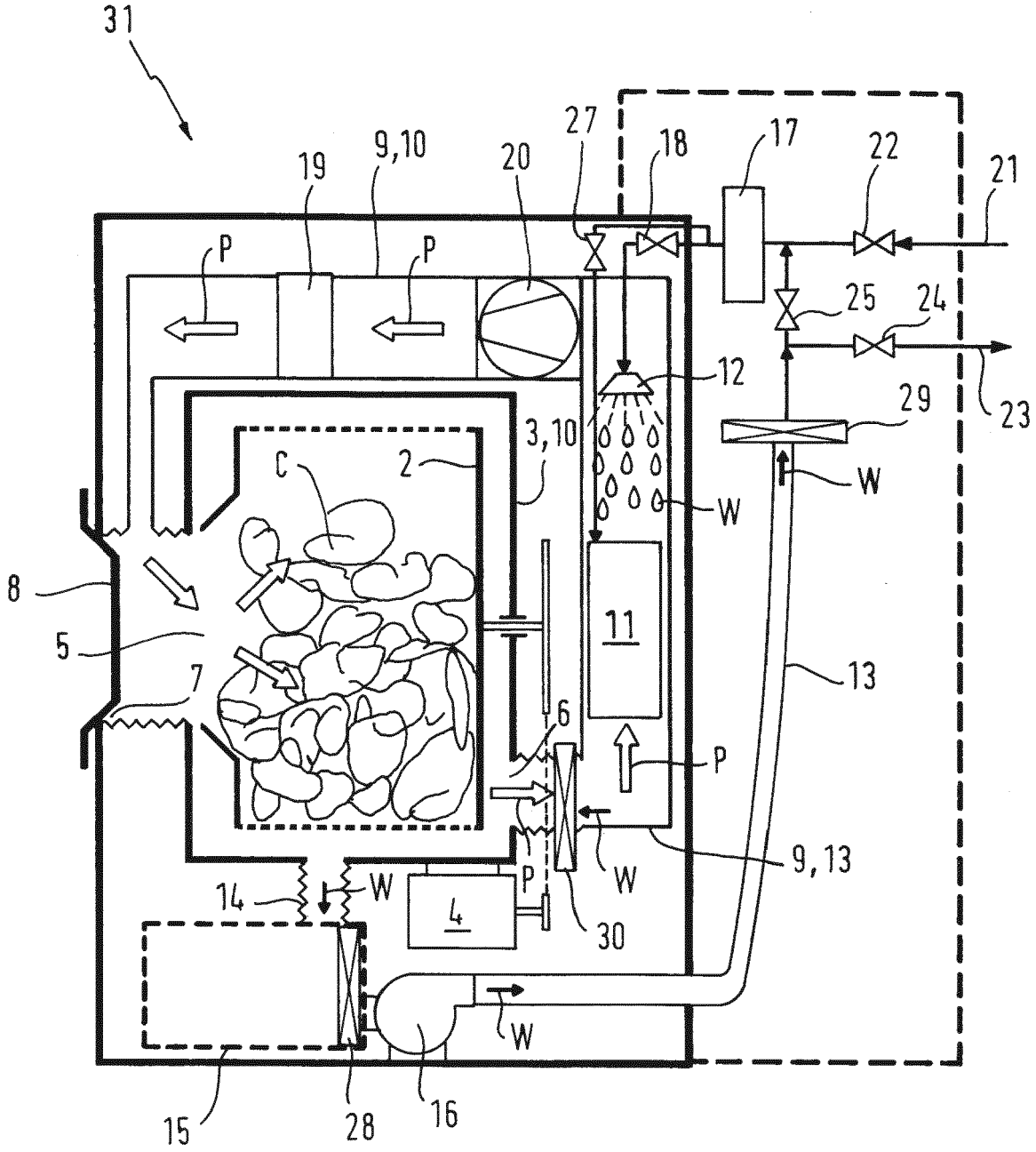
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Fig. 3

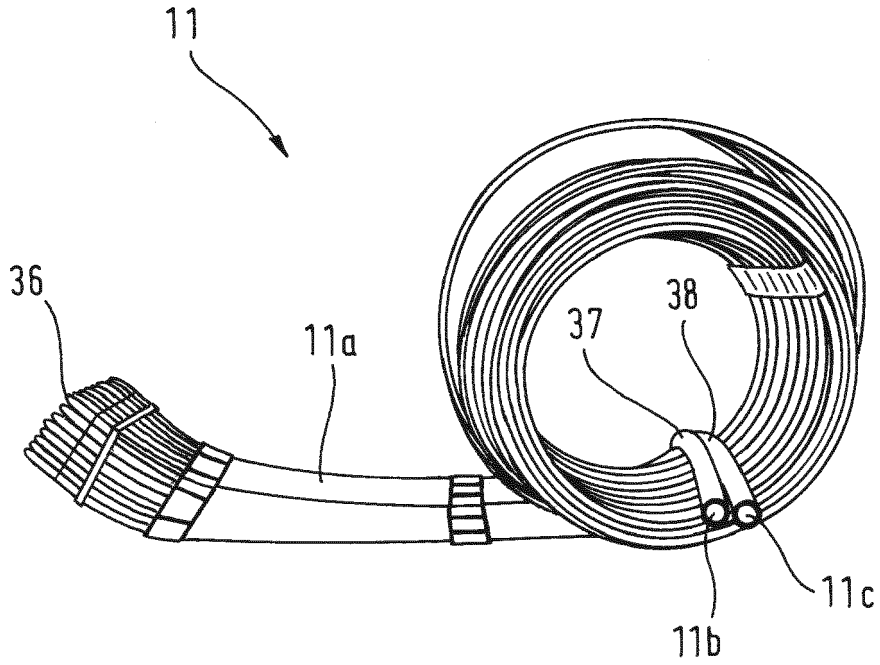
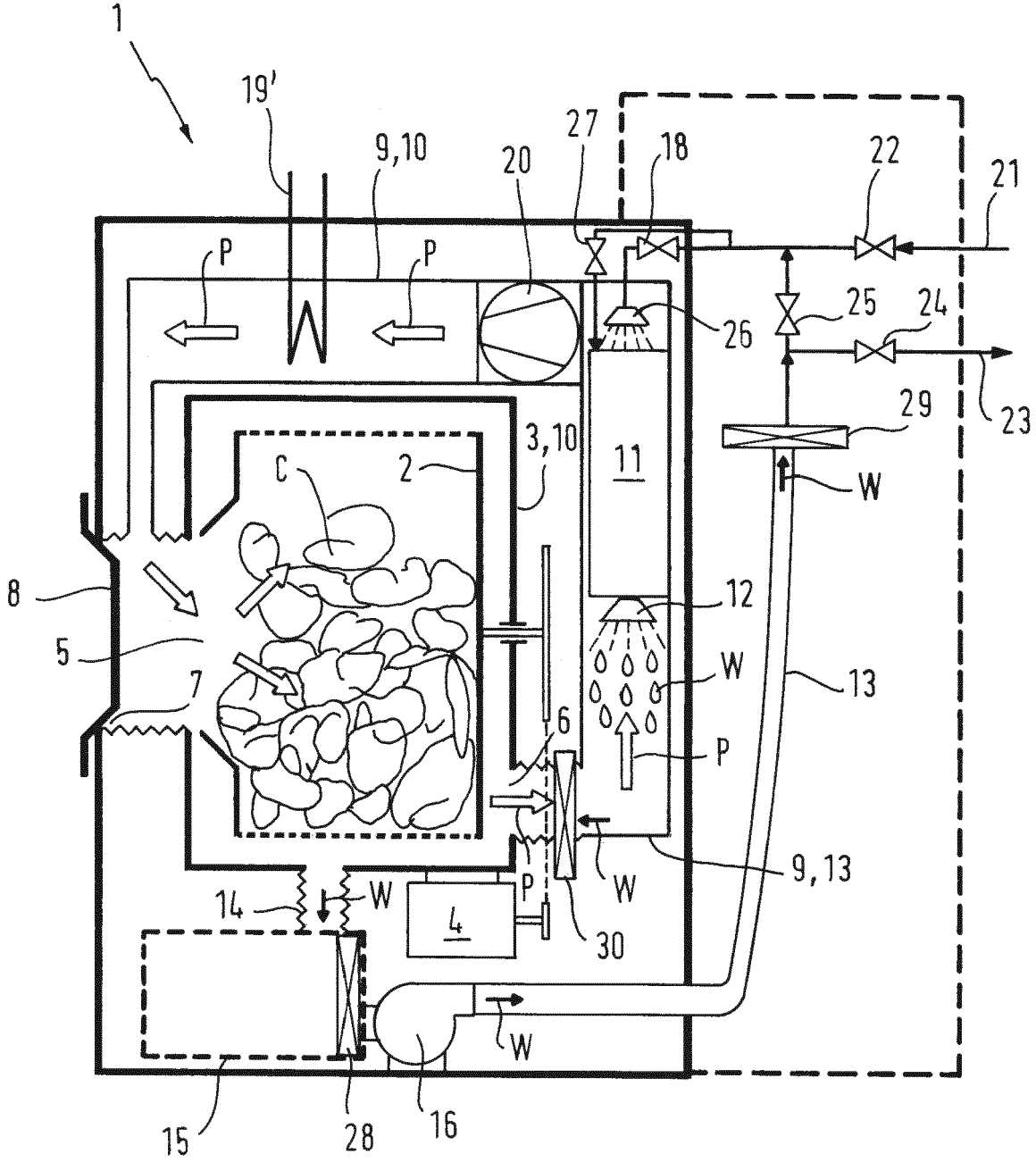


Fig. 4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EUROPEAN SEARCH REPORT

Application Number
EP 16 16 8198

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2013/008049 A1 (PATIL MAHENDRA MADHUKAR [IN]) 10 January 2013 (2013-01-10) * paragraph [0025] - paragraph [0047]; figures *	1-6, 8-11,15	INV. D06F58/24 D06F25/00 D06F58/22 D06F58/20
X	EP 2 019 164 A1 (CANDY SPA [IT]) 28 January 2009 (2009-01-28) * paragraph [0017] - paragraph [0039]; figures 1,2 *	1,2, 8-10,14	
A	EP 2 746 455 A1 (BSH BOSCH UND SIEMENS HAUSGERÄTE GMBH [DE]) 25 June 2014 (2014-06-25) * the whole document *	1-15	
A	US 2013/145644 A1 (MOSCHUETZ HARALD [DE] ET AL) 13 June 2013 (2013-06-13) * the whole document *	1-15	
A	DE 10 2007 060853 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 25 June 2009 (2009-06-25) * abstract *	1-15	TECHNICAL FIELDS SEARCHED (IPC) D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 July 2016	Beckman, Anja

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14-07-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013008049 A1	10-01-2013	NONE	
EP 2019164 A1	28-01-2009	NONE	
EP 2746455 A1	25-06-2014	CN 103882654 A	25-06-2014
		EP 2746455 A1	25-06-2014
US 2013145644 A1	13-06-2013	US 2013145644 A1	13-06-2013
		WO 2013088316 A2	20-06-2013
DE 102007060853 A1	25-06-2009	AT 547551 T	15-03-2012
		CN 101903581 A	01-12-2010
		DE 102007060853 A1	25-06-2009
		EP 2225413 A1	08-09-2010
		WO 2009077336 A1	25-06-2009

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