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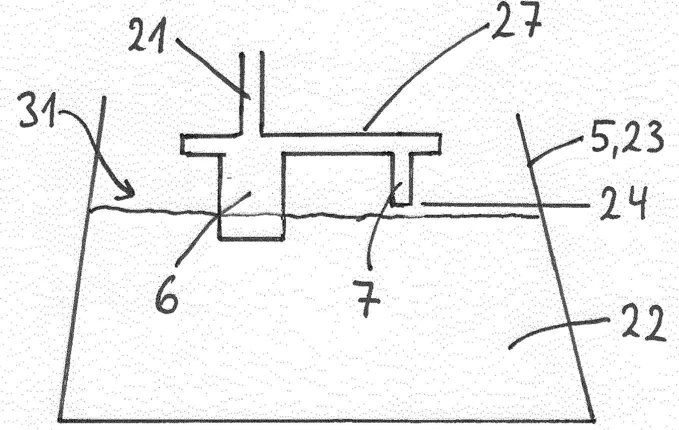
(54) **DRYER WITH A HEAT PUMP AND A WATER CONTAINER COMPRISING AN ELECTRODE AND PROCESS FOR ITS OPERATION**

(57) The invention relates to a dryer 1 with a drum 2 for laundry items to be dried; a process air circuit 3, wherein heated process air is moved by means of a blower 12 above and through the laundry items to be dried; a heat pump circuit 8, 9, 11 comprising an evaporator 8, a compressor 11 and a condenser 9; a water container 5 for the collection of water 31 condensed at the evaporator 8, the water container 5 being in contact with at least one electrode 7 and an electric pump 6 for pumping water 22 out of the water container 5, wherein the electric pump 6 is adapted to start pumping when at least one of the electrodes 7 senses its contact with water 22 in the water container 5; and a control unit 4 comprising a clock 19 for measuring the time elapsed during a drying process; and wherein the control unit 4 is adapted to measure and register time periods Δt_i, wherein i is an integer from 1 to n, during the drying process in which the electric pump 6 is not running between pumping steps of a preset duration Δt_{op} and to analyze the measured time periods Δt_i with respect to the development of the drying process. The invention also relates to a process for the operation of this dryer.

Fig. 3



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Description

[0001] The invention relates to a dryer with a heat pump and a water container comprising an electrode and a process for its operation. The invention relates in particular to a dryer with a drum for laundry items to be dried; a process air circuit, wherein heated process air is moved by means of a blower above and through the laundry items to be dried; a heat pump circuit comprising an evaporator, a compressor and a condenser; a water container for the collection of water condensed at the evaporator, the water container being in contact with at least one electrode and an electric pump for pumping water out of the water container, wherein the electric pump is adapted to start pumping when at least one of the electrodes senses its contact with water in the water container; and a control unit comprising a clock for measuring the time elapsed during a drying process.

[0002] Currently, several systems are known which allow to detect the end of a drying stage with different levels of technological readiness, cost and accuracy based on the sensing sensors used. The sensor might measure for example temperature, temperature difference, relative humidity, electrical resistance or conductivity, capacitance, near infrared radiation (NIR), radar-microwaves. Only a few of them are commercially available and implemented in the market such as electrical resistance measurement, capacitance, autodry. In general, all these solutions look for a variable that is directly related to the water content of laundry items to be dried and deliver a signal to show the end of the drying process.

[0003] In general, clothes dryers are used as exhaust air or circulating air dryers. In both cases, air (so-called "process air") is led by means of a blower over a heating device and into a drum containing wet clothes as a drying chamber. The hot air takes up humidity from the clothes to be dried. In the case of exhaust air driers, the air which is loaded with humidity is upon exiting the drum in general led out of the dryer with no heat energy being recovered. In the case of circulating air dryers, however, the process air is moved in a circle. Circulating air dryers are thus generally designed as condensation dryers.

[0004] Condensation dryers whose function is based upon the condensation of evaporated humidity from clothes do no require a tube for exhausted air and allow the recovery of energy from the heated process air, for example by using a heat pump. Condensation dryers are very popular, because they can be used in bathrooms which are located inside an apartment or laundries of larger living complexes.

[0005] By using a heat pump, a loss of energy can be reduced significantly. In a condensation dryer equipped with a heat pump, the cooling of the warm humid process air is effected mainly in the evaporator of the heat pump, where the heat energy transferred is used for evaporating the refrigerant utilized in the heat pump circuit. The refrigerant of the heat pump which evaporated due to the heating is led through a compressor to the condenser of the heat pump, where heat energy is set free on account of the condensation of the gaseous refrigerant. This heat energy is used for heating the process air before it is introduced into the drum.

[0006] During the drying process, liquid water is formed in the evaporator and can be collected and/or led away in various ways. For example, the condensed water from the evaporation can be conducted to a draining pump to be pumped to a drainage system out of the dryer. The condensed water can however also be collected in a reservoir, and, once it reaches a certain level, pumped out or into another container with a corresponding pump. One possibility of detecting the level of water is by means of electrodes which provide a signal once the water in the reservoir reaches the electrodes.

[0007] The publications EP 3187652 A1 and EP 3252211 A1 each describe a method for controlling a heat pump laundry drying machine, wherein the drying machine comprises an outdoor textiles drying procedure for drying outdoor textiles. In this regard, outdoor textiles have a waterproof and breathable thin film material with a micro-porous structure. The method involves detecting a signal indicative of the humidity of the outdoor textile. The step of detecting a signal indicative of the humidity of the outdoor textile includes inter alia the detection of a level and/or the temporal gradient of a level of water removed from the outdoor textile to be dried and collected in a water container. If for example the level of water does not increase for a given time interval, reasonably it means that there is no more water to be removed from the textile in the drum and that the textile is thus substantially dry. It is also disclosed that the number of activation of a pump driving water removed from the textile contained in the drum to a container may also be representative of the laundry humidity status within the drum.

[0008] In view of this situation, it was an object of the present invention to provide a dryer with a heat pump which allows a better control of the drying process. Preferably, the dryer allows a better assessment of the water content in laundry items to be dried and of the change in the humidity of the laundry items to be dried.

[0009] This object is achieved according to the present invention by means of the dryer and the process for its operation pursuant to the independent claims. Preferred embodiments of the dryer according to the invention are shown especially in the dependent claims. Preferred embodiments of the process correspond to preferred embodiments of the dryer and vice versa even if not expressly stated herein.

[0010] The invention is thus directed to a dryer with a drum for laundry items to be dried; a process air circuit, wherein heated process air is moved by means of a blower above and through the laundry items to be dried; a heat pump circuit comprising an evaporator, a compressor and a condenser; a water container for the collection of water condensed at the evaporator, the water container being in contact with at least one electrode and an electric pump for pumping water out of the water container, wherein the electric pump is adapted to start pumping when at least one of the electrodes senses its contact with water in the water container; and a control unit comprising a clock for measuring the time elapsed during a drying process; wherein the control unit is adapted to measure and register time periods Δt_i, wherein i is an integer from 1 to n, during the drying process in which the electric pump is not running between pumping steps of a preset duration Δt_{op} and to analyze the measured time periods Δt_i with respect to the development of the drying process.

[0011] The drum is usually rotatable around a horizontal or vertical axis, preferably a horizontal axis.

[0012] The term "water" must not be interpreted too narrowly in that it refers essentially to an aqueous liquid with essentially consists of water.

[0013] The number n will depend on the progress of the drying process and depend especially on the intended level of humidity remaining in the laundry items to be dried.

[0014] In a preferred embodiment of the dryer, the control unit is adapted to stop a drying process when the time periods Δt_i increase with time such that a time period Δt_i is equal or larger than a preset time period Δt_i^{setmin}. Namely, in the course of a drying process the amount of water removed from the laundry items per time unit will decrease. Accordingly, the time periods Δt_i increase with time. The preset time period Δt_i^{setmin} will depend on the intended final humidity of the laundry items, and also of the amount of laundry items to be dried. In general, the preset time period Δt_i^{setmin} will be larger if a less humid final state of the laundry is desired. In a typical drying process, desired final states might be for example the dryness levels "iron dry", "wardrobe dry" or "bone dry". They would then in general correspond to different values of the preset time period Δt_i^{setmin}.

[0015] The water container might have different shapes and have different volumes. The water container might be for example a cylindrical or a cubic shape. Often the water container will have in its height direction the same cross-section. In a preferred embodiment, the water container is tapered. As result thereof, the cross-section in the water container will decrease in its height direction. Water arriving from the evaporator will thus lead to a faster increase of the water level in the water container. In this manner, the determination of the time periods Δt_i can be made more often and the accuracy of the entire evaluation of the drying process can be increased.

[0016] It is preferred with the present invention that a height position of the at least one electrode in the water container is adjustable. In this manner, the start of the pump can be prolonged by increasing the height position of the at least one electrode. This might perhaps be useful in the case of very wet and/or many laundry items to be dried.

[0017] In a preferred embodiment of the dryer, the dryer thus contains a system for measuring the load with laundry items to be dried. The system is not limited as long as the load can be determined. The electric current for the rotation of the drum could be evaluated or the weight of the laundry items could be determined by means of a balance.

[0018] In a further preferred embodiment of the dryer of the present invention, the control unit is adapted to set the values of the preset duration Δt_{op} in dependence of the load with laundry items to be dried. Namely, if a large amount of water is to be removed from the laundry items, it might be useful to have larger time periods during which the pump will work. This might decrease the frequency of On and Offs of the pump during drying phases during which it is not necessary to closely observe the drying process. In accordance with the present invention, the values of the preset duration Δt_{op} can be set differently for different phases in a drying process.

[0019] In the present invention, a dryer is moreover preferred, wherein the control unit is adapted to set the values of the preset duration Δt_{op} in dependence of the type and/or material of the laundry items to be dried. In this manner, the different speeds at which laundry items might release the water contained therein might be accounted for.

[0020] Preferred is also a dryer, wherein the control unit is adapted to count the number of pumping periods Δt_{op} to determine the amount of water removed from the laundry items. This would provide further information on the course and the trend of a drying process.

[0021] In a preferred dryer, the volume of the water container is adjustable to the load with laundry items to be dried. This would allow to account for different loads and humidity levels of the laundry items without detrimental effects on the accuracy of the evaluation of the measured time periods.

[0022] In a preferred embodiment of the inventive dryer, the preset time interval Δt_{op} is set smaller when a time period Δt_i is smaller than a preset minimum time period Δt_i^{setmin}.

[0023] It is preferred in the dryer according to the present invention that two electrodes are used and the control unit is adapted to measure the electric conductivity I between the two electrodes and to sense a contact with the water in the water container once the electric conductivity I has reached a given value I^{set}.

[0024] In the dryer of the present invention, the electric pump and the at least one electrode are preferably formed as a one-piece pump-electrode-system that is placed in an upper part of the water container. A one-piece pump-electrode-system has the advantage that it is compact. It is however also possible in the dryer of the present invention that the electric pump and the at least one electrode are formed as separate parts.

[0025] The dryer of the present invention is preferably a washer-dryer comprising a lye container in which a rotable drum is placed.

[0026] In the dryer of the present invention, a refrigerant in the heat pump circuit is preferably selected from the group consisting of butane, propane, a butane-isopropane mixture, carbon dioxide and a fluoro hydrocarbon compound.

[0027] Preferably, the dryer of the present invention comprises in the air process channel an additional heating, preferably an electrical resistance heating, for heating process air. This might help to heat the process air if necessary.

[0028] The invention is moreover directed to a process for operating a dryer with a drum for laundry items to be dried; a process air circuit, wherein heated process air is moved by means of a blower above and through the laundry items to be dried; a heat pump circuit comprising an evaporator, a compressor and a condenser; a water container for the collection of water condensed at the evaporator, the water container being in contact with at least one electrode and an electric pump for pumping water out of the water container, wherein the electric pump is adapted to start pumping when at least one of the electrodes senses its contact with water in the water container; and a control unit comprising a clock for measuring the time elapsed during a drying process; wherein the control unit is adapted to measure and register time periods Δt_i, wherein i is an integer from 1 to n, during the drying process in which the electric pump is not running between pumping steps of a preset duration Δt_{op} and to analyze the measured time periods Δt_i with respect to the development of the drying process, wherein the process comprises the steps

(a) starting a drying process;
(b) starting the clock;
(c) starting the electric pump to pump when at least one of the electrodes senses its contact with water in the water container for a preset duration Δt_{op};
(d) measuring and registering a time period Δt_i, wherein i is an integer from 1 to n, in which the electric pump is not running;
(e) repeating steps (c) and (d); and
(f) analyzing the measured time periods Δt_i with respect to the development of the drying process.

[0029] The clock can start with the beginning of a drying process or preferably with the first time, the electric pump starts to pump water out of the water container. The water pumped out of the water container can be pumped into a drainage system or into another container where it might be collected for example for a washing cycle in a washer-dryer or for a final disposal.

[0030] The meaning of the term "to analyze the measured time periods Δt_i with respect to the development of the drying process" refers in general to the course and speed of the drying process, for example the development of the humidity state in the laundry items. Preferably, the term refers to the determination, preferably a very accurate determination of humidity levels in laundry items to be dried and thus to the intended endpoint of a drying process.

[0031] At the start of a drying program, there is no or little water in the water container such that the electrodes are not in contact with the water and the pump is not working. As the drying process evolves, water coming from the evaporator reaches the water reservoir and fills. When it reaches the level determined by the position of the electrodes, the electrodes provide a signal to the control unit of the dryer which then triggers the start of the pump.

[0032] It is noted here that the term control unit is used herein with a broad meaning in that it covers all control subunits that are in charge of controlling or conducting the working of the different parts of the dryer. A subunit can be envisaged that is in charge of controlling the contact of water with the electrodes and the evaluation of electrode signals to then effect the working of the water pump.

[0033] The heat pump in the dryer according to the present invention comprises an evaporator, a condenser and a compressor. The compressor is in general located in the flow direction of the refrigerant between the evaporator and the condenser. In the heat pump, a relaxation valve (also called "throttle valve") is placed in general in flow direction of the refrigerant between the condenser and the evaporator.

[0034] The refrigerant used in the heat pump preferably circulates in the heat pump circuit in turbulent flow. Turbulent flow can be established via an appropriate design of the flow channel and/or by means of suitable actuation means (for example compressor).

[0035] With an increasing degree of dryness of the laundry items to be dried, in particular clothes, a lower heating power or even an increasing cooling power is required. In particular, upon completion of a drying phase, the temperature in the process air circuit would increase strongly. Thus, in general, the heating pump and, if applicable, the (electrical) heating in the dryer are controlled such that a maximum admissible temperature in the drying chamber is not exceeded.

[0036] The invention has a number of advantages. It allows to reduce the complexity of a dryer and of the drying processes occurring therein. In embodiments it is possible to take advantage of electrode pumps that are existing already in some appliances, in particular heat pump washer-dryers, and to use in this respect existing electrodes as drying sensors for example for a heat pump washer-dryer. There would be then no need of sensors, for example sensors placed in the drum, to determine the drying level of the laundry to be dried. The accuracy of the estimation of the water content in the laundry to be dried can be very high allowing a precise control of already existing drying programs and also the development of new ones.

[0037] The present invention allows moreover to use the values of the time periods Δt_i between subsequent time intervals Δt_{set} in which the electric pump works by means of artificial intelligence (AI) for the learning of the dryer depending on the use, the kind of clothing and so on. This may allow to determine in which manner a user uses the dryer and howe the dryer is able to learn it through the data monitoring for learning.

[0038] Moreover, the dryer allows a better control of the drying process, in particular of the water content in the laundry items to be dried. It is thus possible to indirectly also control the heat pump circuit, such that the temperature in the heat pump circuit can be kept better in an optimum range.

[0039] Non-limiting examples for dryers according to the present invention or for parts which make a technical contribution to the invention and in which the process of the present invention can be implemented, are shown in Figs. 1 to 5.

Fig. 1 shows a vertically cut condensation dryer according to a first embodiment wherein a water container is provided for condensate originating from the evaporator and wherein the container is equipped with an electric pump and electrodes for detecting a water level.

Fig. 2 shows a water container that is used in a non-limiting embodiment of the dryer of the present invention. An electric pump for pumping up water and electrodes used for detecting when the water in the water container reaches the height position of the electrodes are used here as separate parts.

Fig. 3 shows a water container that is used in a further non-limiting embodiment of the dryer of the present invention. In this embodiment, an electric pump for pumping up water and the electrodes used for detecting when the water in the water container reaches the height position of the electrodes constitute a one-piece pump-electrode-system.

Fig. 4 shows a diagram with the development of the water content in laundry items to be dried over time.

Fig. 5 is an alternative diagram which shows the development of the water content in laundry items to be dried over time. Here the amount of condensed water is shown.

[0040] Fig. 1 shows a vertically cut condensation dryer 1 (in the following abbreviated as "dryer") according to a first embodiment wherein a water container 5 is provided for condensate originating from the evaporator 8 of a heat pump and wherein the water container 5 is equipped with an electric pump 6 and electrodes 7 for detecting a water level.

[0041] The dryer shown in Fig. 1 depicts a drum 2 as drying chamber which is rotatable around a horizontal axis. Within the drum, tappets 14 are fixed in order to move the laundry items (which are not shown here) during a rotation of the drum 3. An electric heating device 13 which supports here the heat pump, a heat pump 8, 9, 10, 11, as well as a blower 12 are provided in a process air circuit 3. Warm process air is thus moved to the drum 3, cooled after having passed through the drum 2 and warmed again after the condensation of the humidity contained in the process air. The heated process air is led from the rear, i.e. from the side of the drum 3 opposite to the access door 17, through its perforated floor into the drum 2, comes into contact with the laundry items to be dried and flows through the opening for filling the drum 2 to a lint filter 20 within the dryer door 17 that closes the opening for filling the dryer 1. Thereafter, the air stream in the dryer door 17 is directed downwards and is moved within the process air circuit 3 to the evaporator 8. There, the humidity taken up from the laundry items condenses due to the cooling and the condensed water is collected by the water container 5. The condensed water can be deposed therefrom.

[0042] Behind the evaporator 8, the process air is moved by means of blower 12 again to the heating device 13 which is however also heated by the condenser 9 of the heat pump 8, 9, 10, 11.

[0043] The control of the dryer 1 is achieved by means of a control unit 4 which may be adjusted by a user by means of an operator panel 15.

[0044] In the heat pump 8, 9, 10, 11, the refrigerant is evaporated in evaporator 8, compressed in compressor 11 which is here a variable power compressor and subsequently condensed in condenser 9. 10 is a throttle.

[0045] Process air is fed through the drum 2 in a process air circuit 3 by means of a blower 12. After passing through the drum 2, the moist, warm process air is directed into the evaporator 8 of a heat pump 8,9,10,11, which also has a variable-speed compressor 11, a throttle 10 and a condenser 9. The arrows shown in Fig. 1 indicate the flow direction of the coolant in the air pump and of the air in the process air circuit.

[0046] The refrigerant of the heat pump 8,9,10,11 evaporated in the evaporator 8 is led to the condenser 9 via the speed-dependent compressor 11. In the condenser 9, the refrigerant liquefies, releasing heat to the process air flowing in the process air circuit 3. The refrigerant, which is now in liquid form, is again fed to the evaporator 8 via the throttle 10, thus closing the refrigerant circuit. In this embodiment, a temperature sensor S^{T}_{WPK} 18 between evaporator 8 and compressor 11 measures the temperature TK of the refrigerant.

[0047] In the embodiment shown in Fig. 1, the electric heater 13 serves to heat the process air more rapidly. In other embodiments of the invention, the electric heater 18 may be omitted.

[0048] An optical/acoustical indication device 16 allows the user of the dryer to display, for example, operating parameters and/or an expected duration of the drying process.

[0049] In the process according to the invention, process air is repeatedly circulated through the process air circuit 3 until preferably a desired degree of drying of the laundry items is achieved.

[0050] As regards the inventive process conducted in the dryer 1 it is noted that the control unit 4 is adapted to measure and register time periods Δt_i, wherein i is an integer from 1 to n, during the drying process in which the electric pump 6 is not running between pumping steps of a preset duration Δt_{op} and to analyze the measured time periods Δt_i with respect to the development of the drying process.

[0051] The dryer 1 of Fig. 1 further enables precise control of the operation of the heat pump, so that a drying phase can be efficiently controlled by regulating the blower 12 and the compressor 11 so that a predetermined maximum temperature T_{max} for the temperature of the process air is not exceeded.

[0052] Fig. 2 shows a water container 5 that is used in a non-limiting embodiment of the dryer of the present invention. An electric pump 6 for pumping up water 22 and electrodes 7 used for detecting when the water 22 in the water container 5 reaches the height position of the electrodes 7 are used here as separate parts. 31 indicates condensed water from the evaporator not shown here. 25 indicates here a pump support and 26 an electrode support which are here in contact with the water container 5. 21 indicates a tube for carrying away pumped off water.

[0053] Fig. 3 shows a water container 5 that is used in a further non-limiting embodiment of the dryer of the present invention. In this embodiment, an electric pump 6 for pumping up water 22 and the electrodes 7 used for detecting when the water 22 in the water container 5 reaches the height position 24 of the electrodes 7 constitute here a one-piece pump-electrode-system 27. 31 indicates condensed water from the evaporator not shown here. 21 indicates a tube for carrying away pumped off water.

[0054] Fig. 4 shows a diagram with the development of the water content in laundry items to be dried over time. In the very beginning the water content in the laundry items is quite high. Upon the start of the pump, the water content in the laundry items decreases. As can be seen there is a roughly linear but pronounced decline of the water content in the beginning. This is indicated by the term "$\Delta t_i \approx$ constant". As the drying process continues the decrease of the water content in the laundry items to be dried decreases, i.e. the slope decreases and slight increasing Δt_i values can be seen. The dashed line indicates the beginning of the drying zone. In the drying zone, several definite endpoints are shown for the laundry to be dried, namely iron, wardrobe and bone dry. The user of the drier may select one of these endpoints.

[0055] Fig. 5 is an alternative diagram which shows the development of the water content in laundry items to be dried over time. Here the amount of condensed water is shown. 28 points to a line which indicated the amount of condensed water removed from the dryer. 29 indicates on the other hand the condensed water as registered by a scale.

Reference Signs

[0056]

1	Dryer
2	Drum
3	Process air circuit
4	Control unit
5	Water container; condensate collection container
6	Electric pump in water container
7	Electrodes in water container
8	Evaporator
9	Condenser
10	Throttle
11	(variable power) Compressor
12	Blower
13	Electric heating device
14	Drum ribs for taking along laundry items
15	Operator panel
16	Optical/acoustical indication device
17	Access door
18	Temperature sensor S^T_{WPK} in the coolant circuit for measuring a temperature T_K of the coolant
19	Clock
20	Fluff filter
21	Tube for pumped off water
22	Water
23	Tapered water container
24	Height position of the electrode(s)
25	Pump support
26	Electrode support
27	One-piece pump-electrode-system
28	Amount of condensed water removed from drier
29	Amount of condensed water registered by a scale
30	Percentage of humidity remaining in the laundry items
31	Condensed water from evaporator

Claims

1. Dryer (1) with a drum (2) for laundry items to be dried; a process air circuit (3), wherein heated process air is moved by means of a blower (12) above and through the laundry items to be dried; a heat pump circuit (8, 9, 11) comprising an evaporator (8), a compressor (11) and a condenser (9); a water container (5) for the collection of water (31) condensed at the evaporator (8), the water container (5) being in contact with at least one electrode (7) and an electric pump (6) for pumping water (22) out of the water container (5), wherein the electric pump (6) is adapted to start pumping when at least one of the electrodes (7) senses its contact with water (22) in the water container (5); and a control unit (4) comprising a clock (19) for measuring the time elapsed during a drying process; **characterized in that** the control unit (4) is adapted to measure and register time periods Δt_i, wherein i is an integer from 1 to n, during the drying process in which the electric pump (6) is not running between pumping steps of a preset duration Δt_{op} and to analyze the measured time periods Δt_i with respect to the development of the drying process.

2. Dryer (1) according to claim 1, wherein the control unit (4) is adapted to stop a drying process when the time periods Δt_i increase with time such that a time period Δt_i is equal or larger than a preset time period Δt_i^{setmin}.

3. Dryer (1) according to claim 1 or 2, wherein the water container (5) is tapered.

4. Dryer (1) according to any of claims 1 to 3, wherein a height position (24) of the at least one electrode (7) in the water container (5) is adjustable.

5. Dryer (1) according to any of claims 1 to 4, containing a system for measuring the load with laundry items to be dried.

6. Dryer (1) according to any of claims 1 to 5, wherein the control unit (4) is adapted to set the values of the preset duration Δt_{op} in dependence of the load with items to be dried.

7. Dryer (1) according to any of claims 1 to 6, wherein the control unit (4) is adapted to set the values of the preset duration Δt_{op} in dependence of the type and/or material of the laundry items to be dried.

8. Dryer (1) according to any of claims 1 to 7, wherein the control unit (4) is adapted to count the number of pumping periods Δt_{op} to determine the amount of water removed from the laundry items.

9. Dryer (1) according to any of claims 1 to 8, wherein the volume of the water container (5) is adjustable to the load with laundry items to be dried.

10. Dryer (1) according to any of claims 1 to 9, wherein the preset time interval Δt_{op} is set smaller when a time period Δt_i is smaller than a preset minimum time period Δt_i^{setmin}.

11. Dryer (1) according to any of claims 2 to 10, wherein two electrodes (7) are used and the control unit (4) is adapted to measure the electric conductivity I between the two electrodes (7) and to sense a contact with the water (22) in the water container (5) once the electric conductivity I has reached a given value I^{set}.

12. Dryer (1) according to any of claims 1 to 11, wherein the electric pump (6) and the at least one electrode (7) are formed as a one-piece pump-electrode-system (27) that is placed in an upper part of the water container (5).

13. Dryer (1) according to any of claims 1 to 12, wherein the dryer (1) is a washer-dryer comprising a lye container in which a rotable drum (2) is placed.

14. Dryer (1) according to any of claims 1 to 13, wherein a refrigerant in the heat pump circuit (13, 14, 15) is selected from the group consisting of butane, propane, a butane-isopropane mixture, carbon dioxide and a fluoro hydrocarbon compound.

15. Process for operating a dryer (1) with a drum (2) for laundry items to be dried; a process air circuit (3), wherein heated process air is moved by means of a blower (12) above and through the laundry items to be dried; a heat pump circuit (8, 9, 11) comprising an evaporator (8), a compressor (11) and a condenser (9); a water container (5) for the collection of water (31) condensed at the evaporator (8), the water container (5) being in contact with at least one electrode (7) and an electric pump (6) for pumping water (22) out of the water container (5), wherein the electric pump (6) is adapted to start pumping when at least one of the electrodes (7) senses its contact with water (22) in the water container (5); and a control unit (4) comprising a clock (19) for measuring the time elapsed during a drying process; **characterized in that** the control unit (4) is adapted to measure and register time periods Δt_i, wherein i is an integer from 1 to n, during the drying process in which the electric pump (6) is not running between pumping steps of a preset duration Δt_{op} and to analyze the measured time periods Δt_i with respect to the development of the drying process, wherein the process comprises the steps

(a) starting a drying process;
(b) starting the clock (19);
(c) starting the electric pump (6) to pump when at least one of the electrodes (7) senses its contact with water (22) in the water container (5) for a preset duration Δt_{op};
(d) measuring and registering a time period Δt_i, wherein i is an integer from 1 to n, in which the electric pump (6) is not running;
(e) repeating steps (c) and (d); and
(f) analyzing the measured time periods Δt_i with respect to the development of the drying process.

Fig. 1

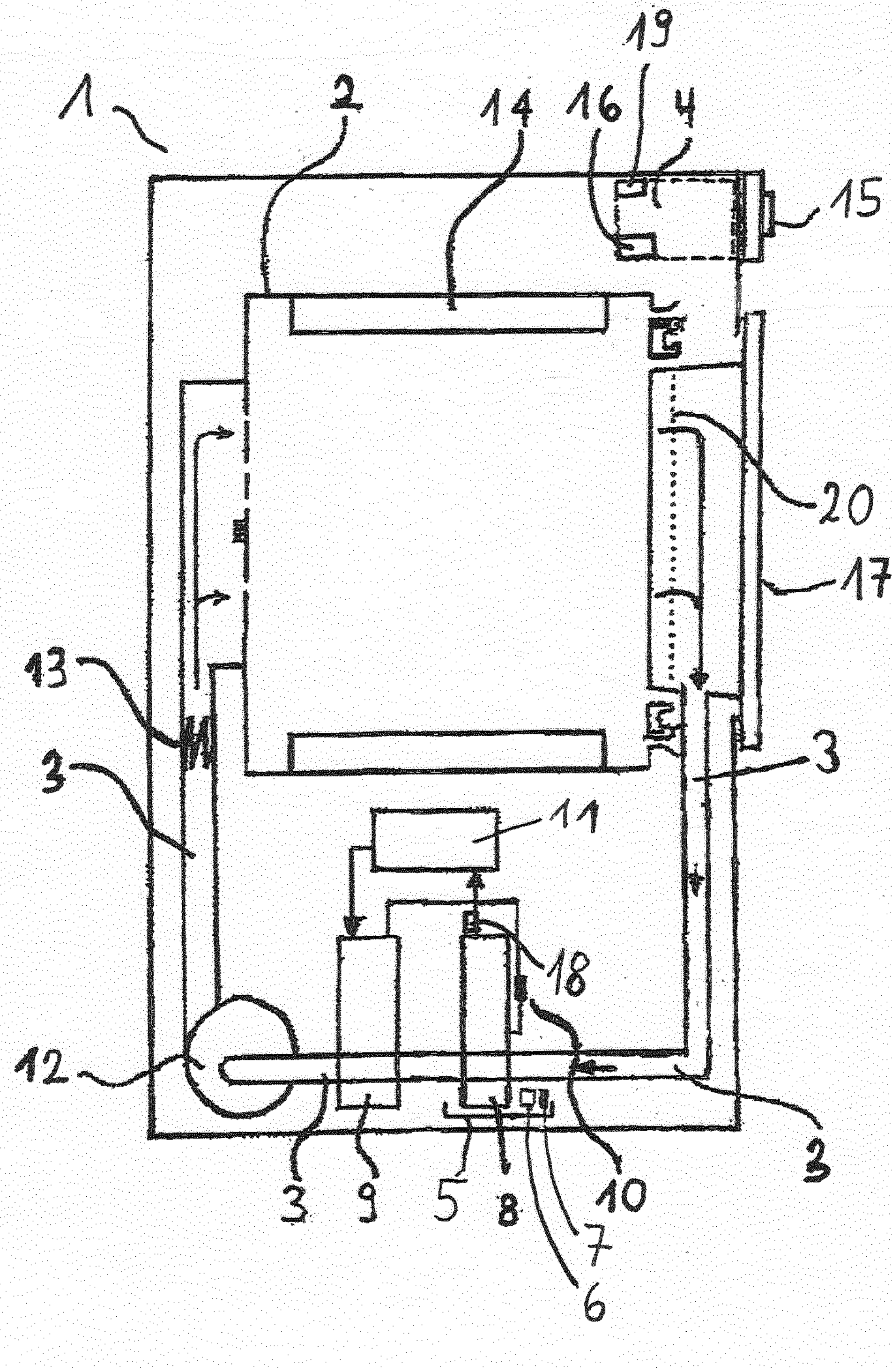


Fig. 2

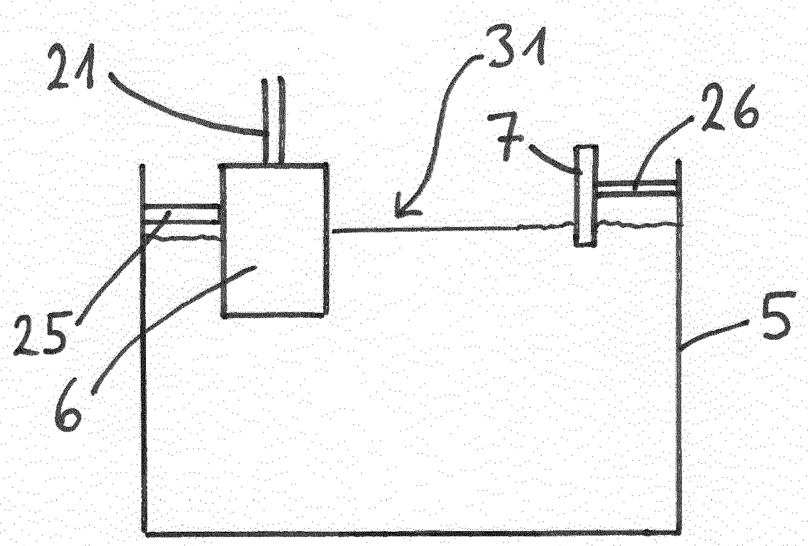


Fig. 3

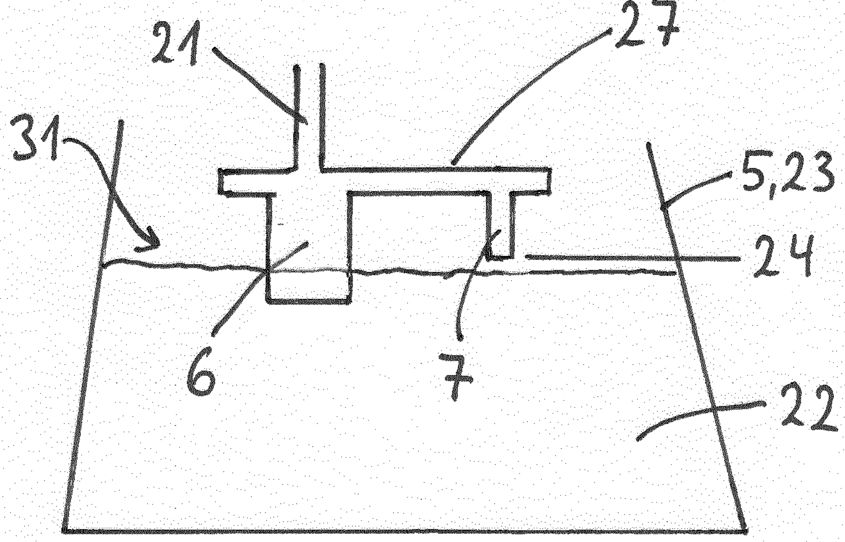


Fig. 4

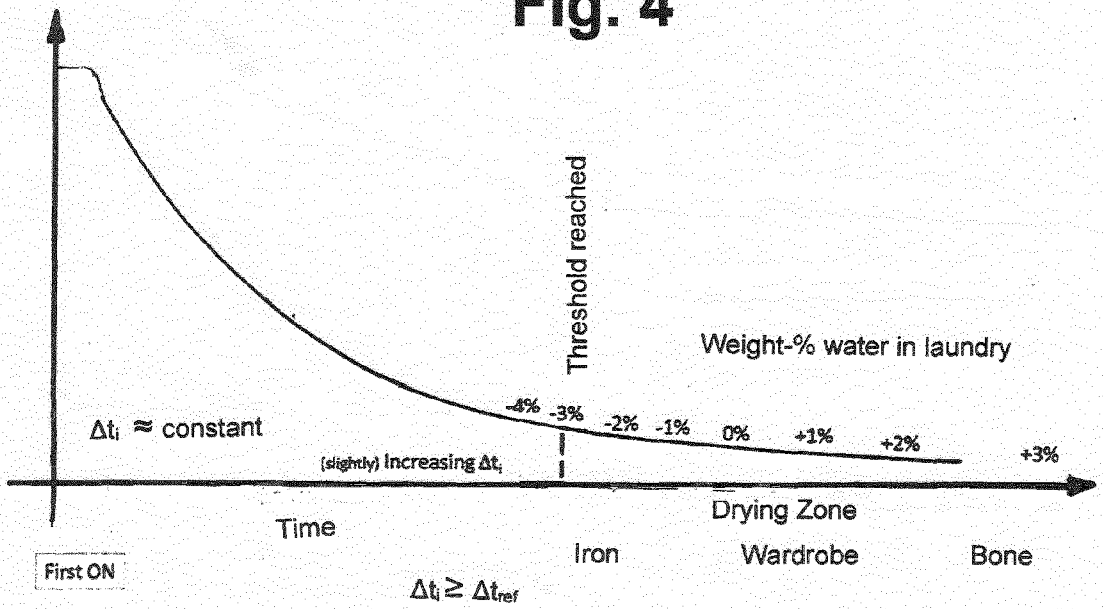
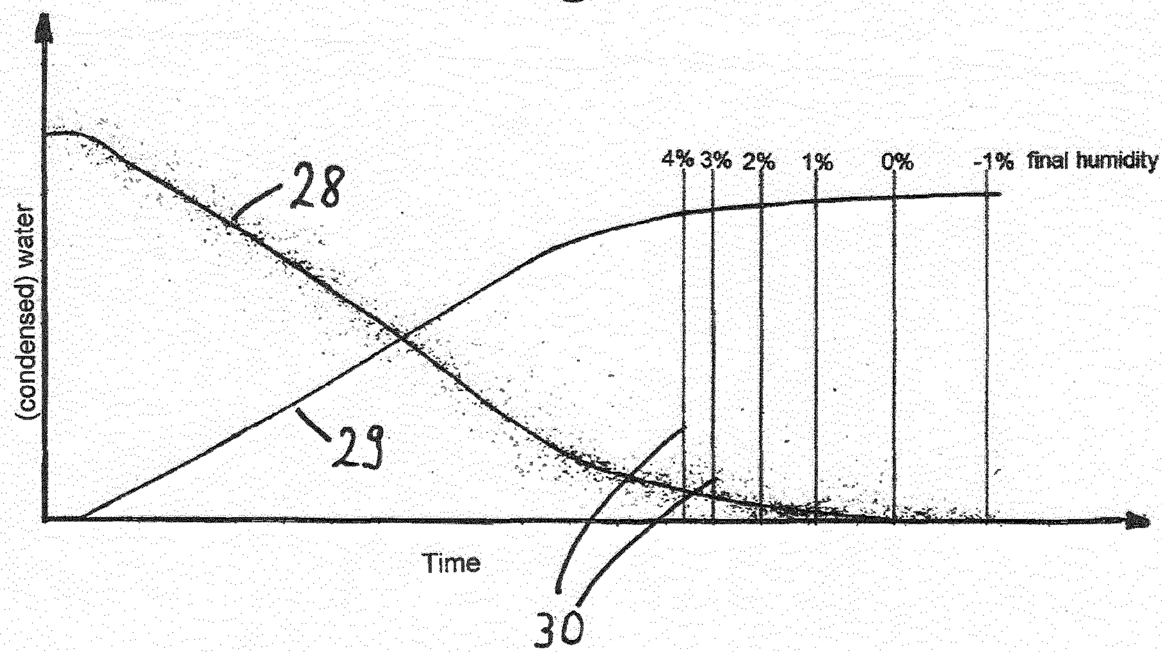

Threshold reached
Weight-% water in laundry
-4% -3% -2% -1% 0% +1% +2% +3%
Δtᵢ ≈ constant
(slightly) Increasing Δtᵢ
Time
Drying Zone
First ON
Iron
Wardrobe
Bone
Δtᵢ ≥ Δt_ref

Fig. 5


(condensed) water
28
29
4% 3% 2% 1% 0% -1% final humidity
Time
30

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EUROPEAN SEARCH REPORT

Application Number
EP 22 21 3390

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 Y A	EP 3 253 914 B1 (BSH HAUSGERAETE GMBH [DE]) 4 September 2019 (2019-09-04) * paragraph [0018] * * paragraph [0032] - paragraph [0036] * * paragraph [0058] - paragraph [0066] * * paragraph [0068] * * figures 1, 2 *	1,5,11, 15 1,3 2,4, 6-10,12, 13	INV. D06F58/24 D06F58/38 ADD. D06F58/20 D06F103/38 D06F103/58 D06F105/12
X A	US 2021/115619 A1 (DUNN DAVID SCOTT [US] ET AL) 22 April 2021 (2021-04-22) * paragraph [0003] - paragraph [0004] * * paragraph [0008] - paragraph [0010] * * paragraph [0021] - paragraph [0031]; figures 1-3 * * paragraph [0039] - paragraph [0053]; figures 4, 5 *	1,6,15 2-5,7-14	
Y	US 2016/138209 A1 (KITAYAMA NAOKI [JP] ET AL) 19 May 2016 (2016-05-19) * paragraph [0013] - paragraph [0014] * * paragraph [0075] - paragraph [0088] * * paragraph [0091] - paragraph [0092] * * paragraph [0096] * * paragraph [0117] - paragraph [0133] * * figures 1, 2, 4-12 *	1,3	TECHNICAL FIELDS SEARCHED (IPC) D06F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	25 May 2023	Sabatucci, Arianna

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25-05-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3253914 B1	04-09-2019	CN 107208350 A	26-09-2017
		DE 102015201831 A1	04-08-2016
		EP 3253914 A1	13-12-2017
		PL 3253914 T3	30-04-2020
		WO 2016124349 A1	11-08-2016
US 2021115619 A1	22-04-2021	NONE	
US 2016138209 A1	19-05-2016	EP 3023531 A1	25-05-2016
		US 2016138209 A1	19-05-2016

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Patent documents cited in the description

- EP 3187652 A1 **[0007]**
- EP 3252211 A1 **[0007]**