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(54) **Laundry treatment apparatus having heat pump system**

(57) The invention relates to a method of operating a laundry treatment apparatus 2, in particular a dryer or a washing machine having dryer function, the apparatus 2 comprising: a storing compartment 6 for storing laundry therein, in particular a rotatable drum, an air circulation channel 20 connected at a first end 22 and at a second end 24 to the storing compartment 6, a blower 26 for blowing the air through the air circulation channel 20 and

the storing compartment 6, a heat pump system 10 having an evaporator 14 and a condenser 16 arranged in the air circulation channel 20, and a steam generator 8, 30 arranged within the body 4 of the laundry treatment apparatus 2; the method comprising the steps of: supplying steam generated by the steam generator 8, 30 into the air circulation channel 20 and/or the storing compartment 6, and at the same time at least for an overlapping period, operating the heat pump system 10.

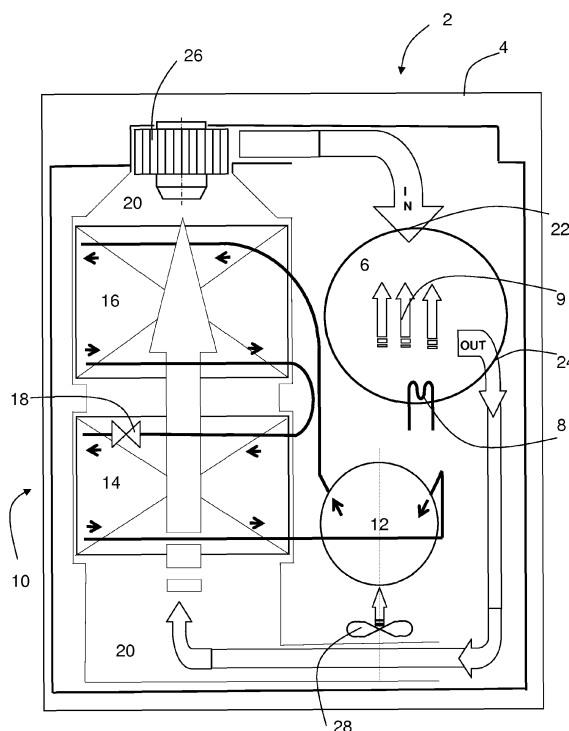


Fig. 1

## Description

**[0001]** The invention relates to a laundry treatment apparatus having a heat pump system, and a method for operating the same. The laundry treatment apparatus may be a dryer or a washing machine having drying function.

**[0002]** If a heat pump system is not operated permanently as in a freezer or refrigerator, but it is operated temporarily when momentarily required, the heat transfer capability for transferring heat from the evaporator to the condenser is slowly increasing over time after starting the heat pump system. It is known to use such heat pump systems in condenser dryers. There are different conventional approaches to increase the initial heat transfer capability and/or to reduce the time required till full heat transfer capability.

**[0003]** For the dryer with heat pump system of DE 31 13 471 A1 it is proposed to heat the circulated drying air not only by a condenser of a heat pump but also by an electrical heater to heat up the evaporator and to dry the laundry.

**[0004]** EP 1 650 343 A1 suggests a dryer with a heat pump system in which the air in the air circulation path can be heated by an electric heater. The electric heater is used before starting the heat pump system to warm up the evaporator and to provide heat for drying the laundry.

**[0005]** In the dryer having a heat pump system of EP 0 999 302 B1 an additional evaporator external to the air circulation path is used which is heated or cooled by air sucked from the outside of the dryer.

**[0006]** An auxiliary evaporator arranged in a water storage tank is suggested in EP 1 983 094 A1. Alternatively it is suggested to open the air circulation path to introduce ambient air to heat up the evaporator in the initial stage of the drying operation.

**[0007]** In the dryer having a heat pump system of WO 2007/023510 A1 there is an external condenser for removing process heat out of the air circulation path on the one hand and on the other hand there is a heating element for additionally and permanently heating the air. The heating element is operated by electric power or by steam.

**[0008]** DE 10 2005 041 145 A1 suggests that the efficiency of the compressor is adapted by operating it at the start with a higher power and then to reduce the power or efficiency of the compressor.

**[0009]** It is an object of the invention to provide a laundry treatment apparatus having a heat pump system and a method of operating a laundry treatment apparatus, in which the time for the heat pump system to come to an elevated efficiency is shortened without the need for additional elements.

**[0010]** The invention is defined in claims 1 and 9, respectively. Particular embodiments are set out in the dependent claims.

**[0011]** According to the method of claim 1, a laundry

treatment apparatus is operated having a storing compartment for storing laundry therein. The laundry treatment apparatus has at least one operation mode in which the laundry can be dried using a heat pump system. In a preferred embodiment the laundry treatment apparatus is a dryer that has a rotatable drum or is a washing machine having drying function in which the laundry is stored in a rotatable drum arranged in a tub. Laundry treatment can, however, also be performed in another type of apparatus, for example a cabinet for dry cleaning of laundry.

**[0012]** The heat pump system has an evaporator and a condenser, wherein the terms evaporator and condenser are used here in relation to the heat pump system. I.e. the evaporator in the laundry treatment apparatus is used normally as condenser with respect to the air circulation path such that in normal operation of the evaporator the humidity circulated with the air is condensed at the evaporator. Correspondingly, in the condenser the coolant liquid is condensed by depositing heat in the condenser and thereby to heat exchange the heat and deposit the heat in the air circulated on the outside surfaces of the condenser. The evaporator and the condenser are arranged in the air circulation channel which has at least a first and a second end each of which is fluidly and/or mechanically connected to the storing compartment. The heat pump system is used to dry the laundry wherein - as in the prior art - humidity is circulated in the air circulation path, the humidity condenses at the evaporator while cooling the air, then the air is heated up for drying at the condenser, and the heated air takes up humidity from the laundry.

**[0013]** The air circulation is powered by at least one blower that blows the air through the air circulation channel and the storing compartment. Preferably, at least the fan of the blower is arranged within the air circulation channel. The compressor of the heat pump system may be arranged within or partially within the air circulation channel or outside of the air circulation channel, preferably in an inner space of the laundry treatment apparatus.

**[0014]** The laundry treatment apparatus has a steam generator which is arranged within the body of the laundry treatment apparatus. The steam generator is nowadays a common element of a laundry treatment apparatus that provides laundry processing by using steam supplied to the laundry. Preferably the method of operating the textile treatment apparatus comprises at least one steam treatment mode or cycle for steam treatment of the laundry stored in the storing compartment. The steam generator is adapted to supply steam into the air circulation channel and/or into the storing compartment for laundry treatment. The steam supplied by the steam generator is allowed to contact the laundry stored in the storing compartment for steam treatment. For at least an overlapping period or for overlapping periods, the steam generator is generating and supplying steam into the air circulation channel and/or the storing compartment while at the same time the heat pump system is operated. Preferably at least in the initial phase or during an initial phase after

starting the operation of the compressor of the heat pump system steam is supplied by the steam generator.

**[0015]** In the initial phase or start-up phase of operating the compressor the purpose or main purpose of the supplied steam is to heat up the evaporator to come to working temperature. However, it is also possible to start operation of the heat pump system, i.e. to operate the compressor thereof, while the laundry is still processed in a steam treatment mode or cycle. The steam is hot steam (at the origin of supply preferably the steam temperature is higher than 70°C, 80°C, 90°C or 95°C) and/or preferably the steam is pure water steam. Alternatively, the steam is essentially water steam (more than 60%, 70% or 80% of volume) to which additives are added. Additives could be a disinfectant agent, a bleaching agent, deodorizing agent, an impregnant agent, a softener agent or others.

**[0016]** In an embodiment the steam is generated by the steam generator and supplied to the air circulation channel and/or the storing compartment for a predefined period since or after starting the operation of the heat pump system and then after the predefined period the steam generation and supply is stopped. By this overlap of the operation of the heat pump system and the steam generator the intermediate effect of additional energy consumption by the steam generator is limited and in total the result of this additional energy consumption and humidification of the laundry is more than counterbalanced by the acceleration of the equilibration process for the heat pump system to come to high efficiency in the drying cycle.

**[0017]** According to another embodiment steam is generated during an initial operation of the heat pump system, for example the steam generation by the steam generator is started when starting the operation of the heat pump system. Steam generation and supply of steam is continued until it is stopped in dependency of one or more predefined parameters. Thus, the duration of steam generation by the steam generator is for example dependent on one or more parameters indicating or being a measure that the heat pump system has arrived at a predefined operation efficiency.

**[0018]** A predefined parameter or one of the predefined parameter(s) is (are) the temperature and/or the pressure of the working fluid circulating in the heat pump system or the temperature of one of the elements of the heat pump system, in particular the temperature of the compressor, the evaporator or the condenser.

**[0019]** Parameters, which are monitored and used to decide whether steam generation can be stopped and/or whether the predefined working efficiency of the heat pump system is effected, are for example the temperature of the working fluid in the heat pump system or a temperature difference of a working fluid measured at different locations in the heat pump system, for example at the inlet/outlet of the evaporator. For example the temperature difference is taken from the temperature of the condenser and the temperature of the evaporator, which

for example are measured with a temperature sensor in contact with the evaporator and condenser. The temperature can also be measured at a fluid conduit coming or going to these elements.

**[0020]** A predefined or sufficient working efficiency has for example been reached when the temperature difference between condenser and evaporator is more than or equal to 5°C, 10 °C, 15°C or 20°C.

**[0021]** Alternatively or additionally one or more of the parameters are the pressure and/or temperature of the working fluid in the evaporator (for example measured at the inlet/outlet thereof), the condenser and/or the compressor. For example, the pressure within the evaporator is measured which indicates the pressure of the working fluid (or cooling fluid), wherein a sufficient pressure limit has to be achieved before the compressor and thus the heat pump system can operate efficiently.

**[0022]** Additionally or alternatively, the power consumption of the heat pump system, for example the current to the compressor, is a parameter indicating when an efficient working condition of the heat pump system is achieved.

**[0023]** Alternatively or additionally, one or more of the parameters is the temperature at a specific location in the air circulation channel and/or a temperature difference between two different locations in the air circulation channel, for example inlet/outlet of the drum. Then these parameters can be monitored as a parameter for determining when the steam generation is to be stopped.

**[0024]** Additionally or alternatively, one or more of the parameters is the humidity of the circulated air, which can be detected at the air inlet or air outlet of one of the following elements: the evaporator, the condenser, the air circulation channel and the storing compartment.

**[0025]** The dependency of the one or more parameters may be a temporal behaviour of the one or more parameters wherein a temporal gradient or change is used to determine the time for stopping the steam generator. In addition or alternatively to the temporal changes or gradients, local changes or gradients can be determined on which the decision to stop steam generation is based.

**[0026]** In a preferred embodiment the steam generated by the steam generator is first supplied into the storing compartment, i.e. the steam is not supplied to the storing compartment via the air circulation channel, but it is directly supplied from the generator into the laundry storing compartment. For example the steam generator is a steam generator within the body of the laundry treatment apparatus, but is arranged external to the storing compartment and the air circulation channel. Then a duct or connection provides steam from the steam generator into the storing compartment which is for example a drum of a washing machine or a dryer.

**[0027]** In another arrangement the steam generator is arranged within a tub in which the storing compartment is arranged, preferably a rotatable drum. For example the steam generator is the electrical heater element of the washing machine arranged in the sump of the tub

and the steam generator heats water in the sump to generate the steam. In this embodiment preferably only a small amount of water is provided in the sump such that the water level is below the storing compartment (rotatable drum) and not in contact with the laundry stored in the storing compartment.

**[0028]** Preferably, the laundry treatment apparatus provides that the amount and/or time and/or temperature of steam supplied by the steam generator depends on a user selection input at a control unit of the laundry treatment apparatus. If for example delicate laundry, which is not convenient for steam treatment, is stored in the storing compartment, the user can suppress steam generation during operation of the heat pump system to avoid damage to the laundry. Alternatively or additionally, the temperature of the steam is reduced by a corresponding user selection when the laundry is sensitive to hot steam. The user selection may be a dedicated selection for reducing steam supply to the laundry or it may be an indirect selection by selecting the type of laundry and/or type of laundry treatment preceding the drying cycle. The amount of steam to be supplied from the steam generator may for example depend on the amount of laundry stored in the storing compartment and/or its humidity. If for example the stored amount of laundry is high and the laundry has a high humidity, then a higher amount of steam is required for bringing up the working temperature of the evaporator. In this case the temperature of the laundry in the compartment has to be increased at the same time with the evaporator's temperature.

**[0029]** The laundry treatment apparatus according to the invention comprises a steam generator arranged within the body of the laundry treatment apparatus and is designed to supply steam into the storing compartment and/or to the air circulation channel. I.e. the steam generator is in fluid connection with the interior of the storing compartment and/or air circulation channel such that the steam generated by the steam generator is available for laundry processing or treatment.

**[0030]** Preferably, the laundry treatment apparatus has embodiments and configurations as described above in connection with the method. All features mentioned above are applicable individually or in any combination as will be readily understood by the skilled person to be a meaningful contribution. The embodiments and their features described below in connection with the laundry treatment apparatus are also applicable individually or in any combination to the laundry treatment apparatus that is operated in the method.

**[0031]** According to a preferred embodiment the control unit of the laundry treatment apparatus is adapted to operate the heat pump system and the steam generator at the same time at least for one or a plurality of overlapping periods, preferably during the initial phase of the operation of the heat pump system such that the evaporator is heated in the start-up phase of the heat pump system. Thereby the working temperature of the evaporator and the coolant liquid therein is increased to in-

crease the evaporation of the coolant liquid within the evaporator. This increases the efficiency of the compressor by providing coolant liquid vapour to be compressed.

**[0032]** In an embodiment the steam generator is arranged within the storing compartment, in particular within a tub surrounding the storing compartment, or is arranged in the air circulation channel. In this configuration no steam supply line is required to convey the steam generated by the steam generator into the storing compartment and/or the air circulation channel. In another embodiment the steam generator is arranged within the body of the laundry treatment apparatus, but outside the storing compartment and the air circulation channel and a steam supply line and/or an opening between steam generator and the storing compartment and/or the air circulation channel is provided.

**[0033]** The steam generator of the laundry treatment apparatus is provided for laundry processing or treatment in respective laundry treatment apparatus operation modes or cycles. Thus the steam generator does not represent an additional element of the laundry treatment apparatus solely for shortening the start-up phase of the heat pump system having the compressor, condenser and evaporator. Laundry treatment processes or cycles in which steam is used for laundry treatment are for example, but not limited to: providing steam to the laundry for anti-wrinkle purposes, providing steam to the wash liquid for heating up the washing liquid, providing steam for sterilisation, and providing steam for dry cleaning.

**[0034]** According to an embodiment, the laundry treatment apparatus has a storing compartment, in particular a rotatable drum, that is enclosed by a tub or container and a sump arranged in the tub below the storing compartment (e.g. rotatable drum). A heating element arranged in or at the sump is configured to heat up water contained in the sump to generate steam and to supply it to the storing compartment. Preferably, the storing compartment has a plurality of openings connecting its interior and the outer volume within the tub, so that the steam can permeate into the storing compartment for laundry processing.

**[0035]** According to a preferred embodiment the blower has an operation mode with reduced or zero air conveying power. For example, an operation mode in which the blower is de-energized or stopped or in which the power provided to the blower is reduced. Then the control unit of the treatment apparatus is adapted to control the steam generator to generate and supply steam while the blower is de-energized or operating with a reduced air amount conveying power at least partially during the initial phase of operating the heat pump system. In case of reduced air conveying, the hot steam is first provided to the evaporator to heat up the evaporator and the reduced air circulation speed causes that the heat exchange time (dwell time) between steam and evaporator is extended. In case of deenergizing the blower the steam can diffuse to the evaporator and deposit the heat energy there. In particular, when the evaporator is arranged at

an upper level within the body of the treatment apparatus, the hot steam will ascend and collect at the evaporator to heat it up. This chimney effect is improved when the laundry treatment apparatus is configured such that the evaporator is arranged above an inlet area or steam generation area for supplying the steam into the storing compartment and/or air circulation channel.

**[0036]** According to an embodiment the compressor is arranged in the air circulation channel, preferably downstream the evaporator. The terms 'downstream' and 'upstream' as well as 'forward air flow' and 'backward air flow' relate to the normal operation mode of the heat pump system and blower. In the normal operation mode the laundry treatment apparatus operates as a condenser dryer in which the humidity-laden air from the storing compartment is sucked into the air circulation channel at the first end of the channel by the operation of the blower and first contacts the evaporator in the air channel for condensing water there. Downstream the evaporator the condenser is arranged to heat up the air that has a reduced humidity after passing the evaporator. The condenser heats up the air before flowing the warm air into the storing compartment through the second end of the air circulation channel.

**[0037]** Reference is made in detail to preferred embodiments of the invention, examples of which are illustrated in the accompanying figures, which show:

- Fig. 1 a schematic illustration of a washing machine having dryer function using a heat pump system,
- Fig. 2A a schematic time diagram of the steam assisted initial phase of the heat pump system,
- Fig. 2B a schematic time diagram of a laundry steam treatment cycle followed by a drying cycle, and
- Fig. 3 a schematic diagram of another embodiment of the washing machine having the evaporator and condenser of a heat pump system arranged above the tub.

**[0038]** Fig. 1 is a schematic diagram of a washing machine 2 showing some of the elements relating to the heat pump system 10 used for the drying cycle. The invention can also be implemented in a condenser-type dryer having a heat pump system similar to the one shown with respect to Fig. 3.

**[0039]** The heat pump system 10 of the washing machine 2 shown in Fig. 1 has a compressor 12, an evaporator 14 and a condenser 16. Compressor 12, evaporator 14 and condenser 16 are connected via coolant liquid or coolant vapour guiding pipes as schematically shown by the respective lines. An expansion valve 18 or capillary is assigned to the evaporator 14. The terms evaporator and condenser are used here in relation to

the closed heat pump system 10 and the processes which the coolant liquid undergoes. The heat pump system 10, its pipes and electrical wiring, a tub 6 enclosing a rotatable drum (7 as shown in Fig. 3), a heater 8 and an air circulation channel 20 are all arranged within the case or body 4 of the washing machine 2.

**[0040]** The heater 8 is arranged at the bottom of the tub 6 in a sump. The heater 8 is used during washing cycles for heating the washing liquid. Further, heater 8 is used to generate steam 9 for steam treatment of the laundry stored in the drum 7 of the washing machine. Laundry steam treatment processes are for example refreshment processes, anti-wrinkle processes, washing process, sterilisation, deodorisation and so on. The steam which is indicated by the arrows 9 distributes around the drum 7 within the tub 6 and penetrates through openings provided in the periphery or sidewalls of the drum 7.

**[0041]** The evaporator 14 and the condenser 16 are arranged at least partially within air circulation channel 20 which has a first end connected to an inlet 22 of the tub 6 and a second end connected to an outlet 24 of the tub 6. The air circulation channel 20 and the tub 6 form a closed channel system for circulating the air, for example during steam laundry treatment cycles and drying cycles of the washing machine. At least the fan of a blower 26 is arranged within the air circulation channel 20 that forcibly circulates the air within the channel system, i.e. the air is blown from the air circulation channel 20 through inlet 22, through the tub 6 and out of the tub 6 through the outlet 24 back into the air circulation channel 20 at the second end thereof.

**[0042]** In the embodiment of Fig. 1 a fan 28 is assigned to the compressor 12 for cooling the compressor which is arranged outside of the air circulation channel system. Alternatively, the compressor 12 may be partially or completely arranged within the air channel 20, preferably in a channel section between the evaporator 14 and the compressor 12. Inlet 22 and/or outlet 24 can be connected to the wall of tub 6 or can be directly connected to the interior of drum 7, for example can be connected to a front or rear sidewall of the drum 7.

**[0043]** When the heat pump 10 has developed full or nearly full working efficiency after the start-up phase, the normal operation of the drying cycle is achieved in which the blower 26 circulates the air through the channel 20 and tub/drum 6/7. The circulated air is cooled at the evaporator 14 so that the humidity-laden air condenses water at the surfaces of the evaporator 14. The condensed water is collected and guided to a tank (not shown) where it can be removed by the user from time to time. Downstream the evaporator 14 the circulated air passes over the surfaces of the condenser 16 where it is heated by the heat of the condenser 16. The heated air with reduced humidity is blown into the tub/drum through inlet 22 where it then passes over the laundry in drum 7. The drum 7 is rotated so that during the drying cycle the laundry is agitated in tumbling mode. The heated air takes humidity

from the laundry and carries it out of the drum/tub through outlet 24 towards the evaporator 14 arranged within the air circulation channel 20.

**[0044]** As in prior art, when starting the heat pump system 10 under the control of a control unit of the washing machine 2 and when the evaporator 14 and compressor 12 have nearly the same temperature after an extended duration of non-operation of the heat pump system, the heat pump system 10 has an extended initial phase in which the operation efficiency is low. Mainly, the efficiency is low as there is no or little coolant liquid vapour within the evaporator 14 which has a low starting temperature. For accelerating the start-up or initial phase of the heat pump system 10, i.e. for shortening the time until full operation or efficient operation of the heat pump system 10, at least during a period during the initial phase of the heat pump system 10, the control unit controls heater 8 to heat water stored in the sump of tub 6 to generate steam. The steam 9 generated in the tub 6 also distributes into the drum 7 and can be sucked in through outlet 24 to the air circulation channel 20 to be flown over evaporator 14. Thus, the hot steam 9 generated in the tub 6 provides additional heat to heat up evaporator 14. An increase in the coolant liquid vapour pressure within the evaporator 14 is achieved much faster than without additional heat from the steam 9. Consequently the duration of the initial phase is shorter than without producing steam.

**[0045]** Fig. 2A schematically shows a drying cycle starting at time T1. The heat pump system undergoes a 'cold start', e.g. when condenser 16 and evaporator 14 have the same initial temperature. In case that the "cold" heat pump system 10 is started at time T1 and no steam is supplied for assisting heat-up, a critical level EC of efficient operation of the heat pump system is achieved at time T3. The dashed line E\* indicates the temporal development of the heat pump efficiency when conventionally using the heat pump system 10 without steam generation. The solid line E shows the time behaviour of the efficiency of the heat pump system when additionally generating steam by operating the heater 8 (or by supplying steam from steam generator 30 as shown in Fig. 3). In this steam assisted drying cycle, the steam generator using heater 8 or steam generator 30 is started at time T1, wherein S indicates the amount of steam provided by the steam generator (or the steam flow rate provided by the steam generator). The full steam amount generation rate is gradually achieved after starting the heater 8 as the little amount of water provided into the sump of the tub 6 has to be heated up before the full steam generation rate is achieved. At time T1' the heater 8 (or generator 30) is switched off or is operated with reduced power so that the amount of steam generated gradually decreases. At time T2 the steam amount S generated approaches zero. At this time T2 or about this time the critical efficiency level EC is reached (i.e. well away from T3) - much faster than when operating heat pump system 10 without steam generation.

**[0046]** The power supplied to heater 8 (or steam generator 30) is switched off or reduced when a temperature/pressure detected at the evaporator 14 reaches a pre-defined level which corresponds to a reference efficiency level Eref of the heat pump system 10. When stopping or reducing the power to the heater 8 (steam generator) at time T1' steam supply by residual heat capacity is sufficient to result in an increase of the temperature of the evaporator 14 to overcome the critical efficiency level EC of the heat pump system 10. The relation Eref/T1' and EC/T2 is known from empirical data of the respective washing machine 2 such that Eref or the temperature associated therewith is the trigger for energy stop or reduction at the steam generator 8/30. Thus Fig. 2A shows overlapping of steam supply and heat pump system operation in the initial phase of the heat pump system 10/10'.

**[0047]** Fig. 2B shows an example of the temporal behaviour and control when the drying cycle succeeds a steam treatment cycle. During the steam treatment cycle steam is supplied into the laundry storing compartment 6 for steam processing the laundry. Fig. 2B shows that the steam flow rate S is continuous and steam supply is switched off towards the end of the steam treatment cycle before time T7 such that steam flow rate S reduces to zero at T7. In other embodiments it can be provided that the steam supply is discontinuous, e.g. that the steam flow rate S is temporally increased and decreased or the steam is supplied periodically or intermittently.

**[0048]** The steam treatment cycle is started at time T5, i.e. prior to time T6 as shown. In another embodiment it can be provided that the steam treatment starts at time T6 or after T6 such that the steam treatment cycle fully overlaps with the initial phase (time period T6 to T7) of the heat pump system after starting the heat pump system 10 at time T6. Here the energy of the steam that is supplied for laundry steam processing is used at the same time for heating up the evaporator 14. In this case not only the time duration required for the drying cycle is reduced by the supply of steam energy, but additionally the time duration is reduced in that the initial phase or start up phase of the heat pump system is overlapping the steam treatment cycle. In effect, energy and time are saved by at least partially overlapping heat pump operation period and steam treatment cycle.

**[0049]** The processes of Fig. 2A and 2B are fully applicable for the washing machine 2' of Fig. 3 or a dryer having a heat pump system.

**[0050]** Fig. 3 shows a simplified illustration of a washing machine 2'. Elements with the same function as in Fig. 1 are assigned the same numerals expanded by an apostrophe '. Differences are explained in the following. From Fig. 3 it is easy to understand that the invention can be implemented in a dryer having a heat pump system for condensation drying: If for example the inlet 22' is arranged at the backside of the drum 7 which has openings at its backside, the outlet 24' is arranged at the front side or at a frame at the front side of the drum 7 and the

tub 6' is omitted, a fully operable condensation dryer is implemented having the air circulation channel 20' correspondingly arranged within the dryer case 4'.

**[0051]** Returning to the embodiment of a washing machine 2' in Fig. 3, the air circulation channel 20' is running from the connections 22', 24' at the tub 6' to the upper region of the washing machine 2' where the evaporator 14' and the condenser 16' are arranged above the tub 6'. The fan of the blower 26' is arranged in the channel 20' and conveys the air through the circulation path 20'/6'/7'. The arrow in the channel 20' indicates the normal operation flow direction of the air flow when the blower 26' is operated in forward or normal flow mode.

**[0052]** Different to Fig. 1, the steam is generated by a steam generator 30 that is arranged outside the tub 6' and outside the air channel 20', but inside the body 4' of the washing machine 2'. The steam supplied by steam generator 30 is guided through a duct 32 having an opening arranged at a frame next to a front loading opening of drum 7. Thus the steam can be directly exhausted into the drum. In another embodiment it can be provided that the opening of duct 32 is arranged at the wall of the tub 6' to exhaust steam into the interior of the tub, or at a wall of the channel 20' to exhaust steam into the interior or the channel, preferably in the section of the channel running directly between tub' or drum 7 and evaporator 14'.

**[0053]** When steam is supplied from the generator 30 during the initial or start-up phase of the heat pump system 10' - for example during processes as shown in Figs. 2A and 2B - the blower 26' can be switched off by the control unit of the washing machine 2' or can be operated with reduced power or can be intermittently be switched off. Thereby the conveyance capacity of the blower is zero or reduced, for example reduced by at least 50%, at least 60% or at least 80%, and the dwell time of the steam at the evaporator 14' is increased. More heat is transferred from the steam to the evaporator and less energy is transported to the condenser 16'.

**[0054]** In particular if the blower 26' is switched off, the hot steam or the hot air heated by the steam is ascending due to convection. As the arrangement and geometry of tub 6' (and/or drum 7), channel 20' and evaporator 14' is designed such that the ascending air or steam preferably reaches the evaporator, the evaporator is the element of the heat pump system that will be primarily heated up. Thus shortening of the initial phase of the heat pump system can be achieved easily.

#### Reference Numeral List:

##### [0055]

- 2 washing machine
- 4 case/body
- 6 tub

- 7 drum
- 8 heater
- 5 9 steam
- 10 heat pump system
- 12 compressor
- 10 14 evaporator
- 16 condenser
- 15 18 expansion valve
- 20 air circulation channel
- 22 inlet
- 20 24 outlet
- 26 blower
- 25 28 fan
- 30 steam generator
- 32 duct
- 30 E efficiency
- S steam flow rate/amount

#### Claims

1. Method of operating a laundry treatment apparatus (2), in particular a dryer, a washing machine having dryer function or a laundry treatment apparatus according to any of claims 9 to 15, the apparatus (2) comprising:

a storing compartment (6) for storing laundry therein, in particular a rotatable drum,  
 an air circulation channel (20) connected at a first end (22) and at a second end (24) to the storing compartment (6),  
 a blower (26) for blowing the air through the air circulation channel (20) and the storing compartment (6),  
 a heat pump system (10) having an evaporator (14) and a condenser (16) arranged in the air circulation channel (20), and  
 a steam generator (8, 30) arranged within the body (4) of the laundry treatment apparatus (2);

the method comprising the steps of:

- supplying steam generated by the steam generator (8, 30) into the air circulation channel (20) and/or the storing compartment (6), and at the same time at least for an overlapping period or a plurality of overlapping periods, operating the heat pump system (10).
2. The method of claim 1, wherein steam is generated by the steam generator (8, 30) during the initial phase of the operation of the heat pump system (10) to increase the working temperature of the evaporator (14).
  3. The method of claim 1 or 2, wherein steam is generated by the steam generator (8, 30) and supplied to the air circulation channel (20) and/or the storing compartment (6) for a predefined period after starting the operation of the heat pump system (10) and then the steam generation and supply is stopped.
  4. The method of claim 1, 2 or 3, wherein during an initial phase of operation of the heat pump system (10) steam is generated by the steam generator (8, 30) and supplied to the air circulation channel (20) and/or the storing compartment (6), and then the generation and supply of steam is stopped in dependency of one or more predefined parameters (E, T7) and/or when the heat pump system (10) has reached a predefined efficiency.
  5. The method of claim 4, wherein the dependency of the one or more parameters is the temporal behavior of one or more of the parameter(s), in particular the gradient or change of the parameter(s), more preferably a predefined change in one or more of the parameters since starting the operation of the heat pump system (10); and/or wherein the dependency of the one or more parameters is a difference of the one or more parameter(s) taken at a first position and taken at a second position within the air circulation channel (20) and/or the heat pump system (10), wherein in particular the parameter is one or more of: the air temperature, the air humidity, the working fluid temperature and the working fluid pressure.
  6. The method of any of the previous claims, wherein during steam generation the blower (26) is stopped, the blower is de-energized, at least temporally operated with a reduced air conveying speed or power, or the blower is at least temporally operated intermittently in forward flow and backflow direction.
  7. The method of any of the previous claims, wherein the steam (9) coming from the steam generator (8, 30) is first supplied into the storing compartment (7), in particular the steam coming from the steam generator is first supplied into a tub (6) surrounding the storing compartment (7).
  8. The method of any of the previous claims, wherein the amount and/or time and/or temperature of the steam supplied from the steam generator (8, 30) is dependent on:
    - a user selection input to a control unit of the laundry treatment apparatus (2),
    - the humidity of the laundry stored in the storing compartment (6), and/or
    - the amount of laundry stored in the storing compartment (6).
  9. Laundry treatment apparatus (2), in particular dryer or washing machine having dryer function, wherein the apparatus comprises:
    - a storing compartment (6) for storing laundry therein, in particular a rotatable drum (7),
    - an air circulation channel (20) connected at a first end (22) and at a second end (24) to the storing compartment (6),
    - a blower (26) for blowing the air through the air circulation channel (20) and the storing compartment (6), and
    - a heat pump system having an evaporator (14) arranged in the air circulation channel (20) and a condenser (14) arranged in the air circulation channel (20) downstream the evaporator (16),**characterized by**
    - a steam generator (8, 30) arranged within the body (4) of the laundry treatment apparatus (2), for supplying steam (9) into the storing compartment (6) and/or the air circulation channel (20).
  10. The apparatus of claim 9, wherein the air circulation channel (20) is not part of the steam supply path (32) and/or the steam supply path (32) is separate to air circulation channel (20), wherein in particular the steam supply path (32) is a steam supply duct connected to the storing compartment (6, 7) separately from the connections of the air circulation channel (20).
  11. The apparatus of claim 9 or 10, wherein the storing compartment, in particular a rotatable drum (7), is arranged in a tub (6) or container at least partially enclosing the storing compartment, wherein a heating element (8) is arranged in the lower region or sump of the tub (6) or container, and wherein a control unit of the washing machine (2) is configured to heat water stored in a lower region or a sump of the tub (6) or container by operating the heating element (8) as the steam generator to generate steam penetrating into the storing compartment (7).

12. The apparatus of claim 9 or 10, wherein the steam generator (30) is arranged outside the storing compartment (6) and the air circulation path (20) within the laundry treatment apparatus body (4) and a steam duct (32) is guiding the steam generated by the steam generator from the steam generator to the interior of the storing compartment (6), wherein an exit opening of the duct is fluidly connected to the storing compartment space or tub space, wherein in particular the exit opening is arranged at a wall of the storing compartment space or tub space.
13. The apparatus of any of the previous claims 9 to 12, wherein a control unit of the laundry treatment apparatus (2) is adapted to operate the heat pump system (10) and the steam generator (8, 30) at the same time at least for an overlapping period, preferably during the initial phase of the operation of the heat pump system to increase the working temperature of the evaporator (14).
14. The apparatus of any of the previous claims 9 to 13, wherein the blower (26) has an operation mode in which a reduced or a zero air amount is conveyed by the blower, wherein in particular a control unit of the laundry treatment apparatus (2) is adapted to stop the blower during the initial phase of operation of the heat pump system (10) or to control the blower to convey a reduced air amount through the air circulation channel (20) during the initial phase of operation of the heat pump system (10).
15. The method according to any of claims 1 to 8 or the apparatus according to any of claims 9 to 14, wherein the laundry treatment apparatus is a washing machine (2) having drying function and/or wherein the storing compartment (6) is a rotatable drum (7), in particular a drum arranged within a tub.

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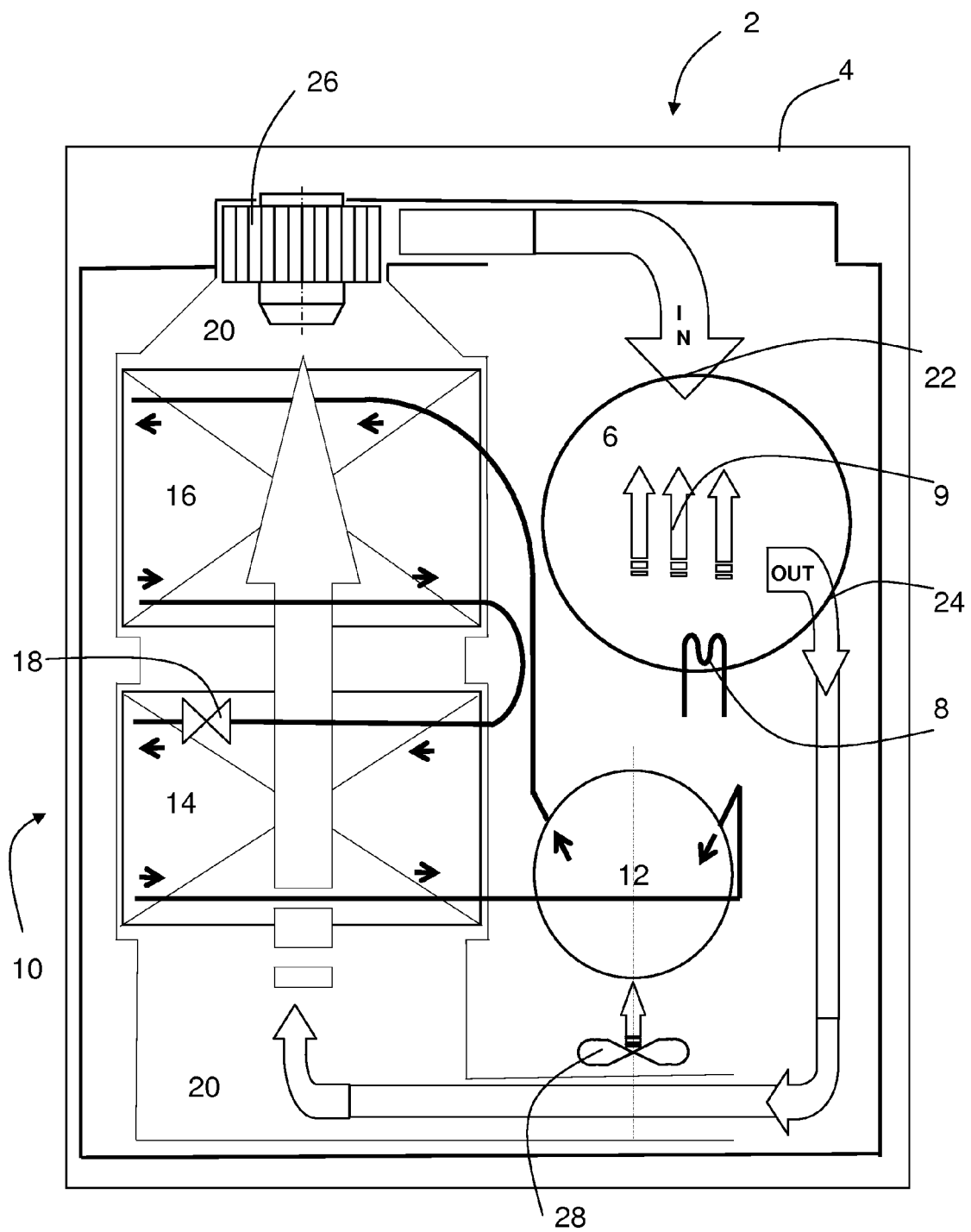


Fig. 1

Fig. 2A

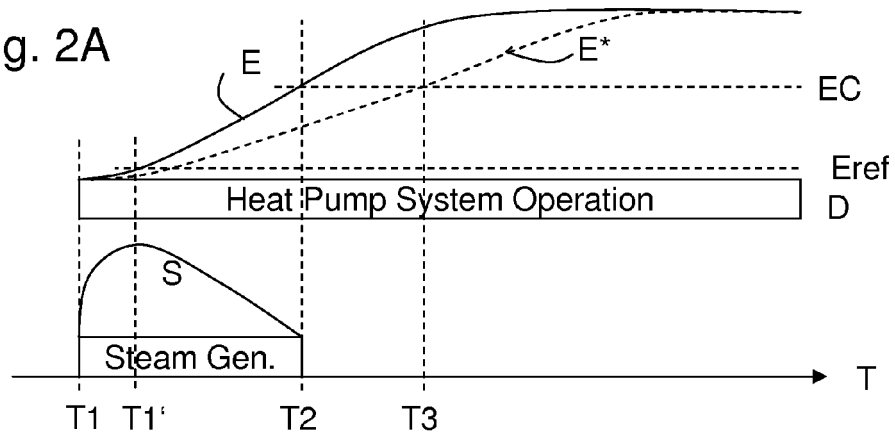


Fig. 2B

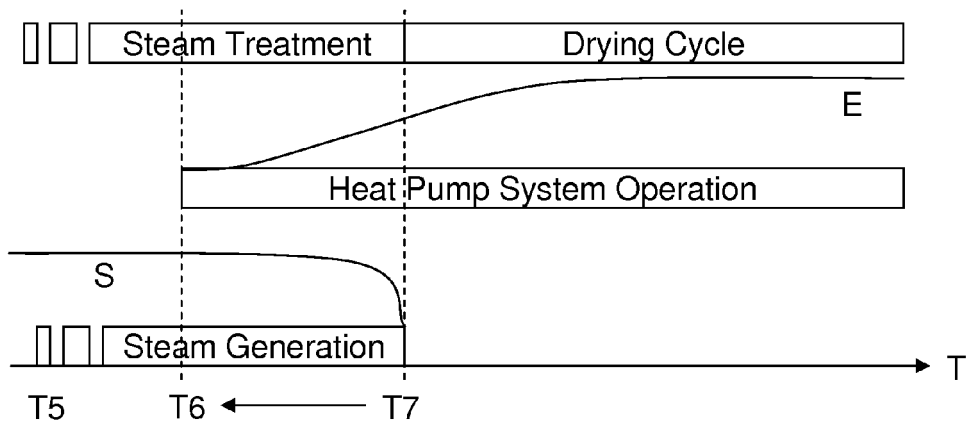
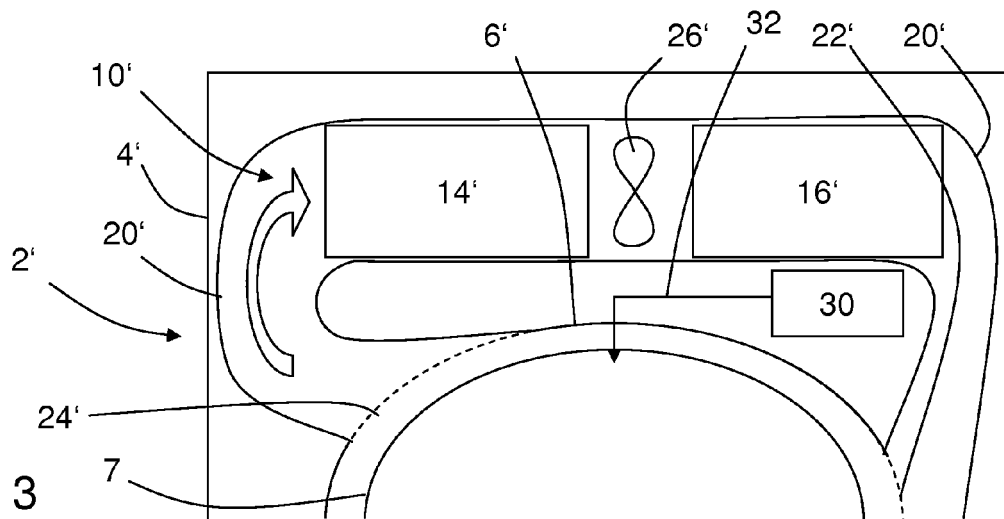


Fig. 3





## EUROPEAN SEARCH REPORT

Application Number  
EP 10 16 3744

| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | DE 10 2006 003552 A1 (CURTIUS FRITZ [DE])<br>3 May 2007 (2007-05-03)<br>* paragraphs [00121] - [00128] *<br>-----                          | 1,9                              | INV.<br>D06F58/20<br>D06F39/00<br>D06F33/02 |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | EP 1 961 857 A1 (ELECTROLUX HOME PROD CORP [BE]) 27 August 2008 (2008-08-27)<br>* paragraphs [0009] - [0017]; claim 1; figure 1 *<br>----- | 1,9                              |                                             |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | DE 10 2005 041145 A1 (ALPHA INNOTECH GMBH [DE]) 1 March 2007 (2007-03-01)<br>* the whole document *<br>-----                               | 1-15                             |                                             |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | EP 1 650 343 A1 (SANYO ELECTRIC CO [JP])<br>26 April 2006 (2006-04-26)<br>* the whole document *<br>-----                                  | 1-15                             |                                             |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                            |                                  | TECHNICAL FIELDS SEARCHED (IPC)             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                            |                                  | D06F                                        |
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                            | Date of completion of the search | Examiner                                    |
| Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                            | 12 November 2010                 | Stroppa, Giovanni                           |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/> Y : particularly relevant if combined with another document of the same category<br/> A : technological background<br/> O : non-written disclosure<br/> P : intermediate document</p> <p>T : theory or principle underlying the invention<br/> E : earlier patent document, but published on, or after the filing date<br/> D : document cited in the application<br/> L : document cited for other reasons<br/> .....<br/> &amp; : member of the same patent family, corresponding document</p> |                                                                                                                                            |                                  |                                             |

1  
EPO FORM 1503 03 82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 16 3744

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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12-11-2010

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| DE 102006003552 A1                        | 03-05-2007          | NONE                       |                     |
| -----                                     |                     |                            |                     |
| EP 1961857 A1                             | 27-08-2008          | AT 472005 T                | 15-07-2010          |
|                                           |                     | CN 101617078 A             | 30-12-2009          |
|                                           |                     | WO 2008101623 A1           | 28-08-2008          |
|                                           |                     | US 2010043245 A1           | 25-02-2010          |
| -----                                     |                     |                            |                     |
| DE 102005041145 A1                        | 01-03-2007          | NONE                       |                     |
| -----                                     |                     |                            |                     |
| EP 1650343 A1                             | 26-04-2006          | CN 1763294 A               | 26-04-2006          |
|                                           |                     | JP 4326445 B2              | 09-09-2009          |
|                                           |                     | JP 2006116004 A            | 11-05-2006          |
|                                           |                     | US 2006080974 A1           | 20-04-2006          |
| -----                                     |                     |                            |                     |

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- DE 3113471 A1 [0003]
- EP 1650343 A1 [0004]
- EP 0999302 B1 [0005]
- EP 1983094 A1 [0006]
- WO 2007023510 A1 [0007]
- DE 102005041145 A1 [0008]