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(54) **Heat pump laundry treatment apparatus and method of operating a heat pump laundry treatment apparatus**

(57) The invention relates to a heat pump laundry treatment apparatus, in particular a heat pump laundry dryer (2) or a heat pump washing machine having drying function, and to a method of operating such a heat pump laundry treatment apparatus. The laundry treatment apparatus (2) comprises a control unit (51) controlling the operation of the laundry treatment apparatus (2), a laundry treatment chamber (18) for treating laundry (19) using process air (A), a process air circuit (20, 20a - 20d) for circulating the process air (A), a heat pump system (4) having a refrigerant loop (6), in which the refrigerant fluid is circulated through a first and a second heat exchanger (10, 12), a compressor (14) for circulating the refrigerant fluid through the refrigerant loop (6), and a cooling fan unit (53) for cooling the compressor (14). During the operation the conveyance capacity of the cooling fan unit (53) is varied. The method comprises monitoring the conveyance capacity of the cooling fan unit (53), and if the monitored conveyance capacity is equal to or below a minimum conveyance capacity value, increasing the conveyance capacity.

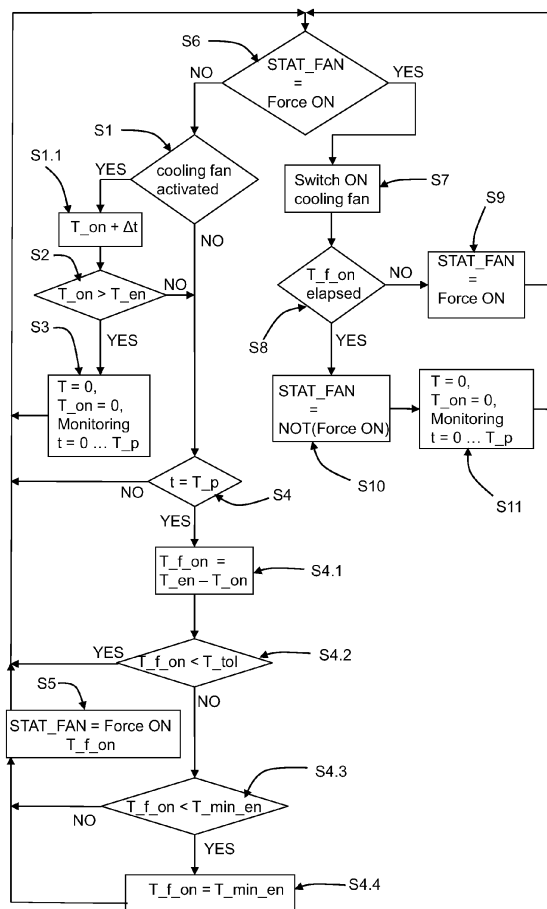


Fig. 2

Description

[0001] The invention relates to a heat pump laundry treatment apparatus, in particular a heat pump dryer or a heat pump washing machine having a dryer function, comprising a heat pump system and a cooling fan unit for cooling a compressor of the heat pump system. Furthermore, the invention relates to a method of operating such a heat pump laundry treatment apparatus.

[0002] EP 2 212 463 B1 discloses a heat pump laundry dryer comprising an open loop cooling channel for cooling the compressor of the heat pump system. The open loop cooling channel contains a blower to be activated and controlled by a control unit according to the signals of a temperature sensor. This temperature sensor is disposed adjacent to the condenser section of the heat pump system's refrigerant loop.

[0003] It is an object of the invention to provide a heat pump laundry treatment apparatus and a method of operating a heat pump laundry treatment apparatus in such a manner that its cooling fan unit offers an efficient cooling function.

[0004] The invention is defined in independent claim 1 and in independent claim 15. Particular embodiments are set out in the dependent claims.

[0005] According to the invention, a heat pump laundry treatment apparatus comprises a control unit controlling the operation of the heat pump laundry treatment apparatus. The heat pump laundry treatment apparatus - in the following description denoted in brief "apparatus" - is in particular configured as a heat pump laundry dryer or a heat pump washing machine having a drying function.

[0006] Furthermore, the apparatus comprises a laundry treatment chamber for treating laundry using process air. The process air is circulated in a process air circuit arranged within the housing of the apparatus. The apparatus also comprises a heat pump system having a refrigerant loop, in which the refrigerant fluid is circulated through a first heat exchanger and a second heat exchanger. A compressor circulates the refrigerant fluid through the refrigerant loop and a cooling fan unit is arranged for cooling the compressor.

[0007] The control unit is adapted to control the operation of the apparatus, wherein the operation comprises at least the following method features:

- during the operation the conveyance capacity of the cooling fan unit is varied,
- monitoring the conveyance capacity of the cooling fan unit, and
- if the monitored conveyance capacity is equal to or below a minimum conveyance capacity value, increasing the conveyance capacity.

[0008] Preferably, this operation control of the cooling fan unit is prioritized in comparison to its general or basic control by the control unit. Thus, a minimum cooling fan activation time (and consequently a minimum convey-

ance capacity) is ensured independent from specific apparatus and/or ambient conditions.

[0009] This ensured minimum cooling capacity is advantageously used for ensuring a sufficient cooling of power units (and/or at least electronic parts, e.g. an electronic inverter, of these power units) in electrical/electronic communication with the compressor even when cooling of the compressor is not intended or required according to some specific operation modes of the apparatus. Usually, cooling of the compressor power units, particularly of their inverter, occurs automatically by the cooling flow of the cooling fan unit which is generated for cooling the compressor according to the specific cooling requests in several operation modes. However, in some operation modes it is not necessary to cool the compressor (for example in a warm-up phase of the heat pump system) and consequently also the power units and particularly their inverter are not cooled. However, a cooling of the power units / inverter could be desired even if the compressor is not cooled. To realize such a desired cooling of the power units / inverter, the cooling fan unit is activated in such a manner that at least the above mentioned minimum cooling capacity is ensured.

[0010] Monitoring the conveyance capacity (which can also be denoted as cooling capacity) has the advantage that operating the control of the cooling fan unit is possible in a cost-saving manner without an additional temperature sensor adapted to provide a temperature signal to the control unit. For example no temperature sensor assigned to the power units and/or converter of the compressor or drum drive/process air blower motor is required. Additionally, incorrect controlling of the cooling fan unit due to malfunction of a temperature sensor is avoided certainly.

[0011] Preferably, there is arranged at least one air inlet and at least one air outlet within the apparatus cabinet. Thus, the cooling fan unit is able to convey air from said air inlet(s) through the apparatus cabinet over the compressor to be cooled and through said outlet(s) out of the apparatus cabinet. This conveyance can be achieved e.g. by sucking at least a portion of the conveyed cooling air through said air inlet(s) and by exhausting at least a portion of the conveyed cooling air through said air outlet(s).

[0012] In particular, the air conveyance occurs within the cabinet without any specific air channel such that the conveyed cooling air can at least partially freely circulate within the cabinet. Thus, air circulation removes heat and/or humidity from the cabinet and prevents potential overheating of electronic parts (e.g. an electronic board, control unit etc.). Furthermore, potential condensate on electronic parts, electric parts, display glass and/or their potential malfunction due to humidity is prevented.

[0013] In an embodiment, the cooling fan unit comprises at least one blower and at least one motor for driving the blower. Thus, the cooling fan unit can be configured cost-saving by standard parts.

[0014] Preferably, the conveyance capacity is moni-

tored in real-time. This can be done continuously or repeatedly. The operation of monitoring the conveyance capacity can be performed in an indirect way or in a direct way, in the latter case, for example, by a flow rate sensor and/or measuring device.

[0015] In a preferred embodiment, the control unit comprises a counter for counting the activation or ON-times of the cooling fan unit. For this purpose a count value is used. Thus, monitoring of the conveyance capacity can be easily implemented by monitoring (and comparing) said count value over a predefined time period. Particularly, the count value is compared with a predefined minimum count value which corresponds to the minimum conveyance capacity value.

[0016] In an embodiment, the conveyance capacity of the cooling fan unit is defined or represented by

- a duty cycle ratio of switching the cooling fan unit ON and OFF, and/or
- the conveyance rate of the cooling fan unit.

[0017] The duty cycle ratio can be represented e.g. by the ratio of two sums, wherein one sum is the sum of the total ON-times (i.e. activation of the cooling fan unit) and the other sum is the sum of the total OFF-times (i.e. cooling fan unit is switched OFF) within a predefined time period. In this connection, it is not necessary to calculate the sum of OFF-times separately. Rather, the sum of OFF-times can be automatically determined by the sum of ON-times and the predefined time period.

[0018] The conveyance rate is preferably determined by the flow rate of the blowing cooling air generated by the cooling fan unit. In an embodiment, the conveyance capacity or the conveyance rate is modified (i.e. particularly increased) by a fan speed and/or a motor speed of the cooling fan unit. Thus the conveyance rate depends on the fan and/or motor speed which in turn may be controlled (monitored) by the power, voltage and/or current supplied to the fan motor.

[0019] In a further embodiment, the conveyance capacity is monitored over a predefined time period and the conveyance capacity to be compared with the minimum conveyance capacity value is represented by the average of the conveyance capacity over the predefined time period.

[0020] Preferably, the minimum conveyance capacity value is determined depending on one or more input variables and/or at least one environment parameter of the apparatus environment. The input variables are particularly represented by

- a previous operation time of the apparatus,
- a user selectable input variable,
- a working parameter of the laundry drum,
- a working parameter of a process air fan,
- a working parameter of an electric driving motor,
- a working parameter of the heat pump system,
- a working parameter of the compressor,

- power supply supplied to the apparatus
- a drying progress status parameter or a status parameter of the laundry to be treated.

[0021] If preferred, the minimum conveyance capacity value may be determined depending on signals provided by a flow rate sensor and/or measuring device. For example, such sensor and/or measuring device may be arranged in proximity of the air inlet from which the cooling fan unit is able to take air from outside the apparatus.

[0022] A previous operation time of the apparatus is a useful input variable since a long operation time causes increasing waste heat from the components within the apparatus cabinet and consequently the minimum conveyance capacity value can be adapted reasonably to the expected waste heat volume.

[0023] A user selectable input variable means a variable selected by the user of the apparatus. This variable is preferably dependent on at least one of the following features: a selected cycle or program, a selected cycle option (ECO, NIGHT, FAST), desired final humidity, laundry amount, laundry type.

[0024] The working parameter of the laundry drum is preferably represented by the motor power or motor speed of the drum motor.

[0025] The working parameter of the process air fan is constituted particularly by a fan speed or fan flow rate.

[0026] The working parameter of the electric driving motor is e.g. the machine power supply (particularly voltage and/or current) or a motor speed.

[0027] The electric driving motor itself is represented e.g. by a laundry drum motor, a blower motor and/or a compressor motor.

[0028] The working parameter of the compressor is constituted e.g. by its compressor power, a compressor speed and/or a status of the compressor motor.

[0029] Another input variable is represented by the power supply (particularly voltage and/or current) supplied to the apparatus.

[0030] The working parameter of the heat pump system may include the temperature and/or pressure of the coolant circulating in the pump system in any section thereof.

[0031] The drying progress status parameter or a status parameter of the laundry to be treated may be constituted, for example, by sensed/estimated laundry humidity, sensed/estimated laundry amount, or sensed/estimated laundry type.

[0032] The environment parameter of the apparatus environment may be, for example, the temperature ambient where the laundry treatment apparatus is placed, or alarms generated by machine control units.

[0033] In an embodiment, the conveyance capacity of the cooling fan unit is controlled to be increased by an amount which is the difference between the predefined minimum conveyance capacity value and the detected conveyance capacity. In this connection, the detected conveyance capacity is the conveyance capacity detect-

ed during monitoring.

[0034] Preferably, the monitoring occurs during a predefined time period. In this regard, the minimum conveyance capacity is defined as a minimum value for the predefined time period, wherein a monitored conveyance capacity is the integral of the conveyance capacity of the cooling fan unit over the predefined time period of monitoring. In order to provide the desired minimum conveyance capacity by a simple control logic it is preferred to compare the monitored conveyance capacity with the minimum value and, if the monitored conveyance capacity is lower than the minimum value, operating the cooling fan unit for a time period such that the integral of the conveyance rate over this time period is the difference between the minimum value and the monitored conveyance capacity.

[0035] Preferably, controlling of the cooling fan unit occurs by a simple control logic on the base of time values. For this purpose, the minimum conveyance capacity value is defined as a minimum operation time of the cooling fan unit over a predefined time period and the monitored conveyance capacity is the actual operation time of the cooling fan unit within the predefined time period of monitoring. In this regard, the actual operation time is compared with the minimum operation time. If the actual operation time is lower than the minimum operation time, then the cooling fan unit is operated (i.e. forced ON) for an operation time which is the difference between the minimum operation time and the actual operation time.

[0036] In a further embodiment, the control logic or the operation of the cooling fan unit works in such a manner that if the difference between the minimum conveyance capacity value and the monitored conveyance capacity is lower than a predefined tolerance deficit capacity, then the conveyance capacity is not increased. In other words, the basic operation of the cooling fan unit is not changed if the cooling deficit (i.e. of ventilating or conveying air in the apparatus cabinet) is below a tolerable value. This operation control of the cooling fan unit prevents repeated and inefficient short-time starting and stopping of the cooling fan unit. Thus, the predefined tolerance deficit capacity contributes to an energy-saving operation mode of the cooling fan unit.

[0037] Particularly, the predefined tolerance deficit capacity is constituted by a predefined tolerance deficit time period. In this regard, a time difference is calculated between the minimum operation time and the actual operation time of the cooling fan unit and, if this time difference is lower than the predefined tolerance deficit time period, then the cooling fan unit is not operated additionally.

[0038] Usually, the cooling capacity of the cooling fan unit can be varied during operation of the apparatus. Preferably, this variation occurs in dependency of at least one input variable and/or at least one environment parameter of the apparatus environment. The input variables are particularly represented by

- a previous operation time of the apparatus,

- a user selectable input variable,
- a working parameter of the laundry drum,
- a working parameter of a process air fan,
- a working parameter of an electric driving motor,
- a working parameter of the heat pump system,
- a working parameter of the compressor,
- power supply supplied to the apparatus,
- a drying progress status parameter or a status parameter of the laundry to be treated.

[0039] Preferred examples of useful input variables are explained in the above description with regard to determination of the minimum conveyance capacity value. These examples are also valid with regard to the variation of the cooling capacity during operation of the apparatus. Only for avoidance of unnecessary reiterations, they are not mentioned again.

[0040] Using the at least partly the same input variables and/or environment parameter for varying the cooling capacity on the one side and for determining the minimum conveyance capacity value keeps the hardware and software of the control components simple, space-saving and cost-saving.

[0041] Usually, a basic control of the cooling fan unit occurs during operation of the apparatus. This basic control is preferably made by considering said at least one input variable and/or environment parameter for variation of the cooling capacity in dependency of them. An additional operation or activation of the cooling fan unit can be necessary or forced by considering the minimum conveyance capacity value (forced control of the cooling fan unit). The control logic is such that this forced control is prioritized over the basic control.

[0042] In an embodiment, the signals of a temperature sensor are considered for operating or controlling the cooling fan unit during operation of the apparatus. Preferably, the temperature sensor detects a temperature of the heat pump system, particularly of the refrigerant fluid. Regarding the detected temperature, the cooling fan unit is activated when a predetermined maximum temperature is detected and the cooling fan unit is deactivated when a predetermined minimum temperature is detected.

[0043] Specifically, the fluid temperature is detected at the outlet of the condenser and/or at the outlet of the compressor. A temperature detection at the outlet of the compressor is applied preferably, since this detection is more precise and faster than at the outlet of the condenser.

[0044] Regarding the refrigerant fluid, this can be configured as a refrigerant gas or a refrigerant fluid.

[0045] 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 view of a laundry treatment apparatus, and

Fig. 2 a flow diagram showing one embodiment of the functioning of the cooling fan unit.

[0046] Fig. 1 shows a schematically depicted laundry treatment apparatus 2 which in this embodiment is a heat pump tumble dryer. The tumble dryer 2 comprises a heat pump system 4, including a closed refrigerant loop 6 which comprises in the following order of refrigerant flow B: a first heat exchanger 10 acting as evaporator for evaporating the refrigerant and cooling process air, a compressor 14, a second heat exchanger 12 acting as condenser for cooling the refrigerant and heating the process air, and an expansion device 16 from where the refrigerant is returned to the first heat exchanger 10. Together with the refrigerant pipes connecting the components of the heat pump system 4 in series, the heat pump system forms the refrigerant loop 6 through which the refrigerant is circulated by the compressor 14 as indicated by arrow B.

[0047] The process air flow within the treatment apparatus 2 is guided through a compartment 18 of the home appliance 2, i.e. through a compartment for receiving articles to be treated, e.g. a drum 18. The articles to be treated are textiles, laundry 19, clothes, shoes or the like. The process air flow is indicated by arrows A in Fig. 1 and is driven by a process air blower 8. The process air channel 20 guides the process air flow A outside the drum 18 and includes different sections, including the section forming the battery channel 20a in which the first and second heat exchangers 10, 12 are arranged. The process air exiting the second heat exchanger 12 flows into a rear channel 20b in which the process air blower 8 is arranged. The air conveyed by blower 8 is guided upward in a rising channel 20c to the backside of the drum 18. The air exiting the drum 18 through the drum outlet (which is the loading opening of the drum) is filtered by a fluff filter 22 arranged close to the drum outlet in or at the channel 20. The optional fluff filter 22 is arranged in a front channel 20d forming another section of channel 20 which is arranged behind and adjacent the front cover of the dryer 2. The condensate formed at the first heat exchanger 10 is collected and guided to the condensate collector 30.

[0048] The condensate collector 30 is connected via a drain pipe 46, a drain pump 36 and a drawer pipe 50 to an extractable condensate drawer 40. I.e. the collected condensate can be pumped from the collector 30 to the drawer 40 which is arranged at an upper portion of the apparatus 2 from where it can be comfortably withdrawn and emptied by a user.

[0049] The cooling fan unit 53 comprises a blower 54 and a motor 56 for activating the blower 54. The cooling fan unit 53 is arranged for cooling the compressor 14 and for cooling its power unit 52 and/or parts of this power unit 52, particularly an electronic inverter as part of the power unit 52. Usually, cooling of the power unit 52, particularly of its inverter, occurs automatically by the cooling flow 58 which is generated for cooling the compressor

14 according to the specific cooling requests in several operation modes. However, in some operation modes it is not necessary to cool the compressor 14 and consequently also the power unit 52 and particularly its inverter are not cooled. However, a cooling of the power unit 52/inverter could be desired even if the compressor 14 is not cooled. For implementing under the control of a control unit 51, such a desired cooling of the power unit 52/inverter, the cooling fan unit 53 is activated in such a manner that at least a minimum conveyance capacity of the cooling fan unit 53 is ensured.

[0050] Preferably the control unit 51 is at the same time the control unit for controlling and monitoring the overall operation of the apparatus 2. For example and as shown in Fig. 1, the control unit 51 receives a temperature signal from a temperature sensor 41 which is arranged at the outlet of the second heat exchanger 12 (condenser) and which is indicative of the refrigerant temperature at that position.

[0051] In normal operation the cooling fan unit 51 is operated or activated by the control unit 51 in response to the temperature signal received from the temperature sensor 41. When the cooling fan unit 51 is activated, which means that cooling air C is blown by the blower 54 towards the compressor 52 and is thus circulated also in the cabinet of the apparatus 2, the status of the fan unit 53 is set to STAT_FAN = "Force ON". The control procedure implemented by the control unit 51 and as described below is activating the fan unit 53 in (extended) periods in which the fan unit 53 is not activated or is not sufficiently enough activated alone due to cooling needs indicated by the temperature from sensor 41. This additional cooling as described below can be named 'prioritized cooling' being prioritized over the cooling requirement of the compressor (via sensor 41 signal). On the other hand, if the signal from temperature sensor 41 indicates cooling need for the compressor (which may depend additionally on other parameters than the temperature signal alone), the activation of fan unit 53 is preferably prioritized over the activation by the requirement for cooling the other components in the apparatus cabinet (e.g. the power unit 52) by the below described procedure. Thus a minimum cooling is guaranteed, whether the compressor or the other components need to be cooled by the blower activation.

[0052] The functioning of the cooling fan unit 53 will be explained by the flow diagram according to Fig. 2. Under a basic control mode, it is continuously checked, if the cooling fan unit 53 is activated (e.g. activated by temperature control) (step S1) to convey the cooling flow 58. The result of this checking (monitoring) is stored by the control unit 51, i.e. it is stored how much time Δt the cooling fan unit 53 is "ON". This corresponds to step S1.1 in the flow diagram, i.e. a cooling fan On time T_{on} is increased by the monitored ON-time unit Δt . In a following step S2 it is compared, if the cooling fan On time value T_{on} is more than a predefined ensured time (or denotable also as a minimum operation time) value T_{en} . If

this condition is fulfilled, a monitoring during a predefined monitoring period time T_p is restarted by resetting the time line $t = 0$ (step S3). This means that again it is monitored and stored how much time the cooling fan unit 53 is "ON". This monitoring occurs at the maximum within the predefined time frame from $t = 0$ to $t = T_p$. For this purpose, the cooling fan On time T_{on} is also reset in step S3 to $T_{on} = 0$.

[0053] If in step S2 the value of the time value T_{on} is equal to the predefined ensured time value T_{en} or even smaller than the ensured time value T_{en} , then it is verified if the monitoring period time T_p is elapsed (step S4). In other words, if at the end of the monitoring period time T_p the value of the time T_{on} is not higher than the defined ensured time value T_{en} , a status of the cooling fan unit 53, namely $STAT_FAN$, is set to "Force ON" (step S5) thus enabling a prioritized control of the cooling fan unit 53. The length of time in which the status $STAT_FAN$ is set to "Force ON" is defined by a forced On time value T_{f_on} . This value T_{f_on} is equal to the difference between the ensured time value T_{en} and the monitored cooling fan On time value T_{on} (step S4.1). In order to avoid that the cooling fan unit 53 has the status "Force ON" for an irrelevant time length there exist two verification steps S4.2 and S4.3.

[0054] In step S4.2 it is verified if the calculated forced On time value T_{f_on} is lower than a predefined tolerance deficit time value T_{tol} . If the forced On time value T_{f_on} is lower than the predefined tolerance deficit time, the cooling fan unit 53 will not be activated by the status "Force ON". Thus, repeated and inefficient short-time start and stop operations of the cooling fan unit 53 are avoided.

[0055] The predefined tolerance deficit time value T_{tol} in step S4.2 is lower than a predefined minimum ensured time value T_{min_en} in step S4.3. At step S4.3, it is verified if the calculated value T_{f_on} is higher or at least equal to the predefined minimum ensured time value T_{min_en} . If this condition is fulfilled, the cooling fan unit 53 will be "forced ON" or activated by the status "Force ON" for a time length equal to the origin calculated forced ON time value T_{f_on} . If the origin calculated value T_{f_on} is less than the predefined minimum ensured time value T_{min_en} , the cooling fan unit 53 will be "forced ON" or activated by the status "Force ON" for a time length equal to the minimum ensured time value T_{min_en} (step S4.4).

[0056] Provided that the status of the cooling fan unit 53 is detected $STAT_FAN = \text{"Force ON"}$ (step S6), the prioritized control causes that the cooling fan unit 53 is activated or "switched ON" (step S7). After this activation, it is verified if the determined forced On time value T_{f_on} is elapsed (step S8). If not, the status $STAT_FAN$ remains "Force ON" (step S9). If the determined forced On time value T_{f_on} is elapsed, the status $STAT_FAN$ is disabled, i.e. the status $STAT_FAN$ is set to NOT ("Force ON") (step 10). This disabled status causes a restart of monitoring during the predefined monitoring period time

T_p (step S11) and under the basic control according to step S1. This is the same procedure as in step S3, i.e. a restart of the monitoring period by resetting the time line $t = 0$. This means that again it is monitored and stored how much time the cooling fan unit 53 is "ON". This monitoring occurs at the maximum within the predefined time frame from $t = 0$ to $t = T_p$. For this purpose, the cooling fan On time T_{on} is also reset to $T_{on} = 0$ in step S11.

10 Reference Numeral List

[0057]

2	tumble dryer
4	heat pump system
6	refrigerant loop
8	blower
10	first heat exchanger
12	second heat exchanger
14	compressor
16	expansion device
18	drum
19	laundry
20	process air channel
20a	battery channel
20b	rear channel
20c	rising channel
20d	front channel
22	filter element
30	condensate collector
36	drain pump
40	condensate container
41	temperature sensor
46	drain pipe
50	drawer pipe
51	control unit
52	power unit
53	cooling fan unit
54	blower
56	motor
A	process air flow
B	refrigerant flow
C	cooling air flow
45	$STAT_FAN$ status of cooling fan unit
S1-S11	control steps
t	time line
Δt	time unit
T_{en}	ensured time
50	T_{f_on} cooling fan forced ON time
T_{min_en}	minimum ensured time
T_{on}	cooling fan ON time
T_p	monitoring period time
55	T_{tol} tolerable deficit time

Claims

1. Method of operating a heat pump laundry treatment apparatus, in particular a heat pump laundry dryer (2) or a heat pump washing machine having drying function, wherein the laundry treatment apparatus comprises:

a control unit (51) controlling the operation of the laundry treatment apparatus (2),
 a laundry treatment chamber (18) for treating laundry (19) using process air (A),
 a process air circuit (20, 20a - 20d) for circulating the process air (A),
 a heat pump system (4) having a refrigerant loop (6), in which the refrigerant fluid is circulated through a first and a second heat exchanger (10, 12),
 a compressor (14) for circulating the refrigerant fluid through the refrigerant loop (6), and
 a cooling fan unit (53) for cooling the compressor (14), wherein during the operation the conveyance capacity of the cooling fan unit (53) is varied, and

wherein the method comprises:

monitoring the conveyance capacity (T_{on}) of the cooling fan unit (53), and
 if the monitored conveyance capacity (T_{on}) is equal to or below a minimum conveyance capacity value (T_{en}), increasing the conveyance capacity (T_{f_on}).

2. Method according to claim 1, wherein the cooling fan unit (53) comprises at least one blower (54) and at least one motor (56) for driving the blower (54).
3. Method according to claim 1 or 2, wherein monitoring the conveyance capacity (T_{on}) is executed in real-time (T_p), continuously or repeatedly.
4. Method according to any of the preceding claims, wherein the control unit (51) comprises a counter for counting the activation or ON-times of the cooling fan unit (53) using a count value (T_{on}) and wherein the monitoring of the conveyance capacity is implemented by comparing the count value (T_{on}) over a predefined time period (T_p), wherein a minimum count value (T_{en}) is the minimum conveyance capacity value.
5. Method according to any of the preceding claims, wherein the conveyance capacity of the cooling fan unit (53) is defined by one or more of the following parameters:

- a duty cycle ratio of switching the cooling fan

unit ON (T_{on}) and OFF, and

- the conveyance rate (58) of the cooling fan unit (53).

6. Method according to claim 5, wherein the conveyance rate (58) of the cooling fan unit (53) is modified by modifying a fan speed or motor speed of the cooling fan unit (53).
7. Method according to any of the preceding claims, wherein the conveyance capacity is monitored over a predefined time period (T_p) and the conveyance capacity is the average of the conveyance capacity over the predefined time period (T_p).
8. Method according to any of the preceding claims, wherein the minimum conveyance capacity value (T_{en}) is depending on one or more of the following input variables:
- a previous operation time of the laundry treatment apparatus (2),
 a user selectable input variable,
 a working parameter of the laundry drum (18),
 a working parameter of a process air fan (8),
 a working parameter of an electric driving motor,
 a working parameter of the heat pump system (4),
 a working parameter of the compressor (14),
 power supply supplied to the apparatus,
 a drying progress status parameter or a status parameter of the laundry (19) to be treated, and
 an environment parameter of the laundry treatment apparatus environment.

9. Method according to any of the preceding claims, wherein the conveyance capacity is increased by an amount of conveyance capacity (T_{f_on}) which is the difference between the minimum conveyance capacity value (T_{en}) and the detected conveyance capacity (T_{on}), wherein the detected conveyance capacity (T_{on}) is the conveyance capacity (T_{on}) detected during monitoring (T_p).
10. Method according to any of the preceding claims, wherein the minimum conveyance capacity is defined as a minimum value (T_{en}) for a given predefined period (T_p), wherein a monitored conveyance capacity (T_{on}) is the integral of the conveyance capacity of the cooling fan unit (53) over the predefined period of monitoring (T_p), and wherein the method further comprises: if the monitored conveyance capacity (T_{on}) is lower than the minimum value (T_{en}), operating the cooling fan unit (53) for a time period (T_{f_on}) such that the integral of the conveyance rate over this time period (T_{f_on}) is the difference between the minimum value (T_{en})

and the monitored conveyance capacity (T_{on}).

11. Method according to any of the preceding claims, wherein the minimum conveyance capacity value is a minimum operation time (T_{en}) of the cooling fan unit (53) over a predefined period (T_p), wherein a monitored conveyance capacity is the actual operation time (T_{on}) of the cooling fan unit (53) within the predefined period of monitoring (T_p), and wherein the method further comprises: if the actual operation time (T_{on}) is lower than the minimum operation time (T_{en}), operating the cooling fan unit (53) for an operation time ($T_{f_{on}}$) which is the difference between the minimum operation time (T_{en}) and the actual operation time (T_{on}). 5
12. Method according to any of the preceding claims, wherein, if the difference between the minimum value (T_{en}) and the monitored conveyance capacity (T_{on}) is lower than a predefined tolerance deficit capacity (T_{tol}), the conveyance capacity is not increased, or wherein, if the time difference between the minimum operation time (T_{en}) and the actual operation time (T_{on}) is lower than a predefined tolerance deficit time period (T_{tol}), the cooling fan unit (53) is not additionally operated. 10
13. Method according to any of the preceding claims, wherein during the operation of the laundry treatment apparatus (2) the cooling capacity of the cooling fan unit (53) is varied in dependency of at least one of the following input variables: 15
 - a previous operation time of the laundry treatment apparatus (2), 20
 - a user selectable input variable,
 - a working parameter of the heat pump system (4), 25
 - a working parameter of the laundry drum (18), 30
 - a working parameter of a process air fan (8), 35
 - a working parameter of an electric driving motor,
 - a working parameter of the compressor (14), 40
 - power supply supplied to the apparatus,
 - a drying progress status parameter or a status parameter of the laundry (19) to be treated, and 45
 - an environment parameter of the laundry treatment apparatus environment.
14. Method according to any of the preceding claims, wherein the laundry treatment apparatus (2) comprises a temperature detector for detecting a temperature of the heat pump system (4), and wherein the method further comprises: 50
 - detecting the temperature of the refrigerant fluid, 55
 - and
 - activating the cooling fan unit when a predeter-

mined maximum temperature is detected and deactivating the cooling fan unit when a minimum temperature is detected.

15. Heat pump laundry treatment apparatus, in particular a heat pump laundry dryer (2) or a heat pump washing machine having drying function, wherein the laundry treatment apparatus (2) comprises:
 - a control unit (51) controlling the operation of the laundry treatment apparatus (2),
 - a laundry treatment chamber (18) for treating laundry (19) using process air (A),
 - a process air circuit (20, 20a - 20d) for circulating the process air (A),
 - a heat pump system (4) having a refrigerant loop (6), in which the refrigerant fluid is circulated through a first and a second heat exchanger (10, 12),
 - a compressor (14) for circulating the refrigerant fluid through the refrigerant loop (6), and
 - a cooling fan unit (53) for cooling the compressor (14);
 - wherein the control unit (51) is adapted to control the operation of the laundry treatment apparatus (2) according to any of the preceding method claims.

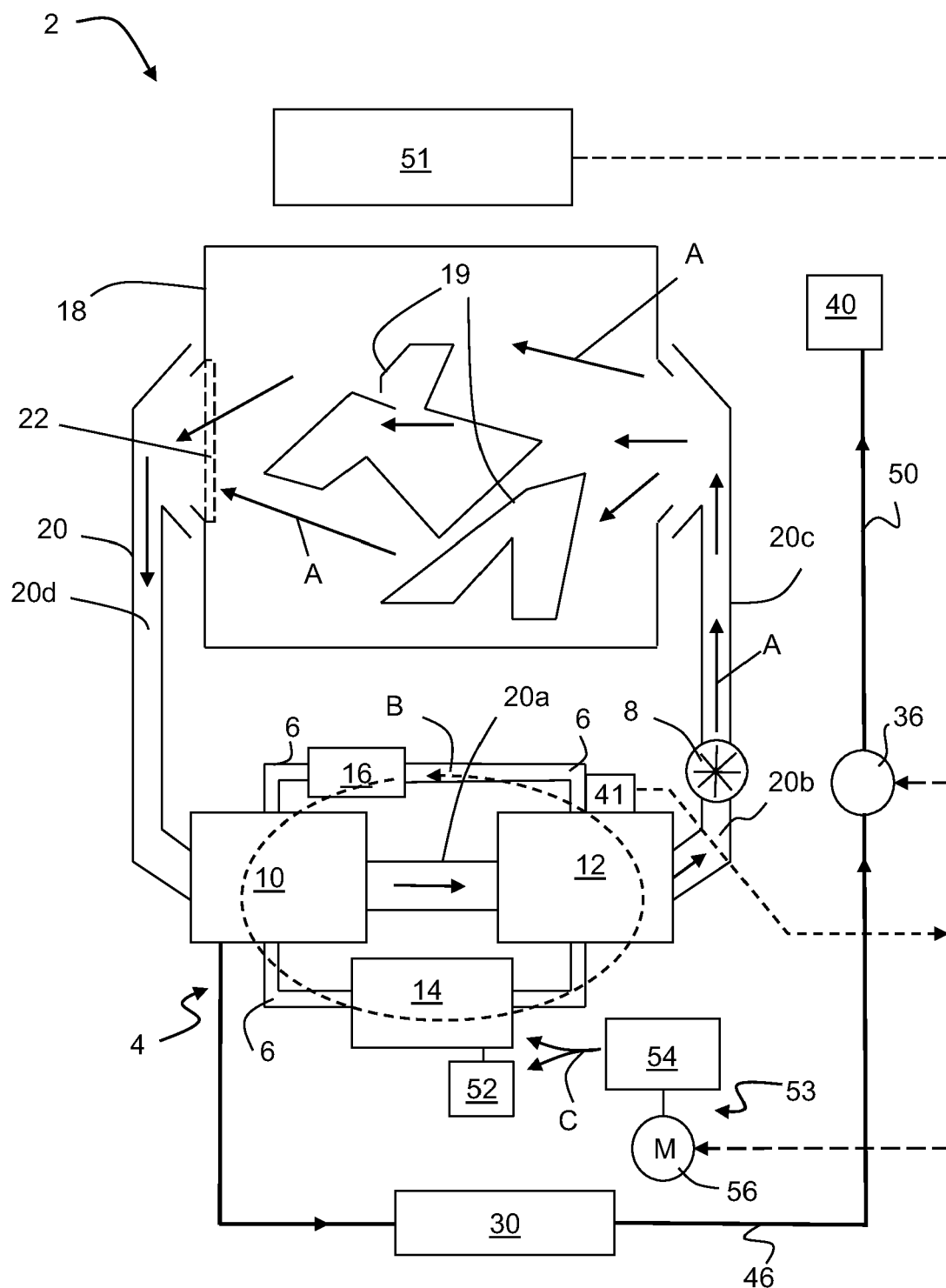


Fig. 1

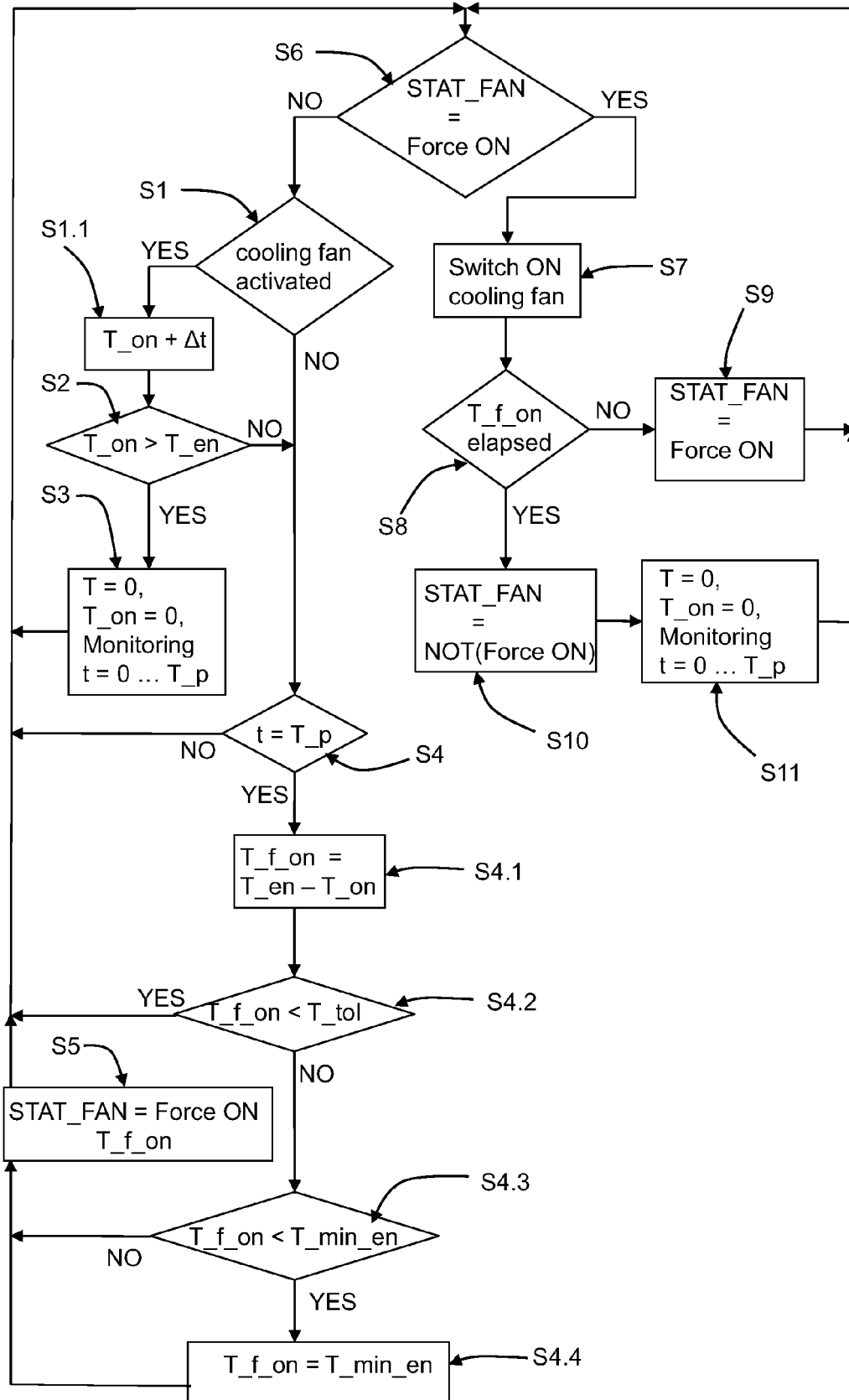


Fig. 2



EUROPEAN SEARCH REPORT

Application Number
EP 12 19 2960

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 March 2013	Examiner Spitzer, Bettina
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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20-03-2013

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