(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 692 940 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.02.2014 Bulletin 2014/06

(51) Int Cl.:
D06F 58/24 *(2006.01)* ***D06F 58/26*** *(2006.01)*
D06F 58/20 *(2006.01)*

(21) Application number: **12178467.2**

(22) Date of filing: **30.07.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **Electrolux Home Products Corporation N.V.**
1130 Brussel (BE)

(72) Inventors:
- **Cavarretta, Francesco**
  33080 Porcia (PN) - Italy (IT)
- **Vignocchi, Massimiliano**
  33080 Porcia (PN) (IT)

(74) Representative: **Markovina, Paolo et al**
Electrolux Italia S.p.A.
Corso Lino Zanussi 30
33080 Porcia (PN) (IT)

(54) **Method for drying laundry in a laundry drying machine and laundry drying machine**

(57) The present invention relates to a laundry drying machine (1) comprising a laundry chamber (9) suitable for receiving the laundry to be dried and an air stream circuit (10) for circulating an air stream through the laundry chamber (9). The air stream circuit (10) comprises a dehumidifying unit (23; 123) for dehumidifying the moist air of the air stream coming from the laundry chamber (9) and a heating unit (21; 121) for heating up the dehumidified air leaving the dehumidifying unit (23; 123) and conveyable into the laundry chamber (9). A first air circulation path (25) connects the laundry chamber (9) to the dehumidifying unit (23; 123) and a second air circulation path (26) connects the heating unit (21) to the laundry chamber (9). The machine (1) comprises an auxiliary heat transferring circuit (50) suitable for transferring heat from the first air circulation path (25) to the second air circulation path (26).

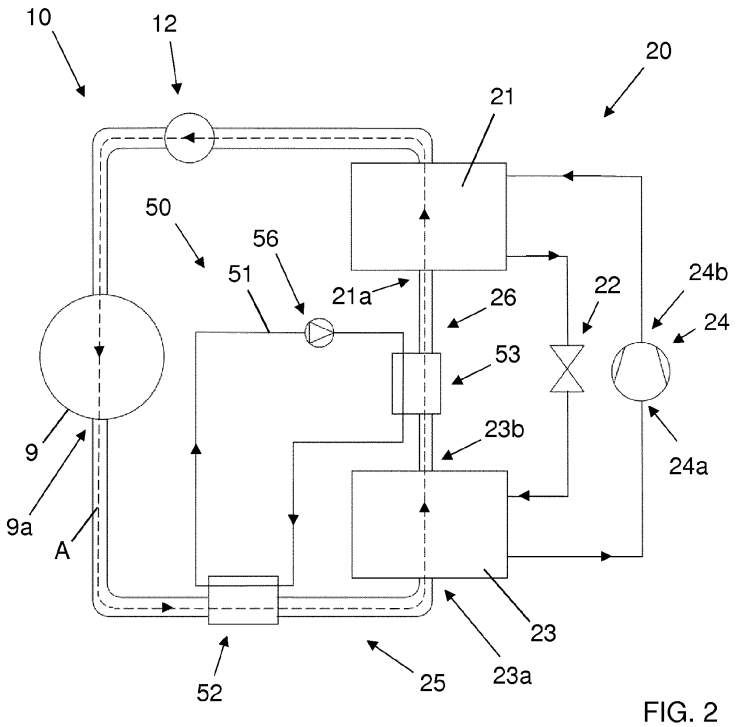


FIG. 2

EP 2 692 940 A1

Description

FIELD OF THE INVENTION

[0001] The present invention concerns the technical field of laundry treating machines, especially laundry drying machines.

[0002] In particular, the present invention refers to a method for drying laundry in laundry drying machines of the condenser type and such laundry drying machines.

BACKGROUND ART

[0003] Laundry treating machines capable of carrying out a drying process on laundry generally comprise a casing that houses a laundry container, like a rotating drum, where laundry to be treated is received and a closed air stream circuit for carrying out drying operation by circulating hot air through the laundry container containing the wet laundry.

[0004] A heating device for heating up the air stream is advantageously arranged upstream of the rotating drum.

[0005] An air circulating device, typically a fan, is provided in the air stream circuit for circulating the hot hair.

[0006] Known laundry drying machines, hereinafter referred simply as dryers, further comprise condensing means provided in the air stream circuit for removing moisture from warm humid air that leaves the drum. The warm humid air is both cooled down and dehumidified by the condensing means.

[0007] In a first type of dryers of known type the heating device and the condensing means are, respectively, the condenser and the evaporator of a heat pump system. In said heat pump system a compressor connects the evaporator outlet to the condenser inlet while expansion means, for example an expansion valve, connects the condenser outlet to the evaporator inlet.

[0008] In a second type of dryers of known type the heating device and the condensing means comprises, respectively, an electrical heater which heats up the air stream and a heat exchanger (typically an air-ait heat exchanger) which dehumidifies the humid air.

[0009] It is known that the drying process in the dryers of the known type requires a large amount of energy. Also, it is know that a drying process in dryers of the known type requires a large amount time. This determines high cost for the user. It is desirable, therefore, to optimize the drying process, in particular in view of energy efficiency.

[0010] It is therefore an object of the present invention to provide a method for drying laundry in a laundry drying machine and a laundry drying machine with higher energy efficiency compared to the known technique.

[0011] Another object of the present invention is to provide a laundry drying machine which has reduced dimensions compared to the systems of known type.

[0012] Advantages, objects, and features of the invention will be set forth in part in the description and drawings which follow and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention.

DISCLOSURE OF INVENTION

[0013] The applicant has found that by providing a laundry drying machine comprising a laundry chamber suitable for receiving the laundry to be dried, an air stream circuit for circulating an air stream through said laundry chamber, wherein the stream circuit comprises a dehumidifying unit for dehumidifying the moist air of said air stream coming from said laundry chamber and a heating unit for heating up the dehumidified air leaving said dehumidifying unit and conveyable into said laundry chamber and by providing an auxiliary heat transferring circuit suitable for transferring heat from said air stream coming from said laundry to said dehumidified air leaving said dehumidifying unit it is possible to obtain a laundry drying machine having a higher energy efficiency compared to the known technique.

[0014] In a first aspect the present invention relates, therefore, to a laundry drying machine comprising a laundry chamber suitable for receiving the laundry to be dried, an air stream circuit for circulating an air stream through said laundry chamber, said air stream circuit comprising:

- a dehumidifying unit for dehumidifying the moist air of said air stream coming from said laundry chamber;
- a heating unit for heating up the dehumidified air leaving said dehumidifying unit and conveyable into said laundry chamber;
- a first air circulation path connecting said laundry chamber to said dehumidifying unit;
- a second air circulation path connecting said heating unit to said laundry chamber;

wherein the machine comprises an auxiliary heat transferring circuit suitable for transferring heat from said first air circulation path to said second air circulation path.

[0015] Preferably, the heat transferring circuit comprises a closed loop circuit. Preferably, the heat transferring circuit comprises a first auxiliary heat exchanger suitable for transferring heat from the first air circulation path to the closed loop circuit.

[0016] In a preferred embodiment of the invention, the first auxiliary heat exchanger comprises an air-fluid exchanger.

[0017] Preferably, the heat transferring circuit comprises a second auxiliary heat exchanger suitable for transferring heat from the closed loop circuit to the second air circulation path.

[0018] In a preferred embodiment of the invention, the second auxiliary heat exchanger comprises a fluid-air exchanger.

[0019] Advantageously, the closed loop circuit comprises a secondary fluid flowing therein.

[0020] Opportunely, the secondary fluid comprises a liquid or a gas, preferably comprises water.

[0021] According to a preferred embodiment of the invention, the closed loop circuit comprises a fluid circulating device for circulating the secondary fluid inside the closed loop circuit.

[0022] Advantageously, the fluid circulating device comprises a pump.

[0023] In a first preferred embodiment of the invention, the dehumidifying unit comprises a first heat exchanger of a heat pump system.

[0024] Preferably, the first heat exchanger is an evaporator or a gas heater.

[0025] In a first preferred embodiment of the invention, the heating unit comprises a second heat exchanger of a heat pump system.

[0026] Preferably, the second heat exchanger is a condenser or a gas cooler. Advantageously, the heat pump system further comprises a compressor and an expansion device.

[0027] According to a preferred embodiment of the invention, the air stream circuit further comprises an air circulating device for circulating air within the air stream circuit.

[0028] In a preferred embodiment of the invention, the machine comprises a control system suitable for activating and/or deactivating the auxiliary heat transferring circuit.

[0029] In a further aspect the present invention relates to a method for drying laundry in a laundry washing machine of the type comprising a laundry chamber suitable for receiving the laundry to be dried, an air stream circuit for circulating an air stream through said laundry chamber, said air stream circuit comprising:

- a dehumidifying unit for dehumidifying the moist air of said air stream coming from said laundry chamber;
- a heating unit for heating up the dehumidified air leaving said dehumidifying unit and conveyable into said laundry chamber;

said method comprising the steps of:

- dehumidifying the moist air of said air stream coming from said laundry chamber by means of said dehumidifying unit;
- heating up said the dehumidified air leaving said dehumidifying unit before it is conveyed into said laundry chamber;

wherein the method further comprises the step of transferring heat from said moist air of said air stream coming from said laundry chamber to said dehumidified air leaving said dehumidifying unit.

[0030] Preferably, the step of transferring heat comprises a step of extracting heat from the moist air of the air stream coming from the laundry chamber by means of a first auxiliary heat exchanger belonging to a closed loop auxiliary circuit and a step of releasing heat to the dehumidified air leaving the dehumidifying unit by means of a second auxiliary heat exchanger belonging to the closed loop auxiliary circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate possible embodiments of the invention and together with the description serve to explain the principles of the invention. In the drawings, corresponding characteristics and/or components are identified by the same reference numbers. In particular:

- Figure 1 shows a perspective view of a laundry drying machine according to a first embodiment of the invention;
- Figure 2 shows a schematic diagram of a preferred configuration of the laundry drying machine of Figure 1;
- Figure 3 shows a schematic diagram of a second preferred configuration of a laundry drying machine according to a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0032] The present invention has proved to be particularly successful when applied to a front-loading drying machine with a rotatable laundry container; however it is clear that the present invention can be applied as well to a top-loading drying machine and also to laundry drying machines of cabinet type, i.e. laundry drying machines where the laundry container does not rotate. Furthermore, the present invention can be usefully applied to all the machines requiring a drying phase for wetted clothes, as for example a combined laundry washing and drying machine. With reference to Figure 1, reference number 1 indicates as a whole a laundry drying machine 1, or dryer, according to the present invention.

[0033] The dryer 1 preferably comprises, though not necessarily, a substantially parallelepiped-shaped outer boxlike casing 2 which is preferably structured for resting on the floor and a preferably, though not necessarily, substantially cylindrical rotatable drum 9 which is structured for housing the laundry to be dried. The drum 9 preferably has its front opening or mouth directly facing a laundry loading/unloading pass-through opening provided in the front wall 2a of the boxlike casing 2. A front door 8, pivotally coupled to the front upright side wall 2a, is provided for allowing access to the drum interior region to place laundry to be dried therein.

[0034] The dryer 1 preferably furthermore comprises an electric motor assembly, not illustrated, which is structured for driving into rotation the rotatable drum about its longitudinal reference axis, preferably by means of a belt/

pulley system.

[0035] The dryer 1 is provided with an air stream circuit 10 which is structured to circulate inside the drum 9 a stream of hot air having a low moisture content. The hot air circulates over and through the laundry located inside the drum 9 to dry the laundry.

[0036] The air stream circuit 10 is also structured for drawing moist air from the drum 9, cooling down the moist air leaving the drum 9 so to extract and retain the surplus moisture. The dehumidified air is then heated up to a predetermined temperature preferably higher than that of the moist air arriving from the drum 9. Finally the heated, dehumidified air is conveyed again into the drum 9, where it flows over and through the laundry stored inside the rotatable drum 9 to rapidly dry the laundry, as said above.

[0037] The air stream circuit 10 forms therefore a closed loop for the air A, as schematically illustrated with dashed line in Figure 2.

[0038] A fan 12 is preferably arranged along the circuit 10 for generating the air stream, more preferably upstream of the drum 9. The fan 12 is adapted and designed for circulating the air within the air stream circuit 10.

[0039] Preferably, and more particularly, the air stream circuit 10 comprises a dehumidifying unit 23 arranged downstream of the drum 9 and a heater unit 21 arranged downstream of the dehumidifying unit 23 and upstream of the drum 9. It is underlined that in the present application the terms "upstream" and "downstream" are referred to the flowing direction of the air, heated air and/or moist air, during the standard functioning of the dryer; for example saying that the fan is arranged upstream of the drum means that in the standard functioning of the dryer the air firstly passes through the fan and then flows into the drum; saying that the dehumidifying unit is arranged downstream of the drum means that in the standard functioning of the dryer the air firstly circulates inside the drum and then passes through the dehumidifying unit.

[0040] The dehumidifying unit 23 is preferably connected to the drum 9 by means of a first air circulation path 25. The dehumidifying unit 23, therefore, preferably comprises an inlet 23a connected to an outlet 9a of the drum 9.

[0041] The dehumidifying unit 23 is preferably connected to the heating unit 21 by means of a second air circulation path 26. The dehumidifying unit 23, therefore, preferably comprises an outlet 23a connected to an inlet 21a of the heating unit 21.

[0042] In the dehumidifying unit 23 the moist air condenses and the water generated therein is preferably collected in a tank, not illustrated, arranged below the unit itself 23.

[0043] In the preferred embodiment here described, the dehumidifying unit 23 is the evaporator of a heat pump system 20 and the heating unit 21 is the condenser of such heat pump system 20.

[0044] Therefore, the evaporator 23 dehumidifies the moist air coming from the drum 9 and then the condenser 21 heats up the dehumidified air coming from the evaporator 23. The heated air is then conveyed again into the drum 9.

[0045] The heat pump system 20 with its evaporator 23 and condenser 21, therefore, interacts with the air stream circuit 10. In fact, the air stream circuit 10 and the heat pump system 20 are thermally coupled by the condenser 21 and the evaporator 23.

[0046] The warm moist air which leaves the drum at a first high temperature T1 when passes through the dehumidifying unit 23 is cooled down and then dehumidified so that, at the dehumidifying output 23b, it is at a lower temperature T2.

[0047] When the warm moist air passes from temperature T1 to temperature T2 it firstly exchanges sensible heat to its surroundings and then it exchanges latent heat during condensation in the dehumidifying unit 23, i.e. when the water vapour condenses to a liquid onto the surfaces of the evaporator. This happens when the warm moist air reaches its saturation condition, i.e. when its temperature falls down to the saturation temperature Ts.

[0048] The heat pump system 20 advantageously comprises, other than the condenser 21 and the evaporator 23, an expansion device 22 and a compressor 24. The heat pump system 20 forms also a closed loop.

[0049] The expansion device 22 preferably comprises a capillary tube. In different embodiments the expansion device may be of different type, for example an expansion valve.

[0050] The condenser 21 and the evaporator 23 are heat exchangers. Preferably such heat exchangers are of the serpentine type, comprising respective pipe corrugated in a zigzag pattern.

[0051] An evaporating and condensing fluid, known as refrigerant, flows in the heat pump system 20. In the heat pump system 20 schematically illustrated in Figure 2 the refrigerant flows counter-clockwise in a closed loop.

[0052] The refrigerant is compressed and heated by the compressor 24. From the compressor outlet 24b the heated refrigerant in its gaseous state reaches the condenser 21. In the condenser 21 the refrigerant condenses and cools down while the air stream of the air stream circuit 10 which is blown across the condenser 21 is heated up. The condensed refrigerant then passes through the expansion device 22 where its pressure abruptly decreases and resulting in a mixture of liquid and vapour at a lower temperature and pressure. The cold liquid-vapour mixture from the expansion device outlet then travels through the evaporator 23 and here is heated up and vaporized. This is obtained thanks to the warm moist air of the air stream circuit 10 coming from the drum 9 which is blown across the evaporator 23. The warm moist air coming from the drum 9 at the same time is cooled down and dehumidified, as said above. The resulting refrigerant vapour is then conveyed from the evaporator outlet 23b to the compressor inlet 24a and compressed and heated again by the compressor 24.

[0053] In different embodiments, the heat pump sys-

tem may comprises a gas cooler instead of the condenser and may comprises a gas heater instead of the evaporator. In this case the refrigerant is advantageously a gas, such as CO_2, which maintains its gaseous state along all the closed-loop circuit, and in particular in the gas cooler and in the gas heater. In this type of heat pump system the gas temperature changes while passing through the gas cooler and the gas heater.

[0054] According to the invention, an auxiliary heat transferring circuit 50 interacts with the first air circulation path 25 and the second air circulation path 26 of the air stream circuit 10 so that heat is transferred from the warm moist air coming from the drum 9 to the dehumidified air leaving the evaporator 23.

[0055] The auxiliary heat transferring circuit 50 preferably comprises a secondary fluid flowing in a closed loop and thermally coupled with the first air circulation path 25 and the second air circulation path 26. The secondary fluid preferably flows inside a sealed duct 51, or pipe, and is thermally coupled to the first and second air circulation paths 25, 26 by means of respective first and second auxiliary heat exchangers 52 and 53.

[0056] The secondary fluid preferably comprises a liquid, more preferably it comprises water.

[0057] In this case, the first auxiliary heat exchanger 52 comprises an air-fluid exchanger and the second auxiliary heat exchanger 53 comprises a fluid-air exchanger.

[0058] In different embodiment, nevertheless, the secondary fluid may be different and comprising any fluid at a proper pressure suitable to transfer thermal energy, such as a vapour or a liquid-vapour mixture.

[0059] The secondary fluid is preferably moved inside the closed loop by means of a pump 56, more preferably a hydraulic pump.

[0060] In a preferred embodiment, the pump is arranged downstream the first auxiliary heat exchanger 52 and upstream the second auxiliary heat exchanger 53, as shown in Figure 2.

[0061] In a further preferred embodiment, not illustrated, the pump may be arranged downstream the second heat auxiliary exchanger and upstream the first auxiliary heat exchanger.

[0062] The heat of the warm moist air coming from the drum 9 is, hence, at least partially transferred to the secondary liquid by means of the first auxiliary heat exchanger 52 before the air reaches the evaporator 23.

[0063] Therefore the warm moist air is cooled down from temperature T1 to a lower intermediate temperature T1' before entering in the evaporator 23, while part of its thermal energy is released to the secondary fluid.

[0064] In other words, the warm moist air coming from the drum 9 before entering in the evaporator 23 is subjected to a pre-cooling by means of the first auxiliary heat exchanger 52

[0065] Advantageously, the warm moist air reaches the evaporator 23 at such lower intermediate temperature T1' which is close to, or preferably equal to, the saturation temperature Ts.

[0066] This is a particular favourable condition since the warm moist air can exchange latent heat in the evaporator 23 substantially from the beginning. This allows the reduction of energy required for the condensation in the evaporator 23, thus increasing the efficiency of the drying operation.

[0067] In particular, the heat pump system 20 may be designed for a lower nominal functioning power compared to the prior art system and may have therefore reduced dimension, for example having a smaller compressor.

[0068] Furthermore, , the reduction of energy required for condensation may advantageously implies the reduction of the condensation surface of the evaporator and, therefore, the reduction of its dimension. The overall dimension, and cost, of the machine may thus be reduced accordingly.

[0069] On the other hand, it is possible to increase the cooling power given to the air by keeping the same dimension of prior art system. In this way the drying time and the energy consumption level is reduced and the machine has a higher energy efficiency compared to the machine of the known type.

[0070] Once the dehumidified air leaves the evaporator 23 at temperature T2 and flows inside the second circulating path 26, the dehumidified air according to the invention is partially warmed up by the second auxiliary heat exchanger 53.

[0071] A quantity of heat from the secondary liquid is therefore transferred by means of the second auxiliary heat exchanger 53 to the dehumidified air before it reaches the condenser 21. Advantageously, the dehumidified air enters in the condenser 21 at a higher value T2' with respect to the know technique.

[0072] In other words, the dehumidified air leaving the evaporator 23 before entering in the condenser 21 is subjected to a pre-heating by means of the second auxiliary heat exchanger 53.

[0073] Advantageously, the warmed air at the condenser output which is conveyed inside the drum 9, has a higher value with respect the temperature of the known technique. This advantageously increases the drying effect of the hot dry air circulating over and through the wet laundry and/or advantageously reduces the duration of the drying process.

[0074] On the other hand, if the temperature of the air which is conveyed inside the drum 9 is maintained at the same value as in the known machine, less energy is required for heating the dehumidified air, thus increasing the efficiency of the drying operation or, alternatively, allowing the reduction of the condenser dimension. The overall dimension, and therefore the cost, of the machine may thus be reduced accordingly.

[0075] In particular, the heat pump system 20 may be designed for a lower nominal functioning power compared to the prior art system and may have therefore reduced dimension, for example having a smaller compressor.

[0076] In a preferred embodiment of the invention, not illustrated herein, the auxiliary heat transferring circuit 50 may be preferably controlled in order to be activated and/or deactivated at a given time.

[0077] In particular, at the beginning of the drying phase the auxiliary heat transferring circuit 50 is preferably kept deactivated (switched-off) while the heat pump system 20 is working in its transitional state. When the heat pump system 20 reaches its steady state, the auxiliary heat transferring circuit 50 is advantageously activated.

[0078] In this case, the heat pump system 20 may work more efficiently.

[0079] With reference to Figure 3 a further preferred configuration of a laundry drying machine according to the invention is described.

[0080] The configuration refers to a laundry drying machine which differs from the laundry drying machine 1 previously described for the fact that the dehumidifying unit 123 advantageously comprises an air-air heat exchanger and the heating unit 121 comprises an electrical heater device, preferably an electric heating element such as a resistor.

[0081] The air-air heat exchanger 123 is in the form of an air-air cross-flow type heat exchanger wherein the moist air crossing the exchanger 123 is cooled by an air cooling flow F, preferably ambient air, passing through the exchanger 123 itself and not mixing with the moist air.

[0082] The air-air heat exchanger 123, as for the previous described embodiment, is connected to the drum 9 by means of the first air circulation path 25 and the air-air heat exchanger 123 is connected to the electrical heater 121 by means of the second air circulation path 26.

[0083] According to the invention, the auxiliary heat transferring circuit 50 interacts with the first air circulation path 25 and the second air circulation path 26 of the air stream circuit 10 so that heat is transferred from the warm moist air coming from the drum 9 to the dehumidified air leaving the air-air heat exchanger 123. The heat of the warm moist air coming from the drum 9 is, hence, at least partially transferred to the secondary liquid by means of the first auxiliary heat exchanger 52 before the air reaches the air-air heat exchanger 123.

[0084] Therefore the warm moist air is cooled down from temperature T1 to a lower intermediate temperature T1' before entering in the air-air heat exchanger 123, while part of its thermal energy is released to the secondary fluid of the heat transferring circuit 50.

[0085] Advantageously, the warm moist air reaches the air-air heat exchanger 123 at such lower intermediate temperature T1' which is close to, or preferably equal to, the saturation temperature Ts.

[0086] This is a particular favourable condition since the warm moist air can exchange latent heat in the air-air heat exchanger 123 substantially from the beginning. This allows the reduction of energy required for the condensation in the air-air heat exchanger 123, thus increasing the efficiency of the drying operation.

[0087] In particular, the air cooling flow F of the air-air heat exchanger 123 may have a reduced mass flow rate compared to the prior art system and may have therefore reduced dimension, for example having smaller conveying ducts for the air cooling flow F or having air forcing means, typically a fan, of reduced dimension and/or nominal power.

[0088] Furthermore , the reduction of energy required for condensation may advantageously implies the reduction of the condensation surface of the air-air heat exchanger 123 and therefore the reduction of its dimension.

[0089] The overall dimension, and cost, of the machine may thus be reduced accordingly.

[0090] On the other hand, it is possible to increase the cooling power given to the air by keeping the same dimension of prior art system. In this way the drying time and the energy consumption level is reduced and the machine has a higher energy efficiency compared to the machine of the known type.

[0091] Once the dehumidified air leaves the air-air heat exchanger 123 at temperature T2 and flows inside the second circulating path 26, the dehumidified air according to the invention is partially warmed up by the second auxiliary heat exchanger 53.

[0092] A quantity of heat from the secondary liquid is therefore transferred by means of the second auxiliary heat exchanger 53 to the dehumidified air before it reaches the electrical heater 121. Advantageously, the dehumidified air enters in the electrical heater 121 at a higher value T2' with respect to the know technique. Advantageously, the warmed air at the electrical heater output which is conveyed inside the drum 9, has a higher value with respect the temperature of the known technique. This advantageously increases the drying effect of the hot dry air circulating over and through the wet laundry and/or advantageously reduces the duration of the drying process.

[0093] On the other hand, if the temperature of the air which is conveyed inside the drum 9 is maintained at the same value as in the known machine, less energy is required for heating the dehumidified air, thus increasing the efficiency of the drying operation. In particular, the power dissipation of the electrical heater 121 may be lower with respect the known machine.

[0094] In a preferred embodiment of the invention, not illustrated herein, the auxiliary heat transferring circuit 50 may be preferably controlled in order to be activated and/or deactivated at a given time.

[0095] In particular, at the beginning of the drying phase the auxiliary heat transferring circuit 50 is preferably kept deactivated (switched-off) for a given period of time (transitional phase) while the electrical heater 121 reaches its steady state. The auxiliary heat transferring circuit 50 is advantageously activated after the transitional phase.

[0096] It has thus been shown that the present invention allows all the set objects to be achieved. In particular, it makes it possible to obtain a laundry drying machine

having a higher energy efficiency compared to the systems of known type. Clearly, changes may be made to the laundry drying machine as described herein without, however, departing from the scope of the present invention.

[0097] For example, the dehumidifying unit and the heating unit may be of any type and different from the units above described.

[0098] Although illustrative embodiments of the present invention have been described herein with reference to the accompany drawings, it is to be understood that the present invention is not limited to those precise embodiments, and that various other changes and modifications may be affected therein by one skilled in the art without departing from the scope or spirit of the invention. All such changes and modifications are intended to be included within the scope of the invention as defined by the appended claims.

Claims

1. A laundry drying machine (1) comprising a laundry chamber (9) suitable for receiving the laundry to be dried, an air stream circuit (10) for circulating an air stream through said laundry chamber (9), said air stream circuit (10) comprising:

   - a dehumidifying unit (23; 123) for dehumidifying the moist air of said air stream coming from said laundry chamber (9);
   - a heating unit (21; 121) for heating up the dehumidified air leaving said dehumidifying unit (23; 123) and conveyable into said laundry chamber (9);
   - a first air circulation path (25) connecting said laundry chamber (9) to said dehumidifying unit (23; 123);
   - a second air circulation path (26) connecting said heating unit (21) to said laundry chamber (9);

   characterized by comprising an auxiliary heat transferring circuit (50) suitable for transferring heat from said first air circulation path (25) to said second air circulation path (26).

2. A machine (1) according to claim 1, **characterized in that** said heat transferring circuit (50) comprises a closed loop circuit.

3. A machine (1) according to claim 2, **characterized in that** said heat transferring circuit (50) comprises a first auxiliary heat exchanger (52) suitable for transferring heat from said first air circulation path (25) to said closed loop circuit.

4. A machine (1) according to claim 2 or 3, **characterized in that** said heat transferring circuit (50) comprises a second auxiliary heat exchanger (53) suitable for transferring heat from said closed loop circuit to said second air circulation path (26).

5. A machine (1) according to any claims from 2 to 4, **characterized in that** said closed loop circuit comprises a secondary fluid flowing therein.

6. A machine (1) according to claim 5, **characterized in that** said secondary fluid comprises a liquid or a gas, preferably comprises water.

7. A machine (1) according to claim 5 or 6, **characterized in that** said closed loop circuit comprises a fluid circulating device (56) for circulating said secondary fluid inside said closed loop circuit.

8. A machine (1) according to claim 7, **characterized in that** said fluid circulating device (56) comprises a pump.

9. A machine (1) according to any preceding claim, **characterized in that** said dehumidifying unit (23; 123) comprises a first heat exchanger (23) of a heat pump system (20).

10. A machine (1) according to claim 9, **characterized in that** said first heat exchanger (23) is an evaporator (23) or a gas heater.

11. A machine (1) according to any preceding claim, **characterized in that** said heating unit (21; 121) comprises a second heat exchanger (21) of a heat pump system.

12. A machine (1) according to claim 11, **characterized in that** said second heat exchanger (21) is a condenser (21) or a gas cooler.

13. A machine (1) according to any claims from 9 to 12, **characterized in that** said heat pump system (20) further comprises a compressor (24) and an expansion device (22).

14. A machine (1) according to any preceding claim, **characterized in that** said air stream circuit (10) further comprises an air circulating device (12) for circulating air within said air stream circuit (10).

15. Method for drying laundry in a laundry washing machine (1) of the type comprising a laundry chamber (9) suitable for receiving the laundry to be dried, an air stream circuit (10) for circulating an air stream through said laundry chamber (9), said air stream circuit (10) comprising:

   - a dehumidifying unit (23; 123) for dehumidify-

ing the moist air of said air stream coming from said laundry chamber (9);
- a heating unit (21; 121) for heating up the dehumidified air leaving said dehumidifying unit (23; 123) and conveyable into said laundry chamber (9);

said method comprising the steps of:

- dehumidifying the moist air of said air stream coming from said laundry chamber (9) by means of said dehumidifying unit (23; 123);
- heating up said the dehumidified air leaving said dehumidifying unit (23) before it is conveyed into said laundry chamber (9);

characterized in that the method further comprises the step of transferring heat from said moist air of said air stream coming from said laundry chamber (9) to said dehumidified air leaving said dehumidifying unit (23; 123).

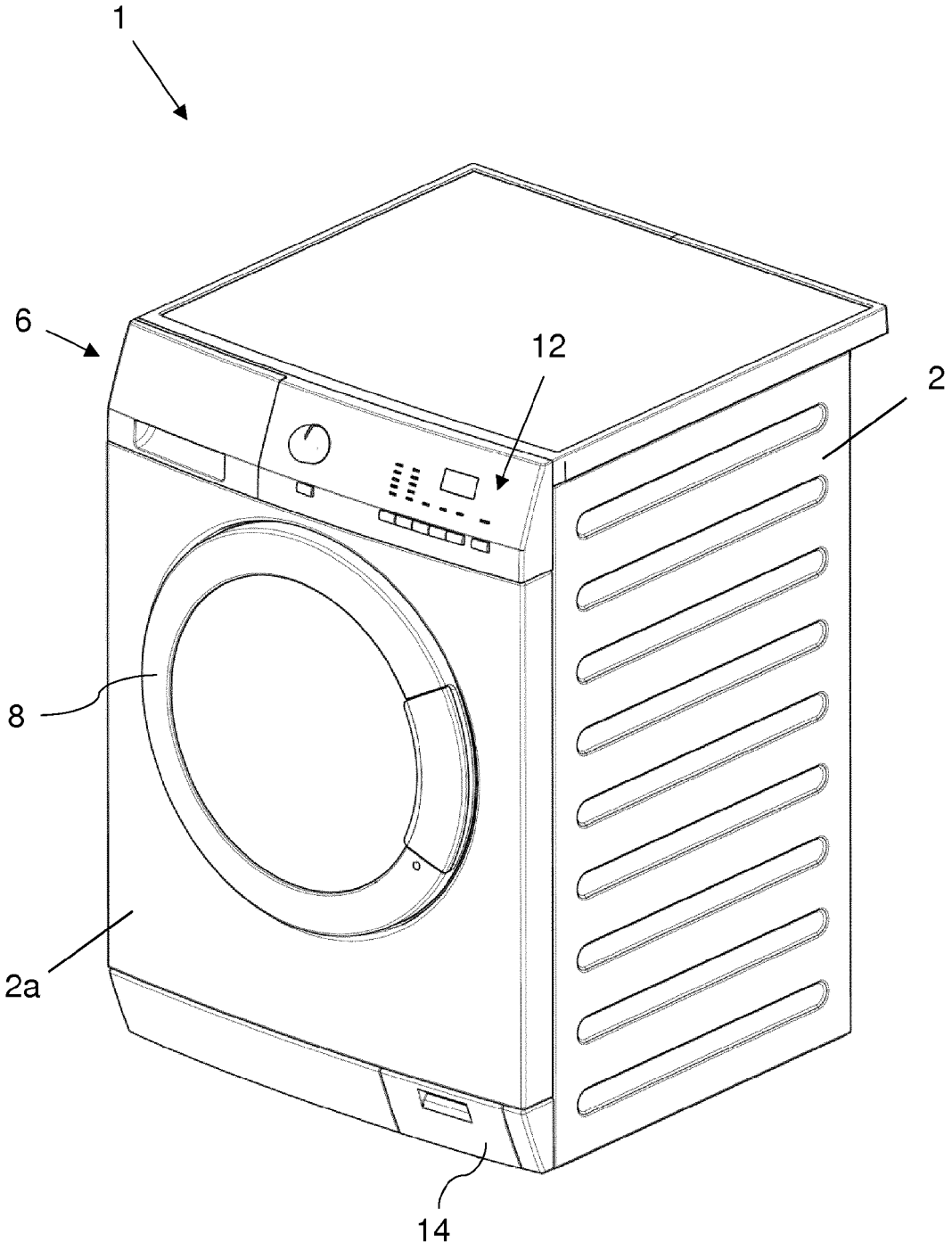


FIG. 1

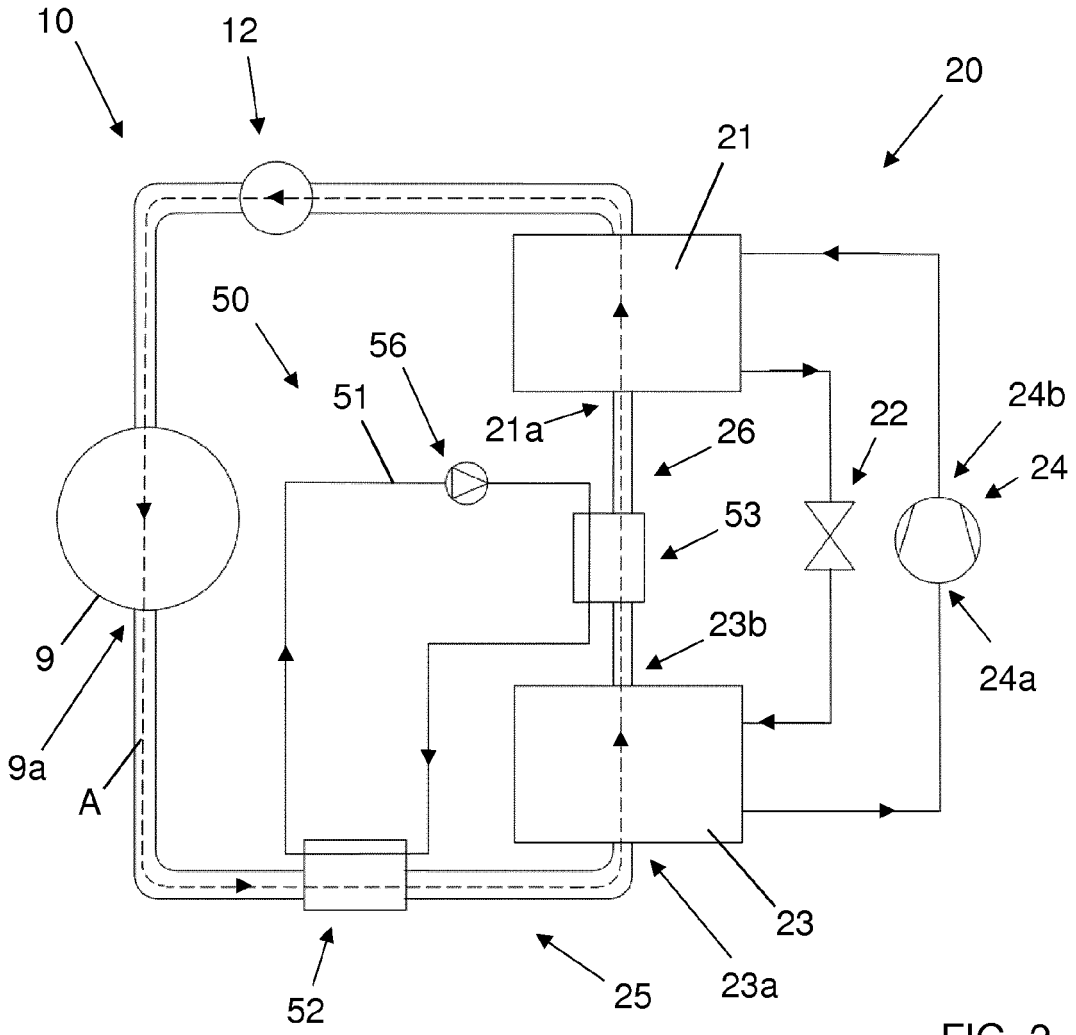


FIG. 2

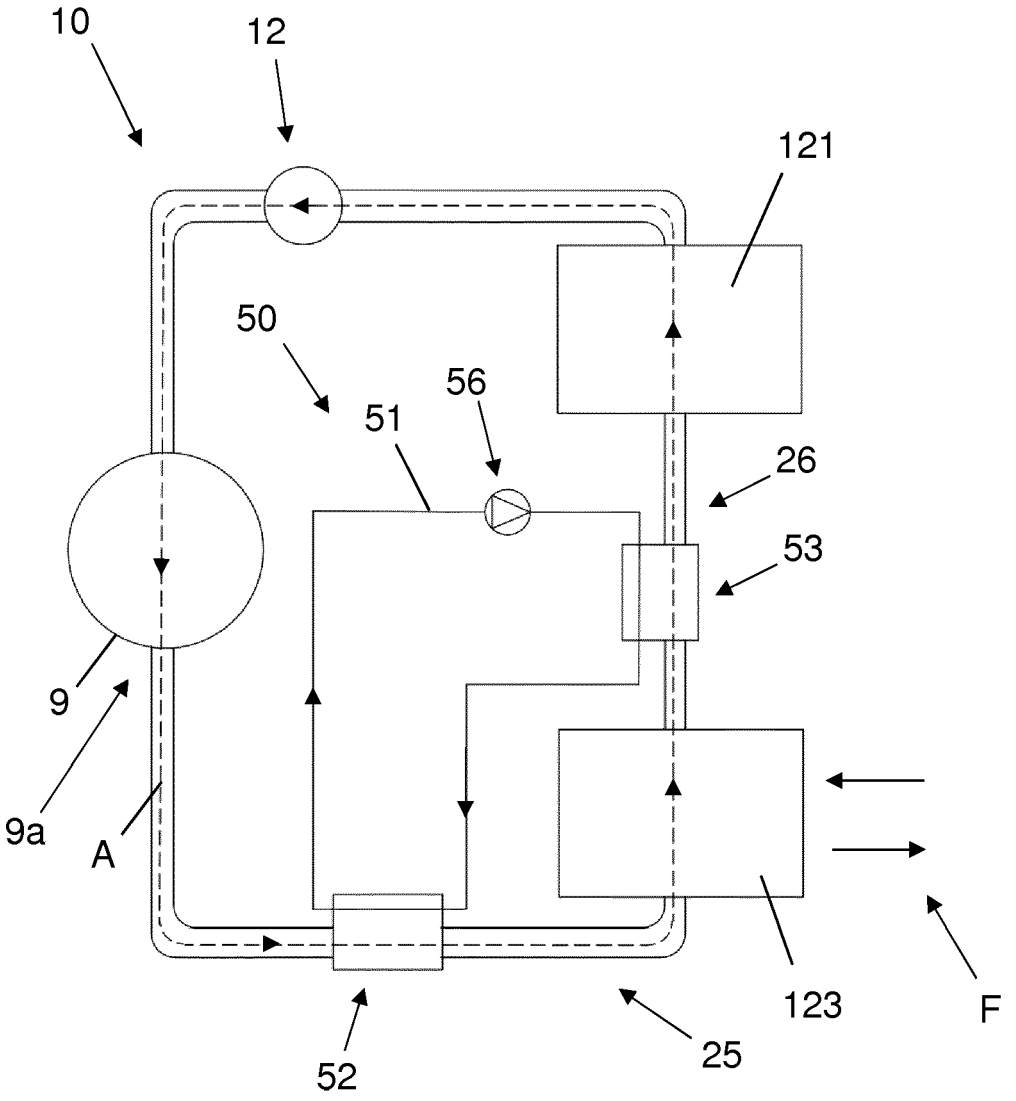


FIG. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 17 8467

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 29 14 859 A1 (BAUKNECHT GMBH G) 30 October 1980 (1980-10-30) * the whole document * -----	1-15	INV. D06F58/24 D06F58/26 D06F58/20
X	GB 2 092 729 A (TECHNOSCRIPT AB) 18 August 1982 (1982-08-18) * the whole document * -----	1-15	
X	US 2005/066538 A1 (GOLDBERG MICHAEL [US] ET AL) 31 March 2005 (2005-03-31) * paragraphs [0052] - [0130]; figures 1-9 * -----	1-15	
X	WO 2010/140334 A1 (PANASONIC CORP [JP]; NISHIDA HIROFUMI; KURAKAKE TOSHIYUKI) 9 December 2010 (2010-12-09) * abstract; figures * -----	1-15	
X	DE 43 06 215 A1 (LICENTIA GMBH [DE]) 1 September 1994 (1994-09-01) * the whole document * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
A	GB 2 375 812 A (DBK TECHNITHERM LTD [GB]) 27 November 2002 (2002-11-27) * the whole document * -----	1-15	D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 December 2012	Prosig, Christina

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

1 EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 17 8467

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-12-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2914859 A1	30-10-1980	DE 2914859 A1	30-10-1980
		ES 8101155 A1	01-03-1981
		FR 2453930 A1	07-11-1980
		IT 1141565 B	01-10-1986
GB 2092729 A	18-08-1982	GB 2092729 A	18-08-1982
		SE 8100042 A	08-07-1982
US 2005066538 A1	31-03-2005	AU 2004277943 A1	14-04-2005
		BR PI0414841 A	21-11-2006
		CA 2540368 A1	14-04-2005
		EP 1667566 A2	14-06-2006
		JP 2007531552 A	08-11-2007
		KR 20060083424 A	20-07-2006
		US 2005066538 A1	31-03-2005
		US 2006179676 A1	17-08-2006
		WO 2005032322 A2	14-04-2005
WO 2010140334 A1	09-12-2010	CN 102803882 A	28-11-2012
		WO 2010140334 A1	09-12-2010
DE 4306215 A1	01-09-1994	NONE	
GB 2375812 A	27-11-2002	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82