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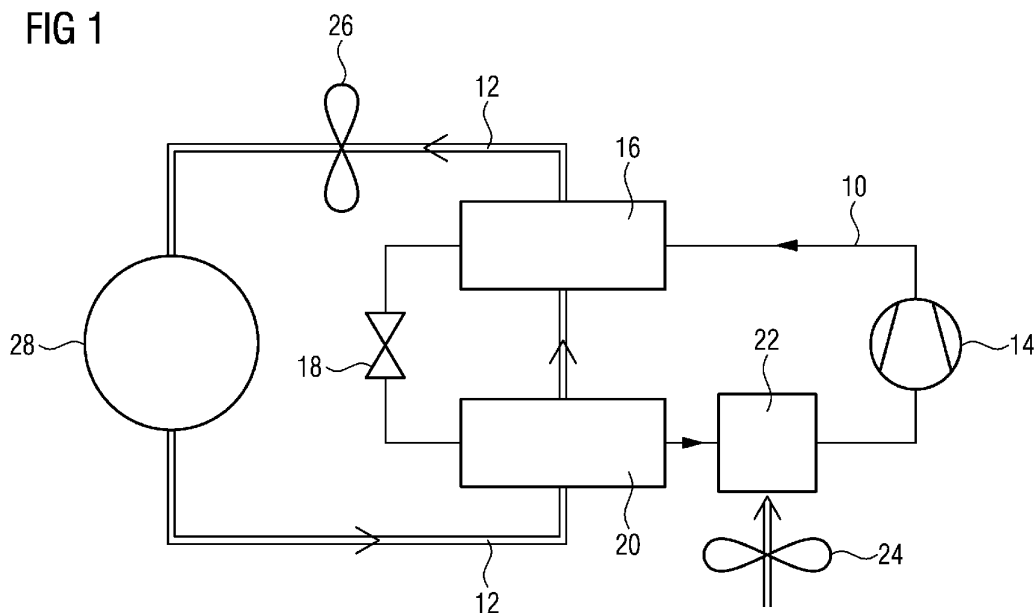
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(54) **A laundry dryer with heat pump system**

(57) The present invention relates to a laundry dryer or a spinner-washer with a heat pump system. The heat pump system comprises a refrigerant circuit (10) for a refrigerant and a drying air circuit (12) for an air stream. The refrigerant circuit (10) includes a compressor (14), a first heat exchanger (16), expansion means (18) and a second heat exchanger (20) connected in series and forming a closed loop. The drying air circuit (12) includes the first heat exchanger (16), at least one air stream fan (30), a laundry drum (28) and the second heat exchanger (20) connected in series and forming a closed loop. The refrigerant circuit (10) and the drying air circuit (12) are

thermally coupled by the first heat exchanger (16) and the second heat exchanger (20). The first heat exchanger (16) is provided for heating up the air stream and cooling down the refrigerant. The second heat exchanger (20) is provided for cooling down the air stream and heating up the refrigerant. The refrigerant circuit (10) includes at least one additional heat exchanger (22) connected between the outlet of second heat exchanger (20) and the inlet of the compressor (14) and is controlled or controllable by the temperature of the refrigerant in at least one position of the refrigerant circuit (10) and/or by the temperature of the drying air.

FIG 1



Description

[0001] The present invention relates to a laundry dryer with a heat pump system according to the preamble of claim 1. Further, the present invention relates to a controller for a laundry dryer.

[0002] In a laundry dryer, the heat pump technology is the most efficient way to save energy. The operation of the laundry dryer with the heat pump system includes two working phases, namely a transitory phase and a steady state phase. The transitory phase is the initial phase after the heat pump system has been switched on. Before the heat pump system starts, the temperatures of the air and the refrigerant are at ambient temperature. During the transitory phase, the temperatures of the air and the refrigerant increase up to a desired level. During the steady state phase, the temperatures of the drying air and the refrigerant are kept quiet constant. For example, said temperatures are kept constant by means of an compressor cooling fan or an auxiliary condenser until the laundry becomes dry.

[0003] The heat pump is in unbalanced, because the same drying air stream is cooled in the evaporator and heated in the condenser, where more heating capacity is available on the side of the refrigerant circuit. The heating power at the condenser is in fact higher than the cooling power at the evaporator, since $P_{\text{condenser}} = P_{\text{cooling}} + P_{\text{compressor}}$

[0004] This results in a continuous increasing of the temperature and pressure of the refrigerant of the heat pump system. The compressor cooling fan, the auxiliary condenser and/or other means stabilize the temperature and pressure of the heat pump during steady state phase

[0005] The compressor cooling fan blows ambient air onto the compressor case. Thus, the power given from the compressor itself to the refrigerant is reduced, since a part of the power absorbed by the compressor is wasted by convection. The auxiliary condenser is an additional heat exchanger between the refrigerant and an auxiliary cold source. The auxiliary condenser is arranged downstream the condenser. In the auxiliary condenser the refrigerant is further cooled down, wherein heat is transferred to a source, which may be water or ambient air. Thus, the refrigerant enters the evaporator in more favourable conditions. The cooling capacity is increased. Also the balancing between the cooling and heating capacity is increased.

[0006] The condenser is a heat exchanger at the high pressure side of the refrigerant circuit. The evaporator is a heat exchanger at the low pressure side of the refrigerant circuit.

[0007] The low pressure side of the refrigerant circuit extends from the outlet of the expansion means, e.g. a capillary tube or an adjustable valve, to the inlet of the compressor. The high pressure side of the refrigerant circuit extends from the outlet of the compressor to the inlet of the expansion means.

[0008] An internal heat exchanger can be used to cool

down the refrigerant between the condenser and expansion means and to heat up the refrigerant at the outlet of the evaporator.

[0009] The internal heat exchanger allows the refrigerant to enter the evaporator in more favourable conditions. The vapour quality is lower and a part of the refrigerant is in the liquid phase, wherein the cooling capacity of the evaporator is increased. Otherwise the temperature of the refrigerant at the outlet of the low pressure side of the internal heat exchanger, which enters the inlet of the compressor, is higher, and the power required to the compressor increases as well. If cooling capacity increases more than the power required by the compressor, then the internal heat exchanger improves heat pump efficiency.

[0010] The internal heat exchanger in a heat pump system of a tumble dryer allows a shorter transitory phase on the one hand and an improved heat pump performance during the steady state phase on the other hand. The internal heat exchanger can additionally improve the heat pump performance more than usual, if said internal heat exchanger is used to flood the evaporator, so that a part of the refrigerant flowing through the evaporator is maintained in the liquid phase. This occurs, if the superheating phase in the evaporator is provided at the low pressure side of the internal heat exchanger.

[0011] Condensed refrigerant is cooled down as usual in the high pressure side of the internal heat exchanger, while in the low pressure side of the internal heat exchanger the vaporization of the refrigerant is completed and the superheating is performed. Therefore the evaporator improves its cooling performance, because the flooding allows a big heat exchange coefficient of the refrigerant in the liquid phase and the internal heat exchanger can improve the refrigerant sub-cooling at the high pressure side, since at the low pressure side of the internal heat exchanger the refrigerant can exchange both latent and sensible heat, so that more energy is available.

[0012] EP 999 302 B1 discloses a laundry dryer with a closed process air cycle and a refrigerant circuit. A heat flow correction element is incorporated into the refrigerant circuit between the evaporator and the compressor. The heat flow correction element allows a heat exchange between the refrigerant on the one hand and the process air and/or the ambient air on the other hand.

[0013] It is an object of the present invention to provide a laundry dryer with a heat pump system, wherein the heat pump performance is improved by low complexity.

[0014] The object of the present invention is achieved by the laundry dryer with the heat pump system according to claim 1.

[0015] According to the present invention the additional heat exchanger is connected between the outlet of second heat exchanger and the inlet of the compressor and is controlled or controllable by the temperature of the refrigerant in at least one position of the refrigerant circuit and/or by the temperature of the drying air.

[0016] The present invention is based on the additional heat exchanger cooling down the refrigerant before compressor suction, wherein said additional heat exchanger is controlled by the temperature of the refrigerant and/or by the temperature of the drying air. The required power of the compressor decreases by the reduced temperature of the refrigerant after passing the additional heat exchanger.

[0017] Preferably, the additional heat exchanger is provided for a heat exchange between the refrigerant on the one hand and ambient air and/or cooling water on the other hand.

[0018] In particular, the additional heat exchanger corresponds with at least one ambient air fan.

[0019] For example, the additional heat exchanger, the ambient air fan and/or the cooling water are controlled or controllable by the temperature of the refrigerant at an inlet and/or at an outlet of the compressor. The additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched on, if the temperature of the refrigerant at the inlet of the compressor becomes higher than a predetermined value. Said predetermined value may be within a range between 20 °C and 45 °C, especially between 25 °C and 40 °C, in particular between 30 °C and 36 °C. The additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched off, if the temperature of the refrigerant at the inlet of the compressor becomes lower than the previous value minus between 0 °C and 5 °C. Further, the additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched on, if the temperature of the refrigerant at the outlet of the compressor becomes higher than a predetermined value. Said predetermined value may be within a range between 50 °C and 110 °C, especially between 60 °C and 100 °C, in particular between 70 °C and 90 °C. The additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched off, if the temperature of the refrigerant at the inlet of the compressor becomes lower than the previous value minus between 0 °C and 5 °C.

[0020] According to another example, the additional heat exchanger, the ambient air fan and/or the cooling water are controlled or controllable by the temperature of the refrigerant at an inlet and/or at an outlet of the second heat exchanger. The temperature of the refrigerant at the outlet of the second heat exchanger and at the inlet of the additional heat exchanger are identical, if not any further component is arranged between them. In a similar way, the temperature of the refrigerant at the outlet of the second heat exchanger and at the inlet of the compressor are identical, if the additional heat exchanger is switched off and no further component is arranged between them.

[0021] Further, the additional heat exchanger, the ambient air fan and/or the cooling water may be controlled or controllable by the temperature of the refrigerant at an inlet of the additional heat exchanger. In this case, the

additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched on, if the temperature of the refrigerant at the inlet of the additional heat exchanger becomes higher than a predetermined value. Said predetermined value may be within a range between 20 °C and 60 °C, especially between 25 °C and 50 °C, in particular between 30 °C and 36 °C. The additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched off, if the temperature at the inlet of the compressor becomes lower than the previous value minus between 0 °C and 5 °C.

[0022] Moreover, the additional heat exchanger, the ambient air fan and/or the cooling water may be controlled or controllable by the temperature of the refrigerant at an outlet of the first heat exchanger. In this case, the additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched on, if the temperature of the refrigerant at the outlet of the first heat exchanger becomes higher than a predetermined value. Said predetermined value may be within a range between 40 °C and 65 °C, in particular between 50 °C and 55 °C. The additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched off, if the temperature of the refrigerant at the inlet of the compressor becomes lower than the previous value minus between 0 °C and 5 °C.

[0023] Further, the additional heat exchanger, the ambient air fan and/or the cooling water may be controlled or controllable by the temperature of the air stream at an inlet of the laundry treatment chamber. In this case, the additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched on, if the temperature of the air stream at the inlet of the laundry drum becomes higher than a predetermined value. Said predetermined value may be within a range between 50 °C and 75 °C, in particular between 55 °C and 65 °C. The additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched off, if the temperature of the refrigerant at the inlet of the compressor becomes lower than the previous value minus between 0 °C and 5 °C.

[0024] Additionally or alternatively, the additional heat exchanger, the ambient air fan and/or the cooling water may be controlled or controllable by the difference between the temperatures of the refrigerant at the inlet of the compressor and an inlet of the second heat exchanger.

[0025] Further, the additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched on, if the difference between the temperatures of the refrigerant at the inlet of the additional heat exchanger and at the inlet of the second heat exchanger becomes higher than a predetermined value. Said predetermined value may be within a range between 5 °C and 60 °C, in particular between 10 °C and 50 °C. The additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched off, if said difference becomes lower than the previous value minus

between 0 °C and 5 °C.

[0026] In a similar way, the additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched on, if the difference between the temperatures of the refrigerant at the inlet and the outlet of the second heat exchanger becomes higher than a predetermined value.

[0027] Said predetermined value may be within a range between 0 °C and 25 °C, in particular between 10 °C and 15 °C. The additional heat exchanger, the ambient air fan and/or the cooling water, respectively, may be switched off, if said difference becomes lower than the previous value minus between 0 °C and 5 °C.

[0028] In particular, a low pressure portion and a high pressure portion of the refrigerant circuit are thermally coupled by at least one internal heat exchanger.

[0029] Thereby, the low pressure portion may extend between the outlet of the expansion means and the inlet of the compressor, and the high pressure portion may extend between the outlet of the compressor and the inlet of the expansion means.

[0030] For example, a high pressure side of the internal heat exchanger is interconnected between an outlet of the first heat exchanger and the inlet of the expansion means.

[0031] Further, a low pressure side of the internal heat exchanger may be interconnected between an outlet of the second heat exchanger and an inlet of the additional heat exchanger.

[0032] The at least one ambient air fan may be switched or switchable in an on-off mode depending on at least one temperature of the refrigerant.

[0033] Alternatively or additionally, the speed of the at least one ambient air fan is continuously variable depending on at least one temperature of the refrigerant.

[0034] Further, the present invention relates to a controller for a laundry dryer or a spinner-washer with a heat pump system mentioned above, wherein the controller is provided for controlling the additional heat exchanger in response to the temperature of the refrigerant in at least one position of the refrigerant circuit.

[0035] The novel and inventive features believed to be the characteristic of the present invention are set forth in the appended claims.

[0036] The invention will be described in further detail with reference to the drawings, in which

FIG 1 shows a schematic diagram of a heat pump system for a laundry dryer according to a first embodiment of the present invention,

FIG 2 shows a schematic pressure-enthalpy-diagram of a refrigerant in the heat pump system according to the first embodiment of the present invention, and

FIG 3 shows a schematic diagram of the heat pump system for the laundry dryer according to a sec-

ond embodiment of the present invention.

[0037] FIG 1 illustrates a schematic diagram of a heat pump system for a laundry dryer according to a first embodiment of the present invention. The heat pump system includes a closed refrigerant circuit 10 and a, preferably, closed drying air circuit 12.

[0038] The refrigerant circuit 10 includes a compressor 14, a condenser 16, expansion means 18, an evaporator 20 and an additional heat exchanger 22. The compressor 14, the condenser 16, the expansion means 18, the evaporator 20 and the additional heat exchanger 22 are switched in series and form a closed loop of the refrigerant circuit 10. The additional heat exchanger 22 corresponds with an ambient air fan 24.

[0039] The refrigerant circuit 10 is subdivided into a high pressure portion and a low pressure portion. The high pressure portion extends from the outlet of the compressor 14 via the condenser 16 to the inlet of the expansion means 18. The low pressure portion extends from the outlet of the expansion means 18 via the evaporator 20 and the additional heat exchanger 22 to the inlet of the compressor 14.

[0040] The refrigerant, for example carbon dioxide, can operate at a supercritical mode in the high pressure portion of the refrigerant circuit 10. In the high pressure portion the refrigerant is at least at the critical pressure and always in gas phase so that the condenser is better indicated as a gas cooler. In the low pressure portion of the refrigerant circuit 10 the refrigerant can also operate at the supercritical mode so that the evaporator is better indicated as a gas heater.

[0041] The drying air circuit 12 includes the compressor 14, a drying air stream fan 26, a laundry treatment chamber for accommodating the clothes 28, preferably a rotatable drum 28, the condenser 16 and the evaporator 20. The condenser 16 and the evaporator 20 are heat exchangers and form the thermal interconnections between the refrigerant circuit 10 and the drying air circuit 12. The evaporator 20 cools down and dehumidifies the drying air, after said drying air has passed the laundry drum 28. Then the condenser 16 heats up the air stream, before the drying air is re-inserted into the laundry drum 28. The drying air is driven by the drying air stream fan 26.

[0042] In the refrigerant circuit 10 a refrigerant is compressed by the compressor 14, condensed in the condenser 16, laminated in the expansion means 18, vaporised in the evaporator 20 and cooled down in the additional heat exchanger 22. The additional heat exchanger 22 cools down the refrigerant by ambient air before the suction by the compressor 14. The ambient air may be driven by the ambient air fan 24.

[0043] The required power of the compressor 14 decreases by the reduced temperature of the refrigerant after passing the additional heat exchanger 22. Considering the pressures in the high pressure portion and the low pressure portion of the refrigerant circuit 10 as constant, the lower the temperature of the refrigerant at the

inlet of the compressor 14, the lower the power for compressing the refrigerant by the compressor 14.

[0044] Further, the temperature at the inlet of the compressor 14 is kept within a predetermined range. On the one hand, the temperature of the refrigerant at the inlet of compressor 14 should not be too low, since refrigerant superheating is required to prevent liquid refrigerant from entering the compressor 14, thereby avoiding damages.

[0045] On the other hand, the temperature at the outlet of the compressor 14 could be too low, so that the refrigerant cannot heat up the drying air to the desired temperature via the condenser 16.

[0046] The temperature at the inlet of the compressor 14 is controlled by the ambient air fan 24. An upper limit of the predetermined range for the temperature at the inlet of the compressor 14 depends on the properties of said compressor 14. Usually, the upper limit for the temperature at the inlet of the compressor 14 is about 40°C. A lower limit of the predetermined range for the temperature at the inlet of the compressor 14 depends on several thermodynamic parameters, in particular on the pressure in the low pressure portion of the refrigerant circuit 10 and on the temperature at the inlet of the compressor 14. Said pressure and temperature determine whether the refrigerant is completely vaporized or not at the inlet of the compressor 14.

[0047] The operation cycle of the heat pump system is subdivided into a transitory phase and a steady state phase. The transitory phase is the initial phase after the heat pump system has been switched on. Before the heat pump system starts, the temperatures of the air stream and of the refrigerant are at ambient temperature. During the transitory phase, the temperatures of the air stream and the refrigerant increase up to a desired level.

[0048] The ambient air fan 24 of the additional heat exchanger 22 can work in an on-off mode or can be driven at a variable speed to maintain the temperature range at the compressor within predetermined value. During the steady state phase of the operation cycle the upper limit for the temperature range at the inlet of the compressor 14 is between 25°C and 40°C. The lower limit for the temperature range at the inlet of the compressor 14 is between 20°C and 35°C during the steady state phase of the operation cycle.

[0049] Additionally, the ambient air fan 24 of the additional heat exchanger 22 may be switched off, if the temperature of the refrigerant at the outlet of the compressor 14 becomes too low, for example below 70°C.

[0050] A further control strategy for the ambient air fan 24 of the additional heat exchanger 22 may be the maintaining of a minimum difference between the temperature of the refrigerant at the inlet of the compressor 14 and the temperature of the refrigerant at the inlet of the evaporator 20. Said minimum temperature difference is between 0°C and 10°C, preferably greater than 5°C. This minimum temperature difference assures a certain margin of superheating of the refrigerant before entering the compressor 14. If the actual temperature difference is

less than said minimum difference temperature value, then the ambient air fan 24 of the additional heat exchanger 22 is switched off.

[0051] The heat pump system comprises a set of temperature sensors within the refrigerant circuit 10 in order to detect the temperature of the refrigerant. In particular, the temperature sensors are arranged at the inlet of the compressor 14, at the inlet of the evaporator 20 and/or at the outlet of the compressor 14.

[0052] FIG 2 illustrates a schematic pressure-enthalpy-diagram of the refrigerant in the heat pump system according to the first embodiment of the present invention. The diagram shows the pressure p of the refrigerant as a function of the specific enthalpy h .

[0053] A curve 32 marks the limit between the portions of the sub-critical conditions and the over-critical conditions of the refrigerant. The sub-critical conditions of the refrigerant occur within the portion inside the curve 32. The over-critical conditions occur in the portion outside the curve 32.

[0054] A first state a and a modified first state a' , respectively, correspond with the refrigerant at the inlet of the condenser 16. A second state b corresponds with the refrigerant at the outlet of the condenser 16. A third state c corresponds with the refrigerant at the inlet of the evaporator 20. A fourth state d and a modified fourth state d' , respectively, corresponds with the refrigerant at the inlet of the compressor 14. The modified first state a' and the modified fourth state d' occur, when the ambient air fan 24 of the additional heat exchanger 22 is switched on.

[0055] When the ambient air fan 24 of the additional heat exchanger 22 is switched off, then the refrigerant follows the cycle with the states a , b , c , d and a again. When the ambient air fan 24 of the additional heat exchanger 22 is switched on, then the refrigerant follows the cycle with the states a' , b , c , d , d' and a' again.

[0056] When the ambient air fan 24 of the additional heat exchanger 22 is switched off, then an unbalancing of the heat pump system is proportional to the difference between the segments $a-b$ and $c-d$ of the diagram in FIG 2. When the ambient air fan 24 of the additional heat exchanger 22 is switched on, then the unbalancing of the heat pump system is proportional to the difference between the segments $a'-b$ and $c-d$ in the diagram of FIG 2. Thus, when the ambient air fan 24 of the additional heat exchanger 22 is switched on, then the unbalancing of the heat pump system is reduced.

[0057] Further, the power absorbed by the compressor 14 is reduced, when the ambient air fan 24 of the additional heat exchanger 22 is switched on. In this case, the compressor 14 transfers the refrigerant from a modified fourth state d' to the modified first state a' , instead of a transfer from the fourth state d to the first state a .

[0058] FIG 3 illustrates a schematic diagram of a heat pump system for a laundry dryer according to a second embodiment of the present invention. The heat pump system includes the closed refrigerant circuit 10 and the, preferably closed drying air circuit 12. Unlike the first em-

bodiment of the present invention, the second embodiment includes additionally an internal heat exchanger 30.

[0059] The refrigerant circuit 10 includes the compressor 14, the condenser 16, the expansion means 18, the evaporator 20, the additional heat exchanger 22 and the internal heat exchanger 30. The compressor 14, the condenser 16, a high pressure side of the internal heat exchanger 30, the expansion means 18, the evaporator 20, a low pressure side of the internal heat exchanger 30, and the additional heat exchanger 22 are switched in series and form the closed loop of the refrigerant circuit 10. The additional heat exchanger 22 corresponds with the ambient air fan 24.

[0060] The drying air circuit 12 includes the compressor 14, an air stream fan 26, a laundry drum 28, the compressor 14 and the evaporator 20. The condenser 16 and the evaporator 20 are heat exchangers and form the thermal interconnections between the refrigerant circuit 10 and the drying air circuit 12. The evaporator 20 cools down and dehumidifies an air stream, after said air stream has passed the laundry drum 28. Then the condenser 16 heats up the air stream, before the air stream is re-inserted into the laundry drum 28. The air stream is driven by the air stream fan 26.

[0061] In the refrigerant circuit 10 the refrigerant is compressed by the compressor 14, condensed in the condenser 16, cooled down in the high pressure side of the internal heat exchanger 30, laminated in the expansion means 18, vaporised in the evaporator 20, heated up in the low pressure side of the internal heat exchanger 30 and cooled down in the additional heat exchanger 22. The additional heat exchanger 22 cools down the refrigerant by ambient air before the suction by the compressor 14. The ambient air may be driven by the ambient air fan 24.

[0062] The internal heat exchanger 30 allows a heat exchange between the high pressure portion and the low pressure portion of the refrigerant circuit 10. The high pressure portion of the second embodiment extends from the outlet of the compressor 14 via the condenser 16 and the high pressure side of the internal heat exchanger 30 to the inlet of the expansion means 18. The low pressure portion of the second embodiment extends from the outlet of the expansion means 18 via the evaporator 20, the low pressure side of the internal heat exchanger 30 and the additional heat exchanger 22 to the inlet of the compressor 14.

[0063] The ambient air fan 24 of the additional heat exchanger 22 is controlled in the same way as in the first embodiment as described above. The internal heat exchanger 30 cools down the refrigerant in the low pressure portion additionally by the refrigerant in the high pressure portion.

[0064] Although illustrative embodiments of the present invention have been described herein with reference to the accompanying 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.

List of reference numerals

[0065]

- 10 refrigerant circuit
- 12 drying air circuit
- 14 compressor
- 16 condenser, first heat exchanger
- 18 expansion means
- 20 evaporator, second heat exchanger
- 22 additional heat exchanger
- 24 ambient air fan
- 26 air stream fan
- 28 laundry drum
- 30 internal heat exchanger
- 32 curve between sub- and over-critical conditions
- a first state of the refrigerant
- a' modified first state of the refrigerant
- b second state of the refrigerant
- c third state of the refrigerant
- d fourth state of the refrigerant
- d' modified fourth state of the refrigerant
- h specific enthalpy of the refrigerant
- p pressure of the refrigerant

Claims

1. A laundry dryer with a heat pump system, said heat pump system comprises a refrigerant circuit (10) for a refrigerant and an drying air circuit (12) for drying air, wherein

- the refrigerant circuit (10) includes a compressor (14), a first heat exchanger (16), expansion means (18) and a second heat exchanger (20) connected in series and forming a closed loop,
- the drying air circuit (12) includes the first heat exchanger (16), at least one air stream fan (30), a laundry treatment chamber (28) and the second heat exchanger (20) connected in series and forming a closed loop,
- the refrigerant circuit (10) and the drying air circuit (12) are thermally coupled by the first heat exchanger (16) and the second heat exchanger (20),
- the first heat exchanger (16) is provided for heating up the air stream and cooling down the refrigerant,
- the second heat exchanger (20) is provided for cooling down the drying air and heating up the refrigerant, and
- the refrigerant circuit (10) includes at least one additional heat exchanger (22),

characterized in, that

the additional heat exchanger (22) is connected between the outlet of second heat exchanger (20) and the inlet of the compressor (14) and is controlled or controllable by the temperature of the refrigerant in at least one position of the refrigerant circuit (10) and/or by the temperature of the drying air.

2. The heat pump system according to claim 1, **characterized in, that**
the additional heat exchanger (22) is provided for a heat exchange between the refrigerant on the one hand and ambient air and/or cooling water on the other hand.
3. The heat pump system according to claim 1 or 2, **characterized in, that**
the additional heat exchanger (22) corresponds with at least one ambient air fan (26).
4. The heat pump system according to any one of the preceding claims, **characterized in, that**
the additional heat exchanger (22), the ambient air fan (26) and/or the cooling water are controlled or controllable by the temperature of the refrigerant at an inlet and/or at an outlet of the compressor (14).
5. The heat pump system according to any one of the preceding claims, **characterized in, that**
the additional heat exchanger (22), the ambient air fan (26) and/or the cooling water are controlled or controllable by the temperature of the refrigerant at an inlet and/or at an outlet of the second heat exchanger (20).
6. The heat pump system according to any one of the preceding claims, **characterized in, that**
the additional heat exchanger (22), the ambient air fan (26) and/or the cooling water are controlled or controllable by the temperature of the refrigerant at an inlet of the additional heat exchanger (22).
7. The heat pump system according to any one of the preceding claims, **characterized in, that**
the additional heat exchanger (22), the ambient air fan (26) and/or the cooling water are controlled or controllable by the temperature of the refrigerant at an outlet of the first heat exchanger (16).
8. The heat pump system according to any one of the preceding claims, **characterized in, that**
the additional heat exchanger (22), the ambient air fan (26) and/or the cooling water are controlled or controllable by the temperature of the drying air at an inlet of the laundry treatment chamber (28).
9. The heat pump system according to any one of the preceding claims, **characterized in, that**
the additional heat exchanger (22), the ambient air fan (26) and/or the cooling water are controlled or controllable by the difference between the temperatures of the refrigerant at the inlet of the additional heat exchanger (22) and at the inlet of the second heat exchanger (20).
10. The heat pump system according to any one of the preceding claims, **characterized in, that**
the additional heat exchanger (22), the ambient air fan (26) and/or the cooling water are controlled or controllable by the difference between the temperatures of the refrigerant at the inlet of the additional heat exchanger (22) and at the inlet of the second heat exchanger (20).
11. The heat pump system according to any one of the preceding claims, **characterized in, that**
a low pressure portion and a high pressure portion of the refrigerant circuit (10) are thermally coupled by at least one internal heat exchanger (30) having a high pressure side interconnected between an outlet of the first heat exchanger (16) and the inlet of the expansion means (18) and a low pressure side interconnected between an outlet of the second heat exchanger (20) and an inlet of the additional heat exchanger (22).
12. The heat pump system according to any one of the

claims 3 to 11,

characterized in, that

the at least one ambient air fan (26) is switched or switchable in an on-off mode and/or the speed of said ambient air fan (26) is continuously variable depending on at least one temperature of the refrigerant and/or drying air. 5

13. A controller for a laundry dryer or a spinner-washer with a heat pump system according to any one of the claims 1 to 14, 10

characterized in, that

the controller is provided for controlling the additional heat exchanger (22) in response to the temperature of the refrigerant in at least one position of the refrigerant circuit (10). 15

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FIG 1

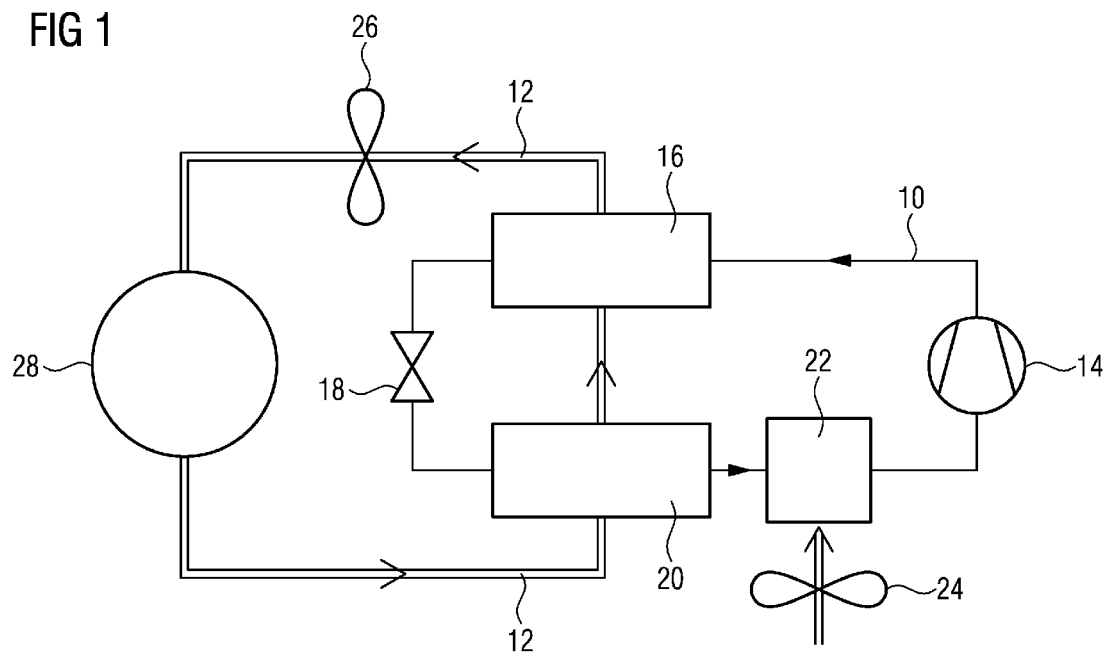


FIG 2

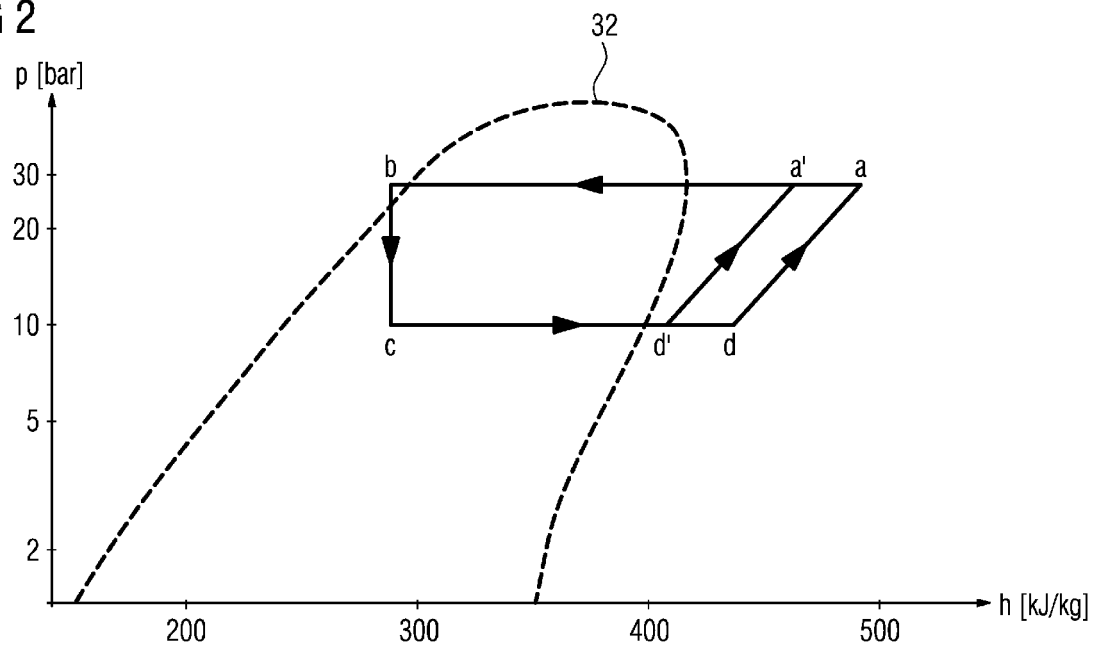
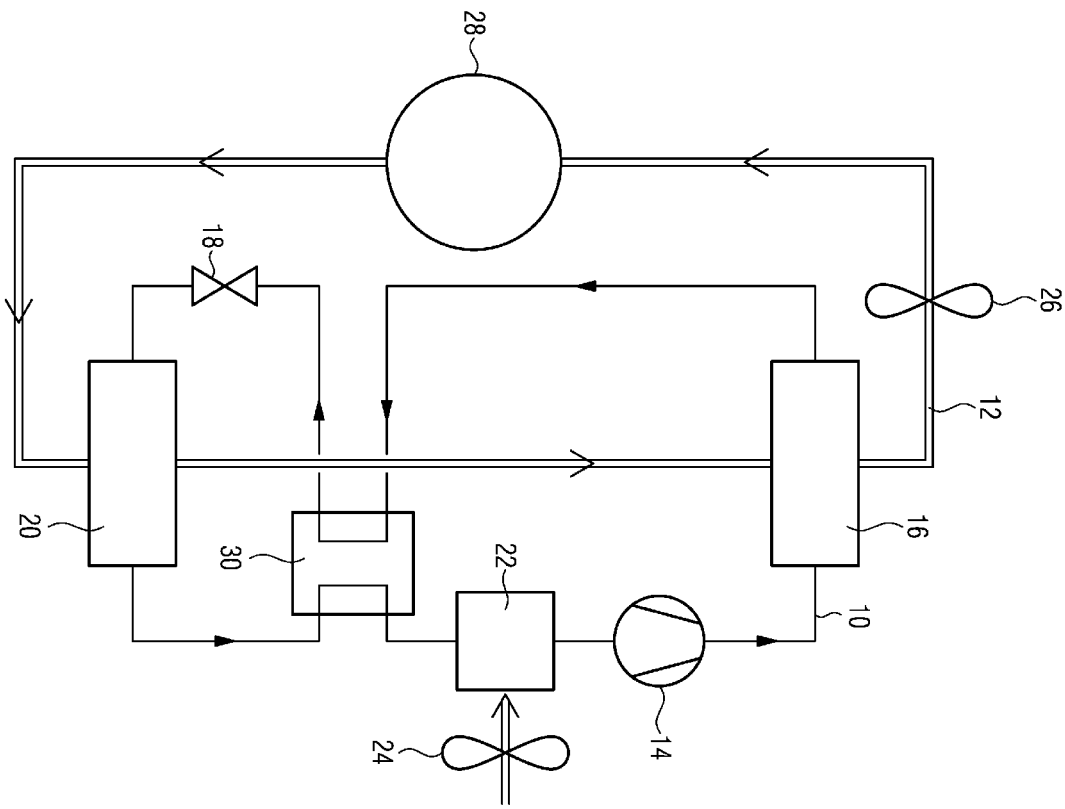


FIG 3





EUROPEAN SEARCH REPORT

Application Number
EP 11 17 1923

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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